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**NATIONAL
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The Asthma Epidemic:
Prospects for Controlling
an Escalating Public
Health Crisis

The
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Overview—After presenting a definition of asthma, this background paper turns to a review of the epidemiological data that document the nature of the asthma epidemic in the United States. Next, the paper discusses health resources utilization linked to asthma and identifies the subpopulations that are most vulnerable to asthma. A brief assessment of the mechanics of asthma and the challenges of diagnosing the disease follows. Then the paper examines the possible causes of asthma and the asthma epidemic, including indoor and outdoor environmental factors, allergies and possible changes in the immune system, and new theories about the relationship of asthma to overall advances in health care and economic development. After that, medical practice and health care coverage issues are explored, including the progress made in asthma management, possible deficiencies in physician practice, the state of patient information about asthma, poverty-related barriers to asthma diagnosis and management, and the effects of health insurance practices and the managed care revolution on asthma. An examination of the economic implications of asthma and possible cost avoidances linked to better asthma management follows. The paper concludes with a discussion of asthma and public health, including weaknesses in current surveillance for the disease, and a review of the plans of the Department of Health and Human Services (DHHS) for addressing asthma.

In a front-page article in the *New York Times* last fall, a reporter observed, “The rapid rise in asthma, in this country and in developed nations around the world, is one of the biggest mysteries in modern medicine.”¹ Epidemiologic evidence suggests that she was not exaggerating. Data from the Centers for Disease Control and Prevention (CDC) indicate that, between 1980 and 1994, the self-reported prevalence rate for asthma in the United States jumped by 75 percent.² Almost 6 percent of all Americans now have asthma, which has become the most common chronic illness among American children. While overall deaths from asthma remain low—roughly 5,600 per year—asthma mortality rates have more than doubled since the mid-1970s; this is especially troubling given the consensus of professionals that asthma deaths are largely preventable.

While science has not yet conclusively identified the root cause of asthma or discovered the means to limit the current epidemic, the medical technology to control individual cases of asthma exists. Indeed, the American Medical Association (AMA) confidently declares, “The characteristic symptoms of asthma . . . can be controlled. Nearly every person with asthma can expect to become

free of symptoms.”³ However, of special concern from a public policy perspective, available research indicates that asthma is a particular problem for poor inner-city children and for minority group members in general, as evidenced by their notably higher rates of hospitalization and use of emergency rooms for asthma treatment. While the incidence of asthma in these populations is not strikingly higher than in middle-class Anglo populations, asthma clearly affects Americans of color and indigent urban residents more seriously. In part, this differential impact seems to reflect their poor access to medical care of acceptable quality, since medical professionals concur that hospitalization and emergency room treatment should not be part of routine care for the vast majority of asthmatics.

Indeed, the evidence is strong that a significant amount of medical resources are being expended unnecessarily for urgent or emergent care for asthma that could have been kept under control using readily available therapies. To cite just one example, a recent study indicates that asthma is the third leading cause of preventable hospitalizations in the United States.⁴ To put this in context, in absolute dollar terms, the total annual costs of asthma in the United States were estimated to be \$11.3 billion in 1998, of which \$7.5 billion were direct medical expenses.⁵

Given its implications for health care spending in the United States, the asthma epidemic is receiving a great deal of attention as a public policy issue from both the public and the private sectors. Numerous federal agencies—most notably the National Institutes of Health (NIH), the CDC, and the Environmental Protection Agency (EPA)—state and local public health departments, individual practitioners and medical facilities, and health plans are engaged in fighting asthma on a day-to-day basis. Total Medicaid and Medicare expenditures for asthma treatment are estimated to