ARC

Asthma Regional Council

Investing in Best Practices for Asthma:

A Business Case for Education and Environmental Interventions

Produced for the
Asthma Regional Council of New England
at The Medical Foundation,
in partnership with the
University of Massachusetts Lowell
and Children's Hospital Boston.

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Acknowledgments:

The Asthma Regional Council of New England (ARC) is a coalition of public agencies, NGO's and researchers that bring together the diverse organizational perspectives and resources of health, housing, education, and environment to focus on the environmental contributors to asthma. Leaders with knowledge, resources, and determination have joined forces to swiftly identify and implement solutions to improve the lives of people with asthma. ARC is a program of The Medical Foundation.

Over the past few years, ARC has partnered with the University of Massachusetts Lowell's Environmental Health Initiative (UMass Lowell) and the U.S. Department of Health and Human Services, Region I (New England) to conduct research, disseminate information and encourage collaboration in the health sector to improve asthma outcomes. Our focus has been to promote continual improvement of asthma management, with a particular focus to embed asthma education and environmental trigger reduction in standard medical care, consistent with NAEPP guidelines. Payers, providers, purchasers, policy-makers, patients and their advocates all have a role to play in improving asthma management, but they need evidence-based information to do the right thing.

To that end, ARC and UMass Lowell sought funding and input from Children's Hospital Boston to produce a Business Case, which documents the health and cost benefits associated with best practices in asthma management, specifically asthma education programs that promote self-guided care in addition to home-based environmental trigger interventions where appropriate. The authors wish to express their appreciation to Lisa Mannix, Amy Burack, Joshua Greenberg, and Dr. Shari Nethersole at Children's Hospital Boston for their guidance. We also wish to thank Dr. James Lee at UMass Lowell for his valuable input. Funding for the development of this Business Case was provided by The Boston Foundation, Children's Hospital Boston and the U.S. Environmental Protection Agency, Region I. We also want to thank Betsy Rosenfeld, of the US Department of Health and Human Services, Region I (New England), for her support and guidance on this project.

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April 2007

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An increasingly robust evidence base shows widespread improvements in asthma patients' health when primary and specialist care are supplemented by in-depth asthma education, home assessment and mitigation of home-based triggers provided by a team of providers. Both the research and practice-based literature show that clinic-based education, in-home education and environmental interventions can markedly improve patients' quality of life, and often decrease medical encounters. Information on health outcomes has been summarized elsewhere.[1,2,3] The literature on the financial implications of these interventions is somewhat less extensive, but still makes a compelling case – from a business standpoint – for investing in asthma education and in-home environmental interventions, targeted to patients based on the severity of their disease and their utilization of health services. This paper presents a business case for asthma education and in-home environmental interventions and concludes that health payer organizations and policy makers will be well-served to invest in these effective asthma management strategies.

Asthma: A Chronic Disease out of Control

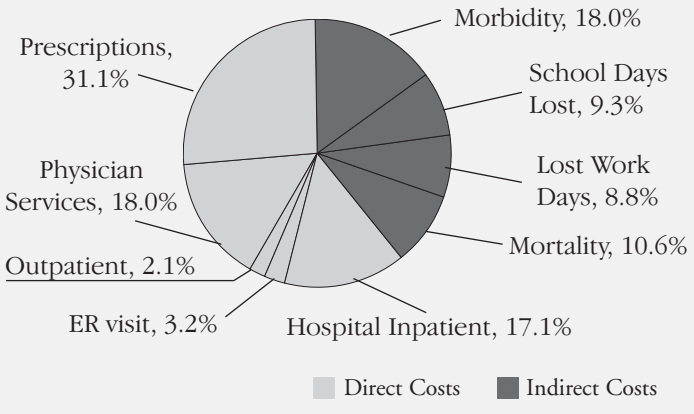
Rates of asthma have nearly doubled in the United States over the last few decades.[4] Today, asthma strikes nearly 11% of people living in the United States.[5] In New England, asthma is a disease out of control: the region has among the highest rates in the nation and rates are increasing.[6] According to the Asthma Regional Council, 2003-2004 New England statistics[6] demonstrate that uncontrolled asthma in both adults and children significantly impacts quality of life:

- sixty percent of children with asthma had an asthma attack and 33% of them used the ER in the past year;
- more than 35% of children with asthma have significant health difficulties because of their disease, according to their caregivers;
- children with asthma are roughly three times more likely to be depressed and unable to engage in activities than their peers;
- children covered by Medicaid have 31% higher rates of asthma than children with other insurance coverage
- low income non-Hispanic Black and Hispanic children and adults report significantly higher disease severity, burden and life limitations;
- nine percent of adults with asthma are unable to work and 21% of those categorized as unemployed have asthma; and
- nearly 33% of adults with asthma report being limited in their daily activities, and 17% report frequent mental distress – twice the rates of those without asthma.

