

# The Role of Pest Control in Effective Asthma Management: A Business Case



Produced by the Asthma Regional Council of New England  
for the Boston Public Health Commission  
AUTHORS: Molly Brett and Laurie Stillman at Health Resources in Action

Building a Healthy Boston  
Mayor Thomas M. Menino



# **The Role of Pest Control in Effective Asthma Management: A Business Case**

**Produced by the Asthma Regional Council of New England for the Boston Public Health Commission**

**AUTHORS: Molly Brett and Laurie Stillman at Health Resources in Action**

**Contact:  
Stacey Chacker, Director  
Asthma Regional Council of New England  
schacker@hria.org  
[www.asthmaregionalcouncil.org](http://www.asthmaregionalcouncil.org)**

## Acknowledgments:

This paper was developed under the auspices and direction of the New England Asthma Regional Council (ARC) and the Boston Public Health Commission (BPHC). It was made possible by funding from the W.K. Kellogg Foundation.

As a coalition of public agencies, non-governmental organizations, and researchers, the New England Asthma Regional Council brings together the diverse perspectives and resources of health, housing, education, and environment organizations to reduce the impact of asthma across New England. ARC is a program of Health Resources in Action (formerly known as The Medical Foundation).

**[www.asthmaregionalcouncil.org](http://www.asthmaregionalcouncil.org)**

The Boston Public Health Commission, founded in 1799, was the first city health department in the country. The Commission's mission is to protect, preserve, and promote the health and well-being of residents, particularly those who are most vulnerable. Through community-based health improvement projects in asthma, diabetes, cancer, infant mortality, elder health, cardiovascular health and other areas, the Commission is seeking to restructure and transform health care delivery systems to reduce the burden of disease and eliminate racial disparities in health outcomes.

**<http://www.bphc.org/programs/cib/healthyhomescommunitysupports/healthyhomes/Pages/Home.aspx>**

This paper is a product of the Healthy Pest Free Housing Initiative (HPFHI). HPFHI is a collaborative effort involving ARC, the BPHC, and housing, health, advocacy and academic institutions, designed to reduce pest infestation and pesticide use in public and affordable housing in Boston. HPFHI is funded with support from the W.K. Kellogg Foundation and the U.S. Environmental Protection Agency. The primary focus of HPFHI is to improve the health and quality of life of residents through the implementation of integrated pest management (IPM), a safer and more effective alternative to traditional pest control. IPM relies on managers, residents and pest control companies working together to reduce pest infestation.

The authors wish to thank Margaret Reid and Emily Litonjua from the Boston Public Health Commission for their guidance. We are grateful to Marta Hernandez at the New York City Department of Health and Mental Hygiene for generously sharing information and data from the city's outstanding IPM program. We also wish to thank Dr. Elizabeth Woods, Children's Hospital Boston, for her helpful comments. Finally, thank you to Dr. Polly Hoppin and Molly Jacobs from the University of Massachusetts Lowell, whose research for ARC's paper *Investing in Best Practices for Asthma: a Business Case for Education and Environmental Interventions* proved an invaluable resource in writing this report.

- Molly Brett, Program Coordinator at the Asthma Regional Council of New England
- Laurie Stillman, MM, Director of the Public Health Policy and Strategies Center at Health Resources in Action, Boston, Massachusetts

*August 2009*

# Executive Summary

---

As research continues to establish a firm link between asthma and certain environmental factors, experts increasingly identify environmental trigger interventions as important components of asthma management. Interventions are most effective when they are multi-faceted and tailored to address exposures. Recently, the New England Asthma Regional Council (ARC) produced a business case demonstrating that education and in-home multi-faceted environmental interventions are sound investments for patients with persistent asthma.<sup>1</sup> Now, ARC has partnered with the Boston Public Health Commission to produce a business case documenting the costs and benefits of one particular environmental intervention: pest management education and services for certain high-risk asthma patients.\*

The case for pest management services is grounded in research suggesting that pests both cause and trigger asthma. Children who are both exposed and allergic to a specific pest and/or rodent allergen (primarily cockroaches and mice) are many times more likely to require hospitalization for their asthma than children who were not allergic or exposed to the allergen.

Seminal research on in-home environmental intervention programs reveals that reductions in allergen levels significantly correlate with reduced complications of asthma, including fewer unscheduled asthma-related hospital visits. Allergen reduction efforts can assume a variety of forms, from education about asthma triggers and provision of basic supplies to actual pest management services. Integrated pest management (IPM) is a prevention-based approach to pest control that reduces the need for pesticides: IPM represents a safe and effective method for reducing allergen levels in the homes of asthma patients whose conditions warrant professional pest services.

Given the high costs of medications and hospital visits for patients and payers, pest management demands consideration by the health sector as a reasonable intervention for asthma patients. An analysis of the research on costs and health benefits of pest management demonstrates that, rel-

ative to standard clinical methods of asthma management, IPM education and services are cost-effective interventions for certain high-risk asthma patients.

## Recommendations:

- For patients with persistent asthma, clinicians should use skin or in vitro testing to determine sensitivity to particular indoor allergens, including cockroaches and mice. Providers should use patients' medical histories to assess potential allergen exposures.
- All asthma patients with moderate to severe persistent asthma who are potentially exposed to pest and rodent allergens should be provided education around the potential role of these exposures in their asthma, as well as integrated pest management techniques. Low-income asthma patients should be provided with basic pest prevention and management supplies as part of their education.
- For patients who are diagnosed with persistent asthma, sensitized and exposed to one or more pest allergen, and live in low-income households, insurers should consider reimbursing or arranging for professional integrated pest management services as part of the patients' treatment plan.

---

\*A wide variety of factors correlate with increased risk of asthma exacerbations. In this paper, we use the term "high-risk" asthma patients to refer to patients who fit the following characteristics: moderate to severe persistent asthma; one or more Emergency Department visit, hospitalization or unscheduled physician visit in 6 months for their asthma; use of more than 3 rescue medications in 6 months. (We recommend that a subset of this group of patients – those exposed and sensitized to a particular pest allergen – receive IPM services).

