

Secondhand cigarette smoke has also been shown to promote inflammation and atherosclerosis and to be a risk factor for illness and death from cardiopulmonary causes — suggesting that exposure to fine particles from common outdoor sources of combustion and from tobacco smoke may invoke similar pathophysiological processes.^{9,10} The Children's Health Study does not provide direct evidence regarding the mechanisms of air-pollution effects, but the authors suggest a role of airway inflammation, such as that observed in smokers and persons who have lived in polluted environments. Although there has been much interest recently in the importance of pulmonary inflammation, atherosclerosis, and cardiovascular disease, the Children's Health Study reminds us not to forget or ignore potentially important effects of pollution on pulmonary function.

From at least one perspective, the overall results of research involving air pollution are good news — the control of air pollution represents an important opportunity to prevent disease. Air pollution is just one of many risk factors for pulmonary and cardiovascular disease, but it is one that can be modified. In the United States and elsewhere, commendable progress has been made on improving air quality and, with regard to fine particulate pollution, new standards have been implemented (Fig. 1). Extremely high concentrations of air pollution remain in many areas of the world, and decreasing these concentrations offers substantial opportunities for disease prevention. As efforts to reduce air pollution progress, debates over the relative benefits and costs associated with additional marginal improvements are inevitable. Nevertheless, continued efforts to improve our air quality are likely to provide additional health benefits.

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Allergen Avoidance to Reduce Asthma-Related Morbidity

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Central to the reduction of the severity of allergic disease is a decrease in — and preferably the removal of — the offending environmental allergen. Such allergen avoidance is particularly relevant to the successful treatment of allergic asthma. However, statistically significant reductions in such asthma-inducing allergen concentrations have been difficult to accomplish. Until recently, strategies to reduce exposure to environmental allergens have

not decreased asthma-related morbidity. In fact, a meta-analysis failed to demonstrate the efficacy of any environmental-control measures in reducing the severity of asthma.¹ Such interventions, however, have usually focused on a single maneuver² — for example, the use of semipermeable bedcovers to exclude dust mites, floor polishing, or the use of high-efficiency particulate air filters — but have not been accompanied by detailed educational pro-

grams regarding the control of environmental allergens.

Any intervention designed to reduce the environmental concentration of a specific allergen must take into account the study subjects' atopic status. Patients with atopic asthma are likely to react to multiple allergens. Most patients with asthma as well as many of their relatives also have allergic rhinitis (hay fever) or eczema (atopic dermatitis). Such affected persons have skin tests, in vitro tests, or both that are positive for a specific IgE antibody against the allergen contributing to their allergic disease. When inhaled, these allergens bind to the relevant IgE antibody on the mast cell, eliciting the release of potent chemical mediators, including histamine, cysteinyl leukotrienes, prostaglandin D₂, and tryptase. The pharmacologic management of such reactions has mainly focused on inhibiting the release of such mediators and their peripheral effects. In contrast, avoidance focuses on reducing ambient allergen concentrations, with a consequent reduction in the concentration of allergens presented to the IgE-sensitized mast cell.

Allergen avoidance as a means of preventing allergic disease has been studied for many years. Rackemann distinguished allergic (extrinsic) asthma from nonallergic (intrinsic) asthma on the basis of the patient's response to an allergen-free hospital room.³ More recent appraisals of environmental control involved children with dust-mite-induced asthma who were temporarily housed in the Alps.⁴ Since the low humidity at such high altitudes inhibits the proliferation of dust mites, the children had a decrease in asthmatic symptoms. Subsequent studies of interventions to reduce exposure to dust mites in the home were summarized in a 2001 Cochrane survey.⁵ Of these 23 studies, 6 used chemical methods, 13 physical methods, and 4 combinations of the two. Using the standardized mean difference in improvement in asthma symptoms, the meta-analysis showed that the current approach to reducing environmental exposure to dust-mite allergens is ineffective.

In fact, two recent articles in the *Journal* failed to demonstrate the efficacy of the use of allergen-impermeable bedcovers.^{6,7} In an accompanying Perspective article, Platts-Mills pointed out that the conclusion to be drawn is not that the use of these bedcovers does not work but that an approach involving allergen avoidance requires the identification of "what patients are allergic to, additional measures beyond the use of mattress covers, and

education."⁸ He emphasized that these studies often involved two kinds of errors: the intervention was insufficient to induce a clinically significant reduction in the level of exposure to the allergen, or the study families made further changes in their lifestyles that had a greater effect than that of the intervention being assessed. The pathogenesis of asthma is not completely understood; thus, alterations in lifestyle, diet, and the environment may significantly increase the prevalence and severity of asthma.

New therapeutic approaches designed to reduce exposure to allergens and asthma-related morbidity continue to be assessed. Presented in this issue of the *Journal* are the results of a successful, multifaceted intervention in the homes of poor urban children with asthma — the Inner-City Asthma Study.⁹ This home-based environmental intervention provided allergen remediation tailored to each child's allergic sensitization and environmental risk factors. A total of 937 children with atopic (allergic) asthma who ranged in age from 5 to 11 years participated in this randomized, controlled trial conducted in seven large U.S. cities. The intervention lasted one year and was followed by a one-year observation period. Each child's bedroom was visually inspected, and dust samples were collected every six months for two years. The children and their primary caregivers were educated about the reasons for and the importance of the intervention, given the tools necessary to perform the remediation, and shown the model behavior. Spirometry was performed at baseline and 12 months after randomization. The primary outcome was the number of days with maximal symptoms.

This individualized, home-based, comprehensive environmental intervention significantly decreased the level of exposure to indoor allergens and reduced asthma-related complications among the children. More than 60 percent of the children's bedrooms had cockroach allergen (Bla g1) at baseline; in fact, 21 percent had cockroach-allergen concentrations on the floor and bed that exceeded 2 U per gram of dust collected. Dust-mite allergen (Der p1 or Der f1) was found in 84 percent of the bedrooms, and 28 percent of the bedrooms had a dust-mite allergen concentration exceeding 2 µg per gram of dust collected. The majority of the children who were sensitive to cockroach allergen (77 percent) and dust-mite allergen (87 percent) had detectable concentrations of these allergens in their bedrooms. The intervention group had fewer symp-

toms of asthma and fewer days with symptoms than the control group during both the intervention year and the follow-up year. The concentrations of cockroach and dust-mite allergens decreased in the bedrooms of both groups over the course of the study. There was a significant relationship between the reduction in the concentrations of both dust-mite allergen and cockroach allergen on the bedroom floor and the reduction in asthma-related symptoms in the intervention group.

A shortcoming of this study was the lack of a more detailed appraisal of the children's airway inflammatory response after the interventions. That aside, the study shows that environmental control of multiple allergens, coupled with repeated educational endeavors, can significantly reduce asthma-related complications among inner-city children with atopic asthma. The results are similar to those of studies evaluating the effects of corticosteroid therapy on asthma. Environmental alteration was central to the improved asthma outcome, a concept that has repeatedly been emphasized in the past decade in statements from the Global Initiative for Asthma¹⁰ and the National Asthma Education and Prevention Program.¹¹ Through the use of this effective intervention, the Inner-City Asthma Study Group has shown the first significant reduction in asthma-related complications induced by the avoidance of environmental allergens.

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