In 2004, the nation spent over $16.1 billion on asthma-related direct and indirect expenditures (*Figure 1*). **For public and private payers of health care expenditures, preventable asthma-related costs include hospitalizations, emergency room visits and high use of asthma rescue medications.**

FIGURE 1:

Distribution of Asthma Costs in the US (2004): $16.1 Billion in Total Costs[7]



Best Practices for Improving Asthma Outcomes

It is useful to have a framework for advancing best practices. The widely respected National Asthma Education and Prevention Program's (NAEPP) *Guidelines for the Diagnosis and Management of Asthma*[8] outlines four vital components of effective asthma management including:

1) Use of objective measures of lung function to assess the severity of asthma and to monitor the course of therapy;
2) Comprehensive pharmacologic therapy for long-term management to reverse and prevent the airway inflammation characteristic of asthma, and pharmacologic therapy to manage asthma exacerbations;
3) Environmental control measures to avoid or eliminate factors that contribute to asthma severity; and
4) Patient education that fosters a partnership among the patient, his or her family, and clinicians.

Quality improvement initiatives by providers and payers have contributed to wider adoption of assessment/monitoring and appropriate prescribing of long-term controller and short-term rescue medications. Indeed, increased pharmaceuticals expenditures have accompanied reductions in health care utilization expenditures, reflecting more consistent and appropriate use of medications to prevent and treat asthma attacks.[9] However, health professionals have made less headway on implementing the last two elements of the national asthma management guidelines: control of environmental triggers (see Figure 2) and ensuring access to asthma education. As is the case with other complex and variable chronic conditions – such as diabetes – effective management of asthma often requires more time than a physician can typically provide in a standard reimbursable office or sick visit. Characteristics of and responses to asthma are highly individual, as are socio-economic and physical conditions that can mitigate or exacerbate symptoms. Because of the role of indoor environmental exposures in exacerbating the disease, education in the home, along with home assessments and materials and supplies, may make the difference in controlling a patient's asthma and substantially improving quality of life.

FIGURE 2:

Environmental Factors Important for Control of Asthma Symptoms

ALLERGENS
- Animals (pests and household pets)
- Dust Mites
- Cockroaches
- Molds
- Outdoor allergens

IRRITANTS
- Environmental tobacco smoke
- Indoor/outdoor fumes
- Wood burning stoves
- Spray/Scents

A Business Case for Health Care Decision-Making

A clear-cut business case for the health care sector,[a] is one in which there is documented **cost savings realized by an additional investment in services** (i.e. savings from reduced health expenditures outweigh the cost of the program). However, a business case also exists if a program is considered **cost effective: investments associated with a new service are considered "reasonable" relative to standard approaches/services considering the value of the health benefits gained** (i.e. costs are reasonable given the improvements in symptoms). For other sectors, including government and employers, additional economic considerations are important, such as lost productivity and missed school days.

This business case consists of a review of the cost and cost-effectiveness literature, including practice-based case studies of asthma education and environmental intervention programs from across the country that are sponsored and/or reimbursed by health care payers.

Evidence of Effectiveness & Cost Evaluations from the Research Literature

Hundreds of research studies undertaken to date have assessed the effectiveness of a variety of patient education strategies. Sixteen of these studies rigorously evaluated the costs of patient education programs.[b] Two additional studies examined the cost-effectiveness of home-based environmental interventions (environmental trigger reduction programs). Our review of these eighteen studies – identified through a Medline search – updates a 1997 and 1999 review[11,12] of cost evaluations of asthma education programs. The appendix summarizes results from these studies.

Research Literature Evidence: Asthma Education

Of the 16 studies identified that examined the costs of patient education and guided self-management programs, 12 were designed as randomized control trials and 4 as pre-post intervention studies (see appendix).[c] These studies vary in terms of the setting of the intervention (clinic, telephone, hospital or home; individual or group sessions) the number of visits (ranging from 1-8) and the type of personnel that provide the education (health educator, social worker, nurse, physician, respiratory therapist). However, all interventions convey similar educational content including: 1) the basic physiology of asthma; 2) medications and medication compliance; 3) asthma triggers and trigger avoidance techniques; and 4) self management techniques such as asthma action plans, asthma diaries and peak flow monitoring. Findings from these studies show statistically significant associations between patient education programs and a range of beneficial outcomes (see appendix). Compared to control/comparison groups, high-risk patients receiving asthma education experienced:

- fewer emergency department (ED) visits observed in 5 of 8 studies that measured (ED) visits;
- fewer hospitalizations/hospital days (observed in 5 of 11 studies that measured hospitalizations)

Compared to patients who did not receive asthma education interventions, patients whose risk level varied from low to high had:

- greater improvements in quality of life (observed in 5 of 6 studies that measured quality of life);
- fewer lost work days or school absences (observed in 4 of 6 studies that measured lost work/school days);
- greater improvements in lung function (observed in 3 of 4 studies that measured lung function).

[a] Leatherman et al report, "A business case for a health improvement intervention exists if the entity that invests in the intervention realizes a financial return on its investment in a reasonable time frame, using a reasonable rate of discounting. This may be realized as 'bankable dollars' (profit), a reduction in losses for a given program or population, or avoided costs. In addition, a business case may exist if the investing entity believes that a positive indirect effect on organizational function and sustainability will accrue within a reasonable time frame."[10]

[b] The literature often uses the term "asthma self-management programs" rather than "asthma education" when the intervention is focused on improving self-management practices such as use of peak flow meters, etc. For this paper, interventions to improve self-management practices are included in the term, "asthma education."