# The Role of Pest Control in Effective Asthma Management:

## A BUSINESS CASE

Produced by the Asthma Regional Council of New England for the Boston Public Health Commission

In 2000, the United States Department of Health and Human Services declared, “We are facing an asthma epidemic,” capturing the concerns of the health care and public health arenas as asthma rates in our nation continued to climb.<sup>2</sup> Asthma is a chronic lung disease which strikes nearly 11 percent of Americans at some point during their lifetime,<sup>3</sup> impacting the health, well-being, and quality of life of millions of children and adults nationwide. The burden is most severe in populations with lower socio-economic status and among certain racial/ethnic minority groups. In addition, there is a growing body of evidence that those living in low-income neighborhoods have higher rates of asthma.<sup>4,5</sup> In 2006, 22.9 million Americans had asthma, and an estimated 12.4 million of them – or 54 percent – suffered an asthma attack.<sup>7</sup> Asthma symptoms, when uncontrolled, result in preventable hospital visits, missed days of school and work, and other costly disruptions to many sectors of society.

Controlling asthma and managing asthma exacerbations costs our nation billions of dollars per year. In 2007, the United States bore \$14.7 billion in direct health care costs attributed to asthma, including \$6.2 billion for prescription drugs. The American Lung Association estimates another \$5 billion expended in indirect costs (lost productivity), bringing the total cost of asthma in America up to \$19.7 billion in 2007 alone.<sup>8</sup> This cost data is of particular consequence for the health care sector, for which asthma represents a significant drain on time and resources.

### Pests as Asthma Triggers

The case for providing pest management services to asthma patients is grounded in research suggesting that pest allergens both cause and trigger asthma. Researchers have induced physiological characteristics of bronchial asthma by sensitizing and exposing mice to house dust containing high concentrations of cockroach allergen, pointing to cockroach allergen as a potential cause of asthma.<sup>9</sup>

Indeed, asthma is a widespread, costly epidemic – an epidemic made even more troubling because asthma is, in fact, controllable. The health care sector is well-positioned to take the lead in aligning clinical practices with expert recommendations. In 2007, the Asthma Regional Council of New England (ARC) partnered with the University of Massachusetts Lowell and Children’s Hospital Boston to produce a business case, *Investing in Best Practices for Asthma: A Business Case for Education and Environmental Interventions*, documenting the health benefits and costs associated with best practices in asthma management, specifically asthma education and in-home environmental interventions. The report, which examined published research studies, demonstrated that:<sup>1</sup>

- Education programs targeted to high-risk patients result in health improvements and can realize a **cost-savings** (Return on Investment)
- Home-based environmental interventions targeted to high-risk patients result in health improvements when tailored to their exposures, and are considered **cost-effective** (Reasonable cost compared to standard treatment with similar results)

This report takes a closer look at one particular home-based environmental intervention: integrated pest management to reduce exposure to pest allergens that cause and trigger asthma.

The impacts of pest exposures on health outcomes are striking:

- The landmark National Cooperative Inner City Asthma Study (NCICAS) found that children who were both allergic to cockroaches and exposed to high cockroach allergen levels were three times more likely to require hospitalization for their asthma than children who were not allergic or not exposed to cockroach allergen.<sup>10</sup>

- The Inner City Asthma Study (ICAS) revealed mouse allergen to be an independent risk factor for asthma morbidity: children who were sensitized to mouse allergen and exposed to it had significantly higher hospitalization rates, maximum symptom days, nights of lost sleep, and days when caretakers had to change plans due to asthma.<sup>11</sup>

The health consequences of cockroach and mouse allergen are more disconcerting in view of their prevalence in urban homes. ICAS researchers detected cockroach exposures in over 73% of urban homes and mouse exposures in 49% of homes.<sup>12</sup> Furthermore, skins tests reveal high levels of sensitization to these allergens: 69% of ICAS participants were sensitized to cockroach allergen and 28% were allergic to mouse allergen.<sup>13</sup> Together, these alarmingly high rates of sensitivity and exposure to mouse and cockroach allergens suggest that pests represent important and pervasive asthma triggers.

In light of an increasingly robust literature base, national asthma experts consider environmental interventions to control allergens among best practices for asthma manage-

ment. In its 2007 update to the authoritative *Guidelines for the Diagnosis and Management of Asthma*, the National Asthma Education and Prevention Program (NAEPP) outlines four components of achieving and maintaining long-term control of asthma.<sup>14</sup> As one of its key recommendations, the report advocates identification and reduction of exposure to allergens, irritants, and other factors proven to cause or exacerbate asthma. For patients sensitive to allergens, the report suggests a “multifaceted, comprehensive approach” to allergen-avoidance, including pest control measures. In particular, the guidelines recommend:

- Mouse allergen exposure can be reduced “by a combination of blocking access, low-toxicity pesticides, traps, and vacuuming and cleaning.” (NAEPP pg.170)
- Cockroach allergen exposure can be reduced by properly storing food and garbage. “Poison baits, boric acid, and traps are preferred to other chemical agents, because the latter can be irritating when inhaled by persons who have asthma.” (NAEPP pg.172)

## *Evidence-based Health Interventions to Control Pests and Rodents*

The NAEPP Guidelines recognize pest control as an important component of asthma management; however, pest management programs differ in their safety and effectiveness for reducing allergen levels and improving asthma outcomes. A review of the literature demonstrates that *integrated pest management* (IPM) is a safer, and frequently more effective long-term means of reducing the presence of pest allergens in homes and workplaces than traditional pest control methods.

### **Dangers of Traditional Methods**

Traditional pest control entails periodic broad-based application of pesticides in reaction to pest infestations. This approach presents particular concerns for asthma patients, as evidence suggests that pesticides, like pests, can both cause and trigger asthma.

- Researchers found that California toddlers exposed to insecticides were over twice as likely to develop asthma.<sup>15</sup>
- A Johns Hopkins study demonstrated that pesticides cause the muscles lining the airway to contract, restricting airflow and initiating or aggravating asthma attacks.<sup>16</sup>

In addition to asthma morbidity, pesticides have been linked to damage to the respiratory and nervous systems, injury to the reproductive organs, dysfunction of the immune and endocrine systems, birth defects, and cancer.<sup>17</sup>

#### Principles of Integrated Pest Management:

- Identify pest problems through monitoring and inspection.
- Block pest entry points.
- Remove pests’ food, water, and shelter.
- Use low-toxicity, low-risk pesticides only as needed.