[c] The studies reviewed are the most rigorous in the literature and the most comparable in terms of the content of the interventions. Nonetheless, they have limitations, including incomplete accounting of direct and indirect costs, lack of sensitivity analyses among many of the studies in which some subjects were lost to follow-up, and short follow-up periods.

Many of these outcomes translate into savings in health care costs, though their measures vary. Examples include:

- A 1991 randomized control trial of adults receiving three group education sessions conducted by a Registered Nurse at a cost of $85 per patient resulted in $1,913 of savings per patient in health care utilization ($22.50 saved in health care costs for every $1 spent on the program);[13]
- A 2003 randomized control trial of adults receiving group education sessions in the clinic, by phone and at home as needed by an Asthma Nurse Specialist at a cost of $186 per patient saved $6,650 per patient in direct and indirect health care expenditures ($36 saved in health care costs and lost work days for every $1 spent on the program);[14]
- A pre-post intervention study of children and their caregivers (2005) receiving eight weekly home visits by a respiratory therapist at a cost of $640 per patient resulted in an average total cost savings from reduced health care utilization of $8,542 per person per year (saved $13.30 in health care costs for every $1 spent on the program);[15]
- A randomized control trial examining the effectiveness of an asthma case management program for children (1999) at a cost of $190 per patient resulted in total savings of $7.69-$11.67 for every $1 spent on a case-manager's salary.[16]

Although not all studies report the risk classification of the patients, results from those that did suggest that reductions in utilization costs as a result of asthma education tend to be higher among patients classified as high risk. High risk classification criteria vary, but often include greater disease severity, age (with young people being at higher risk), ethnic backgrounds (Puerto Rican and Black), low level of income, and history of poor compliance with pharmacotherapy recommendations. Claims data are also used to classify disease severity including measures such as unscheduled medical encounters, frequent emergency room visits, or hospitalizations.

Asthma Education: Evidence of Cost Savings

The literature examined (see appendix) and corroborated by previous published literature reviews[11,12] provide **strong evidence that effective asthma education programs targeted to high risk patients are likely to result in health care cost savings**, as high risk patients tend to use health services most frequently. The literature also suggests that **programs targeting patients whose health service utilization is lower may or may not generate net cost savings, but will result in improved health outcomes, such as quality of life, lung function, and reduced school and work absences.**

Research Literature Evidence: Home-based Environmental Interventions

A decade ago, the body of evidence on the effectiveness of in-home environmental interventions was thin. More recently, prompted by the findings of a seminal Institute of Medicine report,[17,d] a number of major research studies have reached the conclusion that in-home environmental interventions – which include a home assessment, education and provision of materials/supplies such as mattress/pillow encasements, pest management, and vacuum supplies with high efficiency particulate air (HEPA) filters, among others (see Figure 3) – reduce exposure to environmental triggers and improve health outcomes. Indeed, a recent review article found that of the five randomized control trials conducted to date, four found positive effects on asthma outcomes.[18] Two of these studies (see appendix)[19,20] also evaluated cost-effectiveness. They conclude that when compared to the control/comparison group, intervention groups receiving in-home environmental intervention services and supplies (see Figure 3):

- have fewer urgent care visits due to asthma (observed in 2 of 2 studies examining urgent care/unscheduled physician visits);
- have fewer symptom-days; (observed in 2 of 2 studies examining symptom days) and
- use fewer rescue medications (observed in 2 of 2 studies that examined rescue medication use).

FIGURE 3:

Environmental Interventions and Supplies

Provided in ALL RCT studies
- Extensive education regarding trigger avoidance
- Mattress/pillow encasements
- Pest abatement
- Vacuum cleaner with HEPA filter
- Smoking cessation

Environmental Interventions Provided in SOME RCT studies
- Professional pest control
- Mold abatement

[d] The 2000 Institute of Medicine's report, Clearing the Air found sufficient evidence to demonstrate a causal association between asthma exacerbations and exposure to house dust mite, environmental tobacco smoke, cat dander and cock roaches based on a comprehensive review of the scientific literature. The report also found sufficient evidence to demonstrate an association between asthma exacerbations and exposure to dog dander, fungi or molds, and nitrogen oxide.

Cost-effectiveness analyses of these programs examined the costs associated with each symptom-free day gained (see side-bar):

- A high intensity home-based environmental intervention program (2005) – targeting high-risk asthmatic children and costing $1469 per patient – resulted in 37.8 more symptom-free days over a 2-year period among those receiving the intervention than among those in the control group, at a cost $28 for each symptom-free day gained ($16 per symptom-free day gained if just one environmental counselor administered the intervention).[19]
- A second high intensity home-based environmental intervention program (2005) targeting medium-high risk children with asthma at a program cost of $1124 per patient resulted in fewer urgent care visits due to asthma, fewer symptom days and improved quality of life for caregivers. The program's cost effectiveness was calculated at $23 for each symptom-free day gained.[18,20] The results for the low intervention group in this study are particularly intriguing: the cost for each symptom-free day gained by children who received just 1 home visit (compared to the 5-9 visits for the high-intervention group) was just $2 (the cost of the 1 visit was $215).[18] Although some may argue this is a placebo effect, the results suggest health outcome improvements result from relatively small interventions.

SIDEBAR:

What is "Cost per Symptom-Free Day Gained"?

A 1997 NAEPP working group evaluating the cost-effectiveness of asthma care programs recommended the use of a symptom-free day as the principle outcome measure for cost-effectiveness analyses.

A symptom-free day is a measure of overall control of asthma symptoms defined as a night and day with no asthma symptoms and no night-time awakenings.

Cost per symptom free day gained is calculated using an incremental cost-effectiveness ratio (ICER) which measures the cost per additional unit of outcome gained by the intervention:

$$\text{ICER} = \frac{\text{Cost (Intervention Group)} - \text{Cost (Control Group)}}{\text{Symptom free-day (Intervention group)} - \text{Symptom free-day (Control group)}}$$

Environmental Interventions: Evidence of Reasonable Cost

When assessing whether the cost of in-home environmental interventions for asthma are "reasonable," it is useful to examine the cost-effectiveness of interventions that are considered the current standard of care.

Two recent studies estimate that each symptom-free day gained as a result of standard pharmacotherapy interventions cost $7.50 in adult patients with mild to moderate asthma (inhaled corticosteroids)[21] and $11.30 in patients 5-66 years old with mild persistent asthma (budenoside).[22] Medications such as Xolair (omalizumab), which is prescribed to patients with moderate-severe, uncontrolled allergic asthma, cost $523 per symptom-free day gained.[23] **When looking across the spectrum of standard asthma management treatments, in-home environmental interventions – which cost $2-$28 per symptom-free day gained – are clearly within the range of what payer organizations have determined is "reasonable" to improve asthma outcomes, and may produce net cost savings if more costly treatment options are avoided.** Indeed one Medical Director of a Managed Care Organization (MCO) stated, "The research suggests that home-based asthma education and intervention programs can substantially improve symptoms of patients with uncontrolled asthma. If covering proven environmental control measures can keep a handful of members from needing Xolair, then home-based programs will generate net cost savings."

In sum, though relatively few rigorous studies have examined cost-effectiveness of these asthma interventions, the literature that does exist suggests that home-based programs to reduce environmental triggers are cost-effective, although evidence does not yet document net cost savings. These findings are corroborated by another literature review which states, "Compared to pharmaceutical interventions, home environmental modifications can be cost effective in certain populations…Overall, existing research indicates that moderate health impact can be achieved with relatively low-cost low-intensity home environmental interventions."[18]

Case Studies of Cost-Effective Comprehensive Asthma Management Programs

Prompted by the research literature, a number of health plans across the country are implementing comprehensive asthma management programs that include asthma education and environmental interventions in conjunction with primary and specialist care.

Optima Health Virginia Beach, Virginia

Optima Health is a non-profit managed care system comprised of Medicaid HMO and commercial HMO, PPO and POS plans. Optima Health provides education, both in-clinic and via mailed materials, to all members with asthma, and more intensive interventions to patients classified as having more severe asthma, based primarily on data from medical and pharmacy claims.[24] For its most severe asthma patients, Optima Health combines asthma education with home-based environmental interventions. These programs have realized cost savings:[24]

- Between 1994 and 2004, asthma hospitalizations among Optima members receiving the home visiting program decreased by 54% in the commercial plans, and 32% in the Medicaid HMO plan. Emergency room visits decreased 18% among members in commercial plans, and 33% among Medicaid HMO plan members.
- Overall costs for patients with severe asthma decreased by 35%.
- A financial return on investment for the program was estimated at 4.1:1 ($4.10 saved for every $1 spent on the program).

Monroe Plan for Medical Care, Rochester, NY

In 2002, Monroe Plan for Medical Care – a non-profit Medicaid MCO – launched a pilot of its *Improving Asthma Care for Children Initiative*. Monroe Plan enrolled children whose asthma was resulting in high utilization of medical services (ED visits, hospitalizations, urgent care etc.) and offered them lung function testing, asthma education, and allergy skin testing through a specialty asthma center. Children also received case management services, and home environmental assessment and supplies for reducing exposure to dust-mites, cockroaches and other environmental triggers. The Monroe pilot results include:[25]

- By 2004, rates of emergency room visits and hospitalizations among children enrolled in the pilot initiative were dramatically lower than among a comparison group of children that did not receive increased asthma management services. Quarterly rates of emergency room visits in 2004 ranged from 191-429 visits per 1000 visits in the intervention group versus 352-843 visits per 1000 visits in the internal comparison group. Quarterly hospital admissions in the intervention group ranged from 21-46 compared to 34-77 in the internal comparison group.
- While costs associated with asthma specialist visits increased slightly among the intervention group, the health plan realized a 20% reduction in total asthma-related medical costs (from an average of $35.50 per member per month (PMPM) to $28.78 PMPM) due to decreased emergency room visits and hospitalizations. Corresponding costs in the comparison group actually increased by 29% ($34.25 PMPM to $44.10 PMPM) over the same time period.[26]

The Monroe Plan for Medical Care did not incorporate the cost of the program into the assessment of total costs, so a cost savings could not be demonstrated. Nevertheless, officials from the Monroe Plan subsequently expanded the program beyond the pilot stage based on the evidence of reduced medical expenditures and health outcome improvements.