IPM is an alternative to traditional pest control methods that is both more effective than traditional methods and poses fewer risks to asthma patients and other members of their households. IPM is a common-sense approach to pest management that emphasizes detecting and correcting conditions that lead to pest problems. IPM favors actions that prevent pest infestations, like blocking pest entryways and eliminating food and water sources; practitioners selectively use low-toxicity, low-risk pesticides as a last resort.<sup>18</sup>

Recent research shows IPM to be significantly more effective than traditional pest interventions:

- A 2004 study compared an IPM intervention that included vacuuming, baits, and insect growth regula-

tors with a traditional approach relying on sprays and insecticides to treat baseboards, cracks, and crevices. In the IPM group, cockroach populations decreased by over 84% by the fourth month of treatment, and the cockroach populations remained constant (under 5 per unit) for the rest of the intervention year. In the non-IPM group, cockroach populations remained steady for the first 5 months of the test and *increased* 300% over the summer.<sup>19</sup>

- IPM has also proven effective at reducing mouse allergen levels. In one study, a 5-month IPM intervention significantly decreased mouse allergen levels in kitchens and bedrooms of urban homes by, respectively, 78.8 and 77.3%. In comparison, allergen levels in homes assigned to a control group increased 319% in the kitchen and 358% in the bedroom.<sup>20</sup>

- Importantly, researchers have found that even *a single IPM visit* can effectively reduce infestations. In a study conducted in New York City public housing developments, researchers found that a single IPM visit, during which IPM services were conducted in kitchens and bathrooms, successfully lowered cockroach counts and allergen levels at three and six months after the visit (compared to units that received traditional pest control involving pesticide applications). The researchers concluded that one-time, low-cost, easily replicable IPM interventions are more effective than traditional pest control.<sup>21</sup>

In selecting a pest management practitioner, health professionals and individuals should be careful to ensure that these practitioners follow true integrated pest management techniques. IPM practitioners should provide both thorough, prevention-based pest control and resident education on how to control infestations in the future.<sup>22</sup>

## Health Benefits of Allergen Reduction

### Evidence of Reasonable Cost

In the health care sector, a business case for a particular service exists if there are documented cost savings realized by investing in the intervention (Return on Investment) OR if the program is considered “cost-effective” – that is, if the cost of a new service is considered “reasonable” relative to costs of standard services, given the health benefits realized by the intervention.<sup>23</sup>

In light of research on the effectiveness of IPM and the health benefits of allergen reduction, a strong case exists for an investment by the health sector in IPM services for certain high-risk asthma patients.

A burgeoning evidence base demonstrates the significant health benefits of multifaceted allergen abatement interventions. Two recent research projects evaluated the health benefits and cost-effectiveness of in-home environmental interventions that included integrated pest management methods in addition to education and services that addressed other asthma triggers:

1. In 2004, the Inner City Asthma Study (ICAS) conducted a randomized controlled trial (RCT) to document the impact of allergen-reduction efforts on asthma outcomes for urban children with moderate-to-severe persistent asthma. During a two-year in-home intervention that included IPM education and remediation (e.g. proper cleaning and food storage, sealing entry points, using gel baits), and supplies tailored to the patient’s sensitization and pest exposures, reductions in levels of cockroach and dust-mite allergen significantly correlated with reduced complica-

tions of asthma. The benefits of the intervention included:

- Fewer days with symptoms
- Reductions in caretakers’ and children’s lost sleep
- Fewer school days missed by the children in the intervention group
- 2.1 fewer unscheduled asthma-related visits to the emergency department (ED) or clinic per child per year<sup>24</sup>

The intervention, which cost \$1,469 per patient, was found to be a cost-effective means of reducing asthma symptom days, relative to costs of standard services.<sup>25</sup>

2. A second RCT (2005) documented the impact of a one-year high-intensity environmental intervention in households of low-income children with persistent asthma. The intervention included in-home instruction in and demon-

stration of IPM methods (e.g. proper cleaning and food storage techniques, using of gel baits, blocking of pest entry points, avoiding pesticides).<sup>26</sup> In comparison with a low-intensity control group, the benefits of the high-intensity intervention included:

- Fewer symptom days
- A 17% reduction in the proportion of participants utilizing urgent health services for their asthma

The high-intensity intervention cost \$1,124 per patient. Due to the decrease in urgent care utilization, researchers projected 4-year net savings per participant among the high-intensity group relative to the low-intensity group of \$189–\$721.<sup>27</sup>

### Costs of IPM

The two studies described above estimated the total costs of comprehensive home-based environmental interventions that addressed a number of environmental asthma triggers (e.g. dust mites, pets, mold, and environmental tobacco smoke) in addition to cockroach and rodent allergens; no published studies have quantified the costs and health outcomes of IPM alone. Data that isolates the cost of professional IPM services from other environmental services provides a significantly lower cost estimate than the more comprehensive package:

- In a HUD-funded demonstration project conducted by the Boston Public Health Commission in 2003, one or two visits by an IPM professional cost \$340 per unit (See Appendix A). In addition, a set of introductory IPM supplies provided to families cost approximately \$35 per family in 2008, for a total cost of \$375 per family (see Table 1).
- In New York City, a three-hour IPM intervention that includes supplies, education, and remediation cost \$400–\$500 per unit in 2008 (see Appendix A).

The randomized trials and model programs described above establish a range of costs for possible kinds of IPM interventions, from about \$400 for one-time services to around \$1400 for an intensive year-long intervention. IPM services, equipment, and educational supplies will be most useful when selectively provided according to household needs (see Tables 1 and 2 for costs of equipment and supplies).

### Cost-Effectiveness of IPM

At this price range, IPM represents a reasonable cost relative to the costs of medications and services for patients with moderate to severe persistent asthma. For example, Advair is a common controller medication that combines a corticosteroid and a long-acting beta<sub>2</sub>-agonist. At its 2006 average wholesale price, a 30-day supply of Advair costs between \$140.38 (for the lowest dose) and \$245.44

**TABLE 1:**

#### Menu of Integrated Pest Management Supplies and Costs

Low-cost supplies can serve as important educational tools when introducing a family to the principles of IPM.

• Roller mop	\$11.00
• Rubbermaid storage container with lid (.67 cubic feet)	\$3.23
• Rubbermaid cereal keeper	\$7.00
• Utility trash can (6-gallon)	\$5.60
• Ocelo sponges (2-pack)	\$1.20
• 3 to 6 cockroach glue traps	\$1.50
• 3 mouse glue traps	\$1.30
• Door sweeps	\$1.20
• 8 feet of copper mesh	\$2.60
<b>Total cost per supply kit:</b>	<b>\$34.63</b>

*Source:* Eugene Barros, Senior Inspector for the Asthma/Healthy Homes program at the Boston Public Health Commission, 2008.

(for the highest dose); thus costs can total up to **\$2,945 per year**.<sup>32</sup> Other medications for allergic asthma, like Xolair, can cost up to \$650 for a twice-monthly injection, for a total of up to **\$15,600 per year**.<sup>33</sup>

In comparison, IPM represents a less-expensive investment with a longer-term impact on asthma outcomes for patients sensitized and exposed to pest allergens. In addition, IPM has the potential to address the health of a household, whereas medication treats only the individual. *Pest control methods would not supplant medication use; however, these drug costs demonstrate that the price of IPM is reasonable relative to costs of standard clinical approaches that yield similar results measured by the number of symptom days, supporting the business case for integrated pest management.*

**TABLE 2:**

#### Costs of Integrated Pest Management Equipment

Equipment can be provided to households on a case-by-case basis, in accordance with household needs. The table below provides prices for products purchased by the Inner City Asthma Study (ICAS) in 2003. Please note that ICAS received many of their supplies at discounted prices.

Item	Cost
Skin test to determine allergies	\$ 50.00
Mattress encasement (twin)	\$ 61.85
HEPA Air Purifier	\$130.00
Replacement HEPA Filter	\$ 8.00
HEPA Vacuum Cleaner	\$140.00
Terminix (1.5 visits)	\$112.50

*Source:* Personal correspondence, Jacqueline Pongracic, Inner-City Asthma Study.

Moreover, the cost of an IPM intervention to reduce asthma exacerbations is reasonable in light of the cost of Emergency Department (ED) and clinic visits for exacerbations of allergic asthma. Data from the Healthcare Cost and Utilization Project – the largest collection of hospital care data in the United States – provides the following average costs for hospital and Emergency Department visits for allergic asthma in 2006:

**Average Costs for Health Care Utilization  
for Allergic Asthma**<sup>34</sup>

An ED visit for allergic asthma that did not result in admission to the hospital	\$ 691
A hospital stay for allergic asthma (adult)	\$9,261
A hospital stay for allergic asthma (children aged 0-17)	\$7,987

Research reviewed earlier in this report demonstrates that exposure to pest allergen increases hospital utilization for sensitized patients, and that allergen abatement interventions like IPM can reduce hospital utilization. *With hospital visits for allergic asthma costing between \$691 and \$9,261, a \$400-\$1400 IPM intervention that results in just one less hospital visit could realize cost savings for payer organizations.*

Other health benefits of IPM: \_\_\_\_\_  
Reduced Exposure to Hazardous Pesticides

Pesticide usage is widespread, especially among immigrants living in urban areas. A recent study measuring lead, allergens, and insecticides in a randomly selected nationally representative sample of residential homes revealed that “most floors in occupied homes in the U.S. have measurable levels of insecticides that may serve as sources of exposure to occupants.”<sup>28</sup> Pesticides may cause or trigger asthma, and exposure has been linked to a variety of dangerous health effects.<sup>29,30</sup>

IPM has been shown to reduce exposure to hazardous insecticides among pregnant women. A pilot project in New York City demonstrated that an IPM intervention reduced both infestations and exposure to insecticides among African American or Latina pregnant women who had reported using high toxicity pesticides or insecticides. Insecticides were detected in maternal blood samples collected at delivery from pregnant women in the control group but not from women receiving the IPM treatment.<sup>31</sup>

IPM contractors teach residents safe, healthy methods for controlling pest problems. Reduced exposure to toxic insecticides represents an important indirect health benefit of IPM.

## *A Framework for Cost-Effective IPM Interventions for Asthma Patients*

The research above suggests a decision-making process for recommending asthma patients to more or less intensive pest management interventions based on their risk of allergic asthma exacerbations (see Table 3 for patient stratification tool). These recommendations apply to high-risk asthma patients with moderate to severe persistent asthma (a classification outlined in the NAEPP Guidelines): these patients are more likely to suffer asthma exacerbations and utilize costly medications and health services for their disease, so the expense of an assessment and intervention is most justified for this subset.

### **Assessment for Exposures and Sensitivities**

1. For any patient with persistent asthma, providers should use the patient’s medical history to identify allergen exposures that may worsen asthma (see sidebar

for assessment tool). Clinicians should follow the NAEPP *Guidelines*, which advise that for patients with persistent asthma, physicians “use skin testing or in vitro testing to reliably determine sensitivity to perennial indoor inhalant allergens to which the patient is exposed” (165).

2. If tests determine that a patient is sensitized to some pest allergen, but the patient does not report any exposures, providers should arrange a home visit by a trained health worker who can more reliably determine exposures.

After patients’ sensitivities and exposures have been identified in the manner outlined above, health plans can use this information to assign patients to various levels of IPM interventions. In determining for which patients IPM is a

sound investment, payers may also consider patients' income level. Low-income patients have higher rates of costly hospitalizations for their asthma,<sup>35</sup> pointing to the need for improved preventive care. In addition, these patients most likely cannot afford IPM services and supplies on their own, including such routine supplies as closed containers and vacuum cleaners.

## Recommendations

All patients with asthma should receive in-clinic education about the role of environmental triggers in potentially exacerbating asthma symptoms, but particularly those who are potentially exposed to pest allergens. Education about safely preventing exposure to pest allergens, conducted by trained health care providers, including case managers or community health workers (CHW), can avert future pest exposure and sensitization. Recent research demonstrates the cost effectiveness of CHWs in delivering environmental services.<sup>38</sup> Low-income asthma patients should also be provided with basic pest prevention and management supplies as part of their education session(s), if they cannot afford or do not have access to them.

In addition to education sessions, an environmental home assessment that evaluates the existence of potential asthma triggers may be indicated. As part of any environmental remediation plan, those patients who are sensitized AND exposed to one or more pest allergen in the home should receive a referral for pest control services, and specifically to a professional IPM provider. For patients who live in low-income households, the literature suggests that it is cost-effective for insurers to reimburse for professional IPM services tailored to the patients' particular allergies and exposures. As with any higher-intensity course of treatment, physicians should use their discretion in assessing patients' needs and recommending them to different levels of interventions.

## Assessing Pest Allergen Exposures:

Allergen exposures can be difficult to assess, as clinicians generally rely on patients' self-reporting. Clinicians should ask the following questions when taking medical histories for patients with moderate to severe persistent asthma:

1. Have you seen cockroaches in your home in the past six months?
2. Have you seen rodents (mice or rats) in your home in the past six months?
3. Have you used pesticides in your home within the past six months?