Asthma Network of West Michigan

The Asthma Network of West Michigan is a community-based asthma coalition that provides intensive home-based case management services to predominantly low-income children and adults diagnosed with moderate to severe asthma. The community organization uses nurses or respiratory therapists to provide up to 18 home visits. Visits include asthma education services in the home and some environmental education. Home visits are primarily reimbursed by private and public health payers to which the Network provides outcome data. Grant dollars pay for uninsured clients. Results of the program include significant improvements in health outcomes and reductions in health-related expenditures.

- Emergency department visits, hospitalizations and days hospitalized among 45 children enrolled in the program decreased significantly compared to 39 matched controls.[27]

- Net cost savings resulting from the reduction in health care utilization expenditures among program enrollees was estimated at $163/child/year.[28]
- Chart reviews of 37 managed care (Commercial and Medicaid) patients who had been enrolled in the Asthma Network of West Michigan for one year between 2003 and 2005 demonstrated a 66% reduction in hospital admissions, 46% reduction in length of stay and 60% reduction in Emergency Department visits. These results helped to bolster previous findings that a partnership between a MCO and an asthma coalition can significantly improve the health outcomes of members with asthma and reduce costs.[28]

Although not published in peer-reviewed journals, **these case studies provide valuable practice-based evidence regarding the costs of asthma education and environmental trigger reduction interventions and demonstrate that enhanced asthma management programs, including these components, can result in decreased costs and improved health outcomes.**

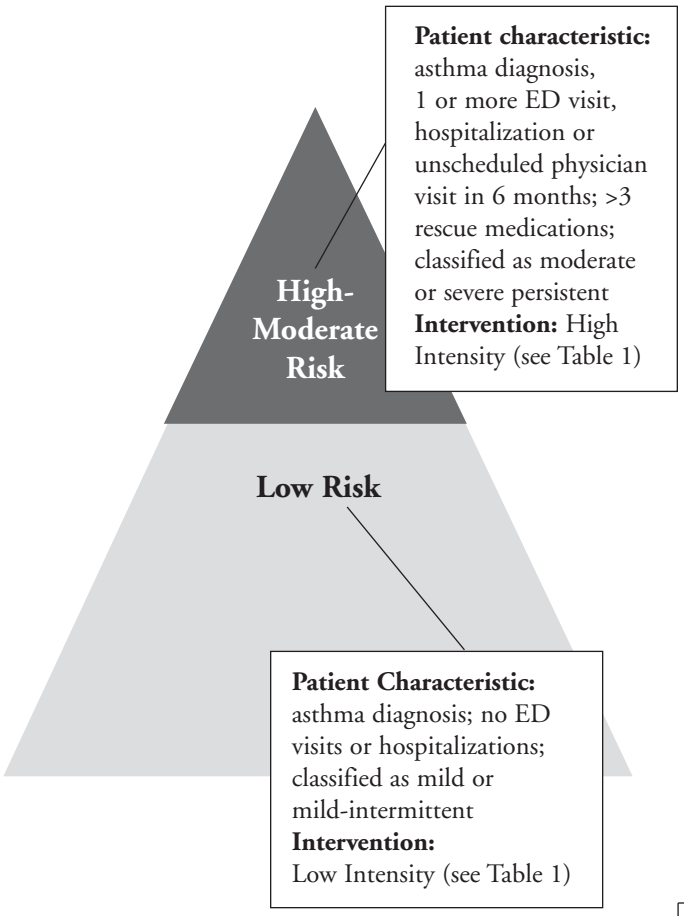
Model Cost-Effective Asthma Education and Environmental Interventions

The research and practice-based literature suggests a conceptual framework for making decisions about which patients should receive more and less intensive interventions in clinical and home settings. This framework takes into account routine methods for stratifying patients and the latest science on the 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 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 health services (Figure 4). These risk profiles help determine the intensity of asthma education and environmental interventions that should be provided to patients (Table 1). Patients classified as low risk 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 reinforce information covered in the session, including: 1) the basic physiology of asthma, 2) medications and medication compliance, 3) asthma triggers and trigger avoidance techniques, 4) self management techniques, 5) referrals to other health and social services, 6) smoking cessation and control, and 7) disease management supplies such as peak flow meters, dust mite-proof mattress and pillow covers and basic pest management supplies. These patients should also receive smoking cessation services and related basic supplies. Patients classified as high risk (diagnosed as having moderate or severe asthma, and/or who have had recent unscheduled office or emergency room visits or hospitalizations), should receive basic education (as described above) as part of a clinical visit in addition to a series of home visits that also include a home environmental assessment, intervention

FIGURE 4:

Patient Intervention Stratification Model



services (including integrated pest management (IPM) and supplies.) When home assessments are provided, and environmental triggers examined, research shows that dust mites, environmental tobacco smoke, cockroaches, mold, dog and cat dander and nitrogen oxide (from wood smoke) are the triggers of most concern.[17] To ensure that exposure reduction reduces risk of asthma exacerbations, some research suggests that services and supplies target allergens to which patients are sensitized (as determined by allergy testing).[29] Services and supplies that reduce levels of allergens and irritants include integrated pest management, moisture control through improved ventilation, removal of carpeting in sleeping and high-moisture areas such as kitchens and bathrooms, removal of clutter that promotes dust and provision of HEPA vacuums and air filters to remove other particulates. Patients often need logistical and financial support in accessing these interventions.

TABLE 1:

MODEL INTERVENTIONS

Asthma Education and Environmental Interventions

LOW INTENSITY	HIGH INTENSITY
SETTING Individual or Group; Clinic and/or Phone-based (1+ visits)	**SETTING** Individual; Clinic then Home-based (1-5 visits); phone calls to supplement
STAFFING Nurse, Respiratory Therapist or Health Educator	**STAFFING** Nurse, Respiratory Therapist, Medical Social Worker or Health Educator (Medical Education); Community Health Worker or Environmental Counselor (Environmental Interventions); Staffing combinations may be appropriate.
EDUCATION Address asthma physiology; medical self-management, written asthma management plan, & control of triggers	**EDUCATION** Same as low intensity
SERVICES Smoking cessation and referrals to other programs/resources	**SERVICES** Same as low intensity as well as in-home environmental assessment and remediation services as indicated (e.g. IPM or Mold)
SUPPLIES Peak flow meters, spacers, environmental supplies as needed	**SUPPLIES** Same as low intensity, plus environmental trigger source reduction (e.g., HEPA air filter for smoking, pest control).

For both high and low risk patients, **the literature suggests that providers other than physicians – including nurses, 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.

Conclusion

As it strives for quality improvement and cost containment, the health care sector is recognizing the benefits of a *Chronic Care Model* (**www.improvingchroniccare.org**). This model attempts to address the deficiencies in current approaches to managing chronic diseases, moving away from a "reactive" physician-centered treatment approach toward a "proactive" prevention-oriented approach provided by a team. Diabetes and heart disease are examples of chronic illnesses that have benefited greatly from this model. Care for asthma is moving in this direction as well, but health payers understandably want to know more about what the evidence on best practices and associated costs.

Rigorously designed research studies and program evaluations conclude 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 at a reasonable cost and when targeted appropriately, may result in net cost savings to payers who invest in them. The need is urgent: the quality of life of increasing percentages of adults and children is substantially impaired by asthma, and public and private payers bear the financial burden of high utilization of health services.

Because indirect costs are not routinely captured, the societal economic case for investing in asthma education and environmental interventions may be even stronger than reflected in the literature. Though a number of the studies reviewed here did assess indirect costs and benefits, several did not. Experts point out additional derivative benefits not quantified in some of their studies, including reductions in costs associated with lost school and work days, reductions in health disparities and improvements in patient co-morbidities such as depression, anxiety and obesity.[30] Additionally, other family members' health and welfare stand to benefit from these services.

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

- **Public and private payers –** who stand to benefit both from net cost savings and improved quality of care – can consider paying for supplies and services shown to reduce exposures to environmental triggers, including mattress and pillow encasements, HEPA filters and vacuums, and pest management. They can structure reimbursement mechanisms for the range of providers of asthma education and environmental services, – including providers in public health departments – establish incentives for providers to appropriately classify patients and refer them to clinical and in-home sessions, and provide staff to proactively reach out to high risk patients who meet criteria for receiving educational and environmental services.
- **Provider groups** can consider supporting asthma educators in their practices, and can encourage referrals to home visitors and environmental assessors. These investments 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.
- **Large employers** can request coverage for comprehensive asthma services through contract negotiations for health insurance. Cost savings and increased worker productivity could strengthen the case for insurance coverage.
- **Policymakers** can create a sustainable statewide reimbursement mechanism that supports best practices for asthma care, including asthma education and environmental interventions.

The literature should prompt us to ask: how can we afford not to give people with asthma access to programs that hold promise for reducing symptoms and costs? Additional analysis will need to be undertaken by any individual organization interested in promoting the delivery and financing of asthma education and in-home environmental interventions. The information in this paper should get them started: it dispels arguments that effective programs are too expensive or unproven, and provides guidance about how to classify patients and target interventions appropriately. The Asthma Regional Council and its partners look forward to working with decision-makers in multiple sectors to support implementation of asthma education and environmental trigger reduction programs: the two highly promising yet often neglected elements of the NAEPP asthma management guidelines.