*Note:* Patients may be reluctant to admit seeing pests in the home. Taking into account recent research on the distribution of indoor allergens, providers should consider asthma patients at high risk of exposure to pest allergens if the patients' household fits the following characteristics:<sup>36,37</sup>

- Part of a high-rise or multifamily unit
- Low-income
- Located in an urban setting, especially the Northeast. *(However, rural single-family homes and higher-income households may still experience infestations.)*

Table 3: Recommended Integrated Pest Management Interventions

	Intervention A: EDUCATION	Intervention B: EDUCATION AND SUPPLIES	Intervention C: PROFESSIONAL IPM
<b>Patient Characteristics</b>	Diagnosed with moderate or severe persistent asthma; poorly controlled symptoms.  Potentially exposed to pest allergen.	Diagnosed with moderate or severe persistent asthma; poorly controlled symptoms.  Potentially exposed to pest allergen.  Lives in low-income household.	Diagnosed with moderate or severe persistent asthma; poorly controlled symptoms.  Sensitized AND exposed to pest allergen.  Lives in low-income household.
<b>Setting</b>	Individual or group; clinic or home.	Individual or group; clinic or home.	Individual; home-based.
<b>Staffing</b>	Nurse, case manager, or community health worker.	Nurse, case manager, or community health worker.	Professional IPM contractor.
<b>Services</b>	Patient education about controlling and preventing infestations.	Same education as intervention A.	At least one home visit, tailored to patients' sensitization, by integrated pest management contractor. Visit should include an inspection, treatment, and education so families can continue to control pest problems.
<b>Supplies</b>	Educational materials.	Educational materials.  Introductory supplies, tailored to household needs: materials for sealing openings (e.g. steel wool), plastic food storage containers, garbage containers, sponges, soap, etc.	Same as intervention B.

## *Conclusion*

---

A review of the research establishes a clear-cut case for providing pest control education and/or services to asthma patients as part of a tailored home-based environmental assessment and intervention, provided that exposures are confirmed and/or skin tests demonstrate sensitivities to pests or rodents. Recent studies document significant, quantifiable health benefits associated with allergen abatement in the homes of asthma patients, and the literature base points to IPM as a safe and effective means of reducing pest and rodent allergen levels. Professional IPM services cost less than medications and hospital visits for allergic asthma while offering potentially long-term health benefits.

IPM offers public and private health payers a cost-effective strategy for improving both the health and quality of life of their highest-risk (and most costly) asthma patients. Individuals from low-income, urban families are disproportionately represented among the subset of asthma patients most likely to qualify for IPM interventions, and it is unlikely that this population could afford preventative measures like IPM on their own.

Integrated pest management represents a highly promising – though admittedly unconventional – approach to improving outcomes for high-risk asthma patients. In a nation where asthma has a price tag of over 14 billion dollars per year in direct medical costs, the health care sector cannot afford to ignore non-medical approaches that have such high potential for preventing costly asthma exacerbations.

## Appendix A: Case Studies

### The New England Healthy Homes Project, Boston, MA

In 2003, the Asthma Regional Council received a grant from the US Department of Housing and Urban Development (HUD) to conduct a Healthy Homes Demonstration project, and they partnered with the Boston Public Health Commission to conduct healthy housing interventions in homes of children with asthma in several Boston neighborhoods with high rates of poverty and asthma. Families in the intervention group received a tailored home intervention to reduce asthma hazards; the menu of services included carpet removal, construction improvements, mold remediation, and one or two visits from an experienced IPM professional.

The costs of the full range of services and supplies offered in the project are detailed below:

	Air purifier	Bath fan	Mold Remed.	Kitchen fan	Window fan	Carpet Removal	Dust control	Reg. IPM*	Expanded IPM*
Avg. Cost	\$215	\$876/ \$1600	\$596	\$1040	\$1680	\$2,290	\$1500	\$340	\$1,333

\* Regular IPM consisted of one or two visits by an experienced IPM professional. In expanded IPM, the unit and any adjacent infested units were treated, along with the common area, basement, and or exterior of the property.

The results included significant improvements in allergen levels, asthma outcomes, and quality of life. As compared to a control group, patients that received tailored interventions experienced:

- o Significant improvements in wheeze, cough, chest tightness; stopping play; days without symptoms; and caregiver waking
- o Significant reduction in use of quick relief medicines, from 67% reporting use at baseline to 48% at follow-up
- o Fewer emergency department visits for asthma<sup>39,40</sup>

### The New York City Asthma Initiative

The New York City Asthma Initiative, a program of the NYC Department of Health and Mental Hygiene, has been a pioneer in providing free IPM to asthma patients in three low-income communities. The Asthma Initiative receives funding from the City Council to conduct around 400 interventions per year. The 3-hour intervention includes a home inspection, vacuuming, steam cleaning, pest exclusion activities (e.g. sealing holes or reporting maintenance conditions that promote infestations), low-toxicity pesticide applications, and tenant education. To sustain the positive impact of IPM and to aid families in continuing to reduce allergens in their homes, the program provides a variety of educational materials and supplies: informational packets, flashlights to inspect kitchens for roach harborage, sponges and soap, and plastic containers for food.

To qualify for the free program, families must include a child or adult diagnosed with asthma, and they must be tenants in a privately-owned multifamily building located in one of

three specified low-income communities. Physicians and case managers refer qualifying asthma patients to the program; interested families fill out a registration form and fax it to the pest control company, who then contacts the patient.

At the moment, the program contracts with two private pest control companies – Healthy Nest and Pest at Rest – who must adhere to a well-defined IPM protocol (for details, see following page). In addition to implementing IPM in homes, the contractors must also conduct workshops about pest management and asthma, provide education about controlling pests safely and effectively (targeting supers, tenant associations, and building management companies), and organize outreach activities (e.g. tabling outside of health care institutions or supermarkets).

The intervention, including all services and the package of supplies, costs from \$400 - \$500 dollars per unit.

# New York City Asthma Initiative

## Integrated Pest Management (IPM) Protocol to Control Cockroaches and Mice

### PRIOR TO YOUR VISIT:

Make sure that you have the correct information about the apartment you are about to visit (language spoken, address, phone number and name of the tenant, etc.), IPM supplies (make sure that tools are working properly and batteries are charged), and an inspection and intervention form. You must also maintain your NYS DEC pesticide application forms following your visit.

Once in the apartment, the IPM team leader must verify the correct information of the family, introduce the team to the tenant, and clearly explain the different IPM activities that will take place in his or her apartment. Subsequent to that, he or she should proceed with IPM.

### I. INSPECTION

*Supplies: Flash light, batteries, extendable mirror, gloves, pen, and inspection form.*

During this process, the IPM members should pay particular attention to points of entry around the apartment, places of harborage for cockroaches and mice, and signs of mice and cockroaches (live or dead cockroaches and mice, mouse feces, cockroach fecal smears, nests, etc.).

Look for sources of food and water for the cockroaches and mice in the apartment: pet food uncovered, exposed food and water, food waste under the stove top, or water leaks. Pay particular attention under the sink in the kitchen and in the bathroom.

Using a flashlight, start inspecting the apartment and look for mice and roaches' points of entry around the apartment in the areas where tenants allow the team to inspect. Concentrate your inspection on heating ducts, bathroom vents, ceiling tiles, areas of peeling paint, steam risers, telephone jacks, small holes and large crevices in walls and closets, holes around radiators pipes and water pipes, and behind sinks. Inspect ventilation ducts if they exist, cabinet hinges, behind refrigerator and stove and other appliances in the kitchen. Look for holes and crevices in floors; inside bathroom cabinets; beside, inside and under bath vanity; and behind pictures and hanging mirrors.

To inspect hard-to-reach places, use an extendable mirror and gently move appliances from the walls.

Fill out the inspection form completely while conducting the inspection. Always ask the tenants if they have seen mice or cockroaches and where. Make sure that you

inspect not only locations listed in the inspection form but also those that were pointed out by the tenant and that the tenant has granted you permission to inspect.

### II. TREATMENT

*Supplies: Steam cleaner, HEPA vacuum, HEPA vacuum filter bags, simple green sponges, caulking gun, face masks, spackling paste, boric acid, Maxforce gel, Maxforce bait stations, spackling knife, steel wool, dust bulb, gloves, stepladder, pump bottle, safety goggles, IPM educational materials, incentives.*

1. In the event that cabinets are not empty when the team arrives at the apartment, proceed to empty them carefully and follow steps described previously, one cabinet at a time.
2. An IPM team member will start systematically vacuuming all kitchen cabinets and the back and sides of large appliances (stove, refrigerator, cabinets, and washing machine if present). For kitchen cabinets, the vacuum begins from top to bottom, then across moving from one cabinet to another. Use an OSHA-approved stepladder to reach upper cabinets. Remove the lower cabinets' drawers and vacuum them. If necessary, another IPM team member will assist the vacuum operator in completing the process.
3. Once an area has been vacuumed, an IPM team member will spray diluted soap solution on cabinet surfaces from top to bottom to loosen the grease on the cabinets' surface. Using a sponge, start carefully scrubbing all cockroach feces from the cabinets, paying particular attention to doors, corners, drawers' slides, and any area with built-up deposits. Sponges are to be rinsed frequently with soap solution. In kitchens where there is high accumulation of grease in cabinets, IPM team should steam clean the cabinets. Follow operational and safety instructions in the steam cleaner manual, paying particular attention to not over-steaming and delaminating wood or formica veneers. Steam machine can also be used to flush out cockroaches from cracks and crevices as needed.
4. After cabinets are cleaned, inspect them for holes, gaps or cracks. Look inside, on top of, and around them. If a gap exists in the area where the cabinet meets the walls, where the shelves meet the cabinet's sides, or where the back of the cabinet meets the frame, proceed

to apply boric acid in very small amounts using the squeeze applicator or dust bulb (you can also use boric acid in the form of gel). Completely seal the area using silicone caulk or premixed vinyl spackling. Never use your mouth or own breath to move boric acid around. Wipe excess from the inside of the cabinets. Explain to the tenant the proper use of boric acid and how it works in controlling cockroaches.

5. Using 100% white or clear silicone caulk, apply caulk to fully seal the gaps or cracks. Caulking must be done in the following areas:
  - a. Inside cabinets (all joins)
  - b. Where cabinets meet the walls (all joins)
  - c. Around heat and water pipes
  - d. Inside closets (all joins)
  - e. Around bathtub and pipes in bathrooms
6. Large gaps and holes on walls are to be stuffed with coarse copper wool (for holes as big as 2 inches) as a backing material over which premixed vinyl spackling should be applied. If holes bigger than two inches are found on walls in the apartment, note the hole location on the inspection form and inform tenants to request repairs from landlords.
7. Seal or caulk in areas other than the kitchen (closets, bathroom, bedroom, etc.) in infected areas that were identified during the inspection. Follow the procedure described in numbers 4 and 5.

*Note: Once everything has been caulked, there should be no boric acid visible. All boric acid should be sealed into the areas where it was puffed.*

8. A team member with appropriate pest control license (category 7A) must apply the Maxforce bait stations (approximately 20 per apartment) **in safe places out of the reach of children and pets**. The licensed IPM team member will place the baits in areas of roach activities identified during inspection, near hiding places, and near water or food sources. Baits are to be placed in areas where cockroaches travel: next to the wall, along baseboard and in corners, under sink, in cabinets (on side walls and corners), in closets and close to water and radiator pipes, etc. Let the tenant know that baits need to be replaced approximately every three months (follow manufacturer recommendations). Also, explain to them how the bait works in the control of roaches.

9. If there are signs of mouse activity, non-toxic glue boards will be placed in areas such as behind the stove, in closets, and on floors behind washing machines.
10. A team member with appropriate pest control license (category 7A) must apply the Maxforce (or other brand) gel in areas previously described in point 8. He or she will apply small dabs (pea-sized) of gel in many places, widely distributed in the apartment, where cockroaches were found. IPM team will explain to the tenant how the gel works in controlling the infestation.
11. To finalize the intervention, the IPM team leader will make sure that no tools, garbage, or supplies are left in the apartment and that the area is completely organized. Finally, vacuum and mop the area with soap solution.
12. The IPM team leader will give the IPM supplies and educational material to the tenant and provide a brief instruction of how to control pests safely and effectively, based on findings during the inspection.

IPM team leader will briefly explain the content of each educational material and will encourage tenant to ask questions.