LITERATURE REVIEWED

Study	Study Size/ Type of Patient	Risk Level	Setting (#, length, group/ individual, site)	Staff	Main Health Effectiveness Outcomes	Positive Intervention Results Relative to Control group (in RCT) or Baseline Group (in Pre-Post)	Program Cost* (per person)	Cost* Evaluation (intervention group compared to control group or baseline)
PATIENT EDUCATION STUDIES								
Randomized Control Trials								
Bolton et al, 1991[13]	241/Adults	High	3, hr, group, clinic	RN (w/ specialized training)	ED visits; Physician visits; Hospitalizations; Days of limited activity	59%[i] fewer ED visits	$85	Saved $1913 per person per year in direct health care costs; saved $22.50 (direct costs) for every $1 spent on the program
Castro et al, 2003[14]	96/Adults	High	NA,NA, clinic, home, phone	Asthma Nurse Specialist	Hospital readmissions; ED visits; Quality of Life; Lost school/work days	54%[i] fewer asthma-hospital readmissions; 34% fewer ED visits; 8%[i] greater improvement in overall Quality of Life; 76% fewer lost work/school days	$186	Saved $6,650 per person per 6 months in direct & indirect health care costs; saved $36 (direct & indirect) or $24 (direct only) for every $1 spent on the program
Clark et al, 1986[31]	310/Children (ages 4-17)	Low-High	6, 1 hr, group, clinic	Health educator	ED visits; Hospitalizations	58%[i] fewer hospitalizations & 59%[i] fewer ED visits among cases with 1 or more baseline hospitalizations	$1558	Saved $11.22 in direct health care costs for every $1 spent on the program for children hospitalized the previous year
Gallefoss et al, 2001[32]	78/Adults	Low- Med	2, 2 hr, group and 1, 1-2 hr, individual, clinic	Respiratory Nurse or Physio-therapist	Quality of Life[ii] includes days with symptoms); Lung function; Lost work days	16.3 unit[i] improvement in Health Related Quality of Life score; 6.1%[i] improvement in FEV1; 71% fewer lost work days	$122[iii]	10 unit improvement in HRQoL associated with a savings of $378[iii]; A 5% improvement in FEV1 associated with a savings of $500[iii]
Greineder 1999[16]	57/ Children (Ages 1-15)	High	Varied # and length, individual, clinic & telephone	Asthma outreach nurse	ED visits; Hospitalizations	57%[i] fewer ED visits; 75%[i] fewer hospitalizations;	$190	Saved $7.69-$11.67 in direct health care costs per year for every $1 spent on a case manager's salary
Kauppinen et al, 1999[33]	162/Adults	NA	3, 1.5 hr, individual, clinic	Respiratory Nurse or Attending Chest Physician	Lung function; Quality of Life[ii]	5.3%[i] improvement and 4.4%[i] FEV1 & PEF, respectively	$426[iv]	No difference in costs between intervention and control programs
Lahdensuo, 1999[34,35]	115/Adults	Low-Med	1+, 2.5 hr, individual, clinic	Nurse with specialized training	Hospitalizations; unscheduled ambulatory visits; Lost work days; Courses of antibiotics; Courses of prednisolone; Quality of life[ii]	98%[i] higher Quality of Life score; 50%[i] fewer unscheduled ambulatory visits; 42%[i] fewer lost work days; 56%[i] fewer courses of antibiotics; 60%[i] fewer course of prednisolone	$334[v]	Saved $22[v] (direct & indirect health care costs) or costs $8[v] (direct health care costs only) for every healthy day gained per patient per year
Neri et al, 1996[36]	55/Adults	Low-High	6, 1 hr, group, clinic	Chest Physician, Respiratory Therapist & Psychologist	Asthma attacks; Urgent medical exams; Hospitalizations; Lost work days	53% fewer asthma attacks; 74% fewer urgent medical exams; 29% fewer lost work days (all mean measures)	$713	Saved $2.66 (direct & indirect health care costs) or $1.89 (direct health care costs only) for every dollar spent on the program
Schermer et al, 2002[37]	193/Adults	Med- High	4, NA hr, individual, clinic	Family Physician	Successfully treated weeks in 2 years of follow-up; Lung function; Quality of life[vi]	6 additional successfully treated weeks in 2 years[i] (measure of asthma control) gained; 17%[i] more participants showed higher emotional control	$172[vii]	Saved $7.90[vii] (direct & indirect health care costs) or costs $6.69[viii] (direct health care costs only) for each successfully treated week
Sondergarard et al 1992[38]	62/Adults	NA	1, NA hr, group, hospital; and 1, NA hr, individual, hospital; and 2, NA hr, individual, home	Physician, Nurse & pharmacist	Hospitalizations; Quality of life[viii]; Health status[ix]	Improvements in both quality of life and health status (relative % improvement unavailable)	$204[x]	$.56[x] saved in lost earnings for every $1 spent on the program (only indirect benefits measured)
Sullivan et al, 2002[39]	1033/Children	High	4, group (2 for child only and 2 for adult); clinic AND home-based pest program	Social worker	Asthma symptoms; Medical visits (unscheduled & scheduled); ED visits; hospital days (ICU & non-ICU); Inpatient Dr. visits	26.6 (5%) additional symptom free days over 2-years; 19% fewer unscheduled medical visits; 5% fewer ED visits; 3% fewer non-ICU hospital days; 2.9% fewer inpatient Dr. visits	$337	$9.20 per symptom-free day gained

*Costs converted to U.S. dollars for the year as reported in the study but were not adjusted to reflect equivalent current day value (if year not reported in study, study period used; if no study period published, publication year used); [i] statistically significant at (p=0.05 or less); [ii] Data measured by the Health Related Quality of Life survey and/or the St. Georges Respiratory Questionnaire; [iii] Data reported in Norwegian Krone, converted to US dollars (9 NOK :$1 US, 2001) ; [iv] Data reported in British Sterling Pounds: converted to US dollars (.58¢£: 1$US, 1991-1993); [v] Data reported in Finnish Marks: converted to US dollars (5.35M: $1US, 1998); [vi] Data measured by the Asthma Quality of Life Questionnaire; [vii] Data reported in Euros, converted to US dollars (1 E : $.912 US, 2000); [viii] Data measured by the Psychosomatic Discomfort Scale; [ix] Data measured by the Asthma Quality of Life Scale questionnaire; [x] Data reported in sterling pounds, converted to US dollars (.57¢£ : $1US, 1992)