*Note: make sure that educational material and instructions are provided in the language the tenant prefers.*

## Appendix B: Resources

---

### More information about IPM

1. ***Integrated Pest Management: A Guide for Managers and Owners of Affordable Housing***  
Produced by the Boston Public Health Commission and the Asthma Regional Council, this document includes model bid specifications, a sample IPM protocol, a sample housekeeping log, and other useful tools.  
**[http://www.asthmaregionalcouncil.org/documents/asthma\\_ipm\\_guide.pdf](http://www.asthmaregionalcouncil.org/documents/asthma_ipm_guide.pdf)**
2. ***Boston Public Health Commission: Healthy Homes Program***  
Information and resources from the Boston Public Health Commission's Healthy Homes program. Includes information about the Healthy Pest Free Housing Initiative, an innovative community demonstration project designed to reduce environmental health risks and asthma among residents of Boston public housing, in homes and communities.  
**<http://www.bphc.org/programs/cib/healthyhomescommunitysupports/healthyhomes/Pages/Home.aspx>**
3. ***New England Asthma Regional Council***  
Links to a wide variety of resources, research, and presentations about IPM.  
**<http://www.asthmaregionalcouncil.org/about/IPM.html>**

### Online Resources for Patients

1. ***Stop Pests in Your Homes***  
An educational video that offers advice on how to avoid pest problems. Available in Spanish and English.  
Produced by the Asthma Regional Council.  
*Available online at:* **[http://www.healthyhomestraining.org/ipm/ARC\\_BHA.htm](http://www.healthyhomestraining.org/ipm/ARC_BHA.htm)**  
*Order free DVDs:* **<http://asthmaregionalcouncil.org/ordering.htm>**
2. ***Ten Steps to Pest Control***  
Fact sheet in English and Spanish on safe methods of pest control.  
**<http://www.spcpweb.org/residential/>**
3. ***Prevent Asthma Attacks***  
An EPA-sponsored site with tips for addressing asthma triggers in the home. Available in English and Spanish.  
**<http://www.noattacks.org/triggers.html>**
4. ***Help! It's a Roach***  
Online roach prevention activities for kids. Available in English and Spanish.  
**<http://www.epa.gov/pesticides/kids/roaches/english/index.html>**

## Toll-free Asthma Hotlines

1. **Allergy and Asthma Network \* Mothers of Asthmatics**  
Patient Support Center  
1-800-315-8056
2. **American Lung Association**  
Lung HelpLine  
1-800-548-8252
3. **Asthma and Allergy Foundation of America**  
National Information Line  
1-800-727-8462, 10 AM to 3 PM EST.

## Finding a Qualified IPM Provider

*Integrated Pest Management: A Guide for Managers and Owners of Affordable Housing*, at [www.asthmaregionalcouncil.org](http://www.asthmaregionalcouncil.org) provides guidance on finding and working with a qualified pest control contractor. In addition, there are certification programs listed below:

### 1. **GreenShield Certified**

Green Shield Certified is an independent, non-profit certification program that promotes practitioners of effective, prevention-based pest control. Their website provides a searchable directory of certified practitioners.

<http://www.greenshieldcertified.org>

### 2. **Quality Pro Green**

The Quality Pro Green certification program is managed by the National Pest Management Association, a national trade association for pest management professionals. The website allows visitors to search for recommended professionals in their zip code.

<http://www.npmaqualitypro.com/Green/GreenTest/login.asp>

### 2. **EcoWise Certified**

EcoWise Certified is a certification program for practitioners of structural integrated pest management in the state of California. Their website includes a list of certified companies in California, as well as various resources for professionals.

<http://www.ecowisecertified.org/>

- 
- <sup>1</sup> Asthma Regional Council and University of Massachusetts Lowell. Investing in Best Practices for Asthma: A Business Case for Education and Environmental Interventions. April 2007.
- <sup>2</sup> Department of Health and Human Services. Office of the Assistant Secretary for Planning and Evaluation. Action Against Asthma: A Strategic Plan for the Department of Health and Human Services. May 2000. Accessed 11/11/2008: <http://aspe.hhs.gov/sp/asthma/overview.htm>
- <sup>3</sup> Asthma Prevalence, Health Care Use, and Mortality: United States, 2003-2005. National Center for Health Statistics. 2008. Accessed 4/17/2009: <http://www.cdc.gov/nchs/products/pubs/pubd/hestats/ashma03-05/asthma03-05.htm>
- <sup>4</sup> Asthma Regional Council. The Burden of Asthma in New England. March 2006.
- <sup>5</sup> Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUP). Statistical Brief #54. June 2008. Accessed 1/7/09: [www.hcup-us.ahrq.gov/reports/statbriefs/sb54.jsp](http://www.hcup-us.ahrq.gov/reports/statbriefs/sb54.jsp)
- <sup>6</sup> Schwarz AG, McVeigh KH, Matte T et al. Childhood Asthma in New York City. NYC Vital Signs. 2008, 7(1): 1-4. Accessed 1/7/2009: <http://www.nyc.gov/html/doh/downloads/pdf/survey/survey-2008asthma.pdf>
- <sup>7</sup> American Lung Association. Trends in Asthma Morbidity and Mortality. November 2007. Accessed 11/04/2008: [http://www.lungusa.org/atf/cf/%7b7a8d42c2-fcca-4604-8ade-7f5d5e762256%7d/ASTHMA\\_TREND\\_NOV2007.PDF](http://www.lungusa.org/atf/cf/%7b7a8d42c2-fcca-4604-8ade-7f5d5e762256%7d/ASTHMA_TREND_NOV2007.PDF)
- <sup>8</sup> Ibid.
- <sup>9</sup> Kim J, Merry AC, Nemzek JA et al. Eotaxin Represents the Principal Eosinophil Chemoattractant in a Novel Murine Asthma Model Induced by House Dust Containing Cockroach Allergens. The Journal of Immunology. 2001; 167(5): 2808-2815.
- <sup>10</sup> Rosenstreich DL, Eggleston P, Kattan M et al. The Role of Cockroach Allergy and Exposure to Cockroach Allergen in Causing Morbidity among Inner-City Children with Asthma. New England Journal of Medicine. 1997; 336 (19): 1356-1363.
- <sup>11</sup> Pongracic JA, Visness CM, Gruchalla RS et al. Effect of mouse allergen and rodent environmental intervention on asthma in inner-city children. Annals of Allergy, Asthma, and Immunology. 2008; 101 (1): 35-41.
- <sup>12</sup> Phipatanakul W, Eggleston PA, Wright EC et al. Mouse allergen. I. The prevalence of mouse allergen in inner-city homes. Journal of Allergy and Clinical Immunology. 2000; 106 (6): 1070-1074.
- <sup>13</sup> Crain EF, Walter M, O'Connor GT et al. Home and allergic characteristics of children with asthma in seven U.S. urban communities and design of an environmental intervention: the Inner-City Asthma Study. Environmental Health Perspectives. 2002; 110(9): 939-45.
- <sup>14</sup> National Asthma Education and Prevention Program. Expert panel report 3: guidelines for the diagnosis and management of asthma, full report 2007. NIH Publication No. 08-4051. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute. August 2007.
- <sup>15</sup> Salam MT, Li YF, Langholz B, Gilliland FD. Early-life environmental risk factors for asthma: findings from the Children's Health Study. Environmental Health Perspectives. 2004; 112(6): 760-765.
- <sup>16</sup> Field M. Asthma: the Breathtaking Disease. The Magazine of Johns Hopkins Bloomberg School Of Public Health. Fall 2002. Accessed 11/14/08: [http://www.jhsph.edu/publichealthnews/magazine/archive/Mag\\_Fall02/Asthma.html](http://www.jhsph.edu/publichealthnews/magazine/archive/Mag_Fall02/Asthma.html)
- <sup>17</sup> National Research Council. Pesticides in the Diets of Infants and Children. Washington: National Academy Press, 1993.
- <sup>18</sup> Altman, Susan. Integrated Pest Management: A Guide for Managers and Owners of Affordable Housing. December 2007.
- <sup>19</sup> Miller DM and Meek F. Cost and Efficacy Comparison of Integrated Pest Management Strategies with Monthly Spray Insecticide Applications for German Cockroach (Dictyoptera: Blattellidae) Control in Public Housing. Journal of Economic Entomology. 2004; 97(2): 559-569.
- <sup>20</sup> Phipatanakul W, Cronin B, Wood RA et al. Effect of environmental intervention on mouse allergen levels in homes of inner-city Boston children with asthma. Annals of Allergy and Asthma Immunology. 2004; 92(4): 420-425.
- <sup>21</sup> Kass D, McKelvey W, Carlton E et al. Effectiveness of an Integrated Pest Management Intervention in Controlling Cockroaches, Mice and Allergens in New York City Public Housing. Environmental Health Perspectives. 15 April 2009. Accessed 21 April 2009: <http://www.ehponline.org/members/2009/0800149/0800149.pdf>
- <sup>22</sup> For more information on finding an IPM practitioner, see Appendix B. The first resource listed, *Integrated Pest Management: A Guide for Managers and Owners of Affordable Housing*, provides detailed descriptions of the activities and documentation that an IPM contractor should provide.
- <sup>23</sup> Leatherman S, Berwick D, Iles D et al. The business case for quality: case studies and an analysis. Health Affairs. 2003; 22 (2): 17-30.

- <sup>24</sup>Morgan WJ, Crain EF, Gruchalla RS et al. Results of a home-based environmental intervention among urban children with asthma. *New England Journal of Medicine*. 2004; 351(11): 1068-1080.
- <sup>25</sup>Kattan M, Stearns SC, Crain EF 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.
- <sup>26</sup>Krieger, JW Takaro TK, Song L, Weaver M. The Seattle-King County Healthy Homes Project: A Randomized, Controlled Trial of a Community Health Worker Intervention to Decrease Exposure to Indoor Asthma Triggers. *American Journal of Public Health*. 2005; 95 (4): 652-59.
- <sup>27</sup>Krieger JW, Takaro TK, Allen C et al. The Seattle-King County healthy homes project: implementation of a comprehensive approach to improving indoor environmental quality for low-income children with asthma. *Environmental Health Perspectives*. 2002; 110 (suppl. 2): 311-322.
- <sup>28</sup>Stout DM, Bradham KD, Egeghy PP et al. American Healthy Homes Survey: A National Study of Residential Pesticides Measured from Floor Wipes. *Environmental Science & Technology*. 2009; 43 (12), pp 4294-4300.
- <sup>29</sup>Weiner BP, and RM Worth. Insecticides: Household use and respiratory impairment. *Hawaii Medical Journal*. 1969; 28(4): 283-285.
- <sup>30</sup>Salameh PR, Baldi I, Brochard P, et al. Respiratory symptoms in children and exposure to pesticides. *European Respiratory Journal*. 2003; 22: 507-512.
- <sup>31</sup>Williams MK, Barr DB, Camann DE et al. An Intervention to Reduce Residential Insecticide Exposure during Pregnancy among an Inner-City Cohort. *Environmental Health Perspectives*. 2006; 114(11): 1684-1689.
- <sup>32</sup>Drug Topics Red Book 2006. Thomson Healthcare.
- <sup>33</sup>Drug Topics Red Book 2008. Thomson Healthcare.
- <sup>34</sup>Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUP). Rockville, MD. 2006. Accessed 12/04/2008: [www.hcup-us.ahrq.gov](http://www.hcup-us.ahrq.gov)
- <sup>35</sup>Kim H, Kieckhefer GM, Greek AA, Joesch JM, Baydar N. Health care utilization by children with asthma. *Preventing Chronic Disease*. 2009; 6 (1). Accessed 1/7/2009: [http://www.cdc.gov/pcd/issues/2009/jan/07\\_0199.htm](http://www.cdc.gov/pcd/issues/2009/jan/07_0199.htm)
- <sup>36</sup>Phipatanakul W, Gold DR, Muilenberg M et al. Predictors of indoor exposure to mouse allergen in urban and suburban homes in Boston, *Allergy*. 2005; 60 (5): 697-701
- <sup>37</sup>Cohn RD, Arbes SJ, Jr., Jaramillo R et al. National Prevalence and Exposure Risk for Cockroach Allergen in U.S. Households, *Environmental Health Perspectives*. 2006; 114(4): 522-526.
- <sup>38</sup>Krieger J, Takaro TK, Song L et al. A Randomized Controlled Trial of Asthma Self-management Support Comparing Clinic-Based Nurses and In-Home Community Health Workers. *Archives of Pediatrics and Adolescent Medicine*. 2009; 163 (2): 141-149.
- <sup>39</sup>Asthma Regional Council. New England Healthy Homes (NEHH) Project Final Report. December 2006.
- <sup>40</sup>Sandel M, Batcheller A, Richman I et al. Can Integrated Pest Management Impact Urban Children with Asthma? Boston University School of Medicine. Department of Pediatrics. 2005. Accessed 11/12/2008: <http://www.healthyhousing.org/clearinghouse/docs/Article0334.pdf>



**Asthma Regional Council**

**Contact:**

**Stacey Chacker, Director**

**Asthma Regional Council of New England**

**[schacker@hria.org](mailto:schacker@hria.org)**

**[www.asthmaregionalcouncil.org](http://www.asthmaregionalcouncil.org)**



**Building a Healthy Boston  
Mayor Thomas M. Menino**

**Boston Public Health Commission**

**1010 Massachusetts Avenue, 2nd Floor**

**Boston, MA 02118**

**Phone: 617-534-5966**

**[www.bphc.org/bphc/healthyhomes\\_main.asp](http://www.bphc.org/bphc/healthyhomes_main.asp)**