LITERATURE REVIEWED: Continued

Study	Study Size/ Type of Patient	Risk Level	Setting (#, length, group/ individual, site)	Staff	Main Health Effectiveness Outcomes	Positive Intervention Results Relative to Control group (in RCT) or Baseline Group (in Pre-Post)	Program Cost* (per person)	Cost* Evaluation (intervention group compared to control group or baseline)
Windsor et al, 1990[40]	254/Adults	Low-High	1, 0.5 hr, individual, clinic; and 1, 1hr, group, clinic; and 2, brief, phone	Health education specialist	Correct inhaler use; Inhaler adherence; Medication adherence; Total adherence	No between group statistical analyses. Greater: inhaler use (410%); inhaler adherence (100%); medication adherence (48%); total adherence (123%)	$32	Cost effectiveness[xi] calculated separately for intervention group ($96) & control group ($244)
Pre-Post Intervention								
Shelledy et al, 2005[15]	18/Children (ages 3-18)	Med-High	8, 1-2 hr, individual, home	Respiratory Therapist	Hospitalizations; ICU days; Non ICU hospital days; ED visits; Dr. Office visits; Missed school days	Reduction in: hospitalizations (82%[i]); ICU days (92%[i]); non-ICU hospital days (90%[i]); ED visits (86%[i]); unscheduled Dr. visits (66%[i]); school days missed (65%[i])	$640	Saved $8542 per patient per year from reduced health care utilization expenditures; Saved $13.3 in direct health care costs for every $1 spent on the program
Taitel et al, 1995[41]/ Kotes et al[42]	76/Adults	Med-High	7, 1hr, group	Group education leader	Asthma symptoms (daytime and nighttime symptoms and PEFR; coughing, chest tightness, wheezing); Medication use; Asthma-related behavior; Cognitive asthma skills; physician visits; ED visits, hospital days	Short term: greater improvement in asthma symptoms (majority of measures); use of asthma management skills; physician visits and cognitive abilities. Long term: greater improvement in asthma attack frequency; cognitive abilities; use of asthma management skills and reduction of medications.	$208	Saved $1.01 (in direct health care costs) or $2.41[xii] (in direct & indirect health care costs) for every $1 spent on the program
Trautner et al, 1993[43]	132/Adults	High	5, 4hr, group, hospital	Specialized Nurse Educator	Hospital days, Missed work days; Physician visits, Severe asthma attacks; Lung function	Average reduction 3-yrs after intervention in: hospital days (51%[i]); missed work days (44%[i]); physician visits (70%[i]); asthma attacks (79%[i]). Average improvements in lung function, FEV1 %VC (8.5%)	$223[xiii]	After 3-years saved $1.63[xiii] (direct health care costs) or $3.00[xiii] (direct & indirect health care costs) for every $1 spent on the program
Weinstein et al, 1996[44]	59/Children	High	2x weekly, individual, hospital	Various staff	Hospital days; ED visits; Corticosteriod bursts; Physician visits;	100%[i] reduction in median ED visits and hospital days in 1st-4th follow-up years; 50%[i] reduction in median corticosteroid bursts in 2nd-4th follow-up years	NA	Over 4 year post-rehabilitation period, discounted cumulative net savings in medical charges was $502 per patient
HOME-BASED ENVIRONMENTAL INTERVENTIONS								
Randomized Control Trials								
Kattan et. al, 2005[19]	937/Children	High	5, 1 hr, individual, home	Environmental Counselor	Scheduled & unscheduled medical visits; ED visits; hospital days; anti-inflammatory medication use; B-agonist inhaler use; symptom days	19%[i] reduction in unscheduled physician visits per year; 13% reduction in B-agonist inhaler use per year; 37.8 additional symptom free days (7%)	$1469	Each symptom-free day gained costs $28 ($15.76 if just 1 staff rather than 2 were used for each home visit (Program Cost=$970)
Krieger et. al, 2005[20]	213/Children	Med-High	5-9, 1hr, individual, home	Community Health Worker	Quality of life; Asthma symptom days; Urgent health service use; Medication use (rescue & controller); missed school & work days	10%[i] greater reduction in days with symptoms/2wks; 17%[i] greater improvement in care giver quality of life; 45%[i] greater reduction in urgent health service use/2mo; 13%[i] fewer days with limited activity/2wks;	$1124	Each symptom-free day gained costs $23[xiv]. The projected 4-year net saving among the high-intensity group relative to the low intensity group was $189-$721
Pre-Post Intervention								
Krieger et. al, 2005[20]	104/Children	Med-High	1, 1hr, individual, home	Community Health Worker	Quality of life; Asthma symptom days; Urgent health service use; Medication use (rescue & controller); missed school & work days	50%[i] reduction in days with symptoms/2wks; 23%[i] improvement in care giver quality of life; 42%[i] reduction in rescue medication use; 60%[i] improvement in days with limited activity/2wks	$215	Each symptom-free day gained costs $2[xiv]

[xi] Cost effectiveness calculated as total costs divided by total adherence improvement score; [xii] Authors report $2.28 for every $1 spent on program, but using only on statistically significant benefits rather than all benefits (as reported in table above). [xiii] Data reported German Marks, converted to US dollars (1.66DM : $1US, 1991); [xiv] Incremental Cost Effectiveness Ratio calculated by Atherly et al, 2007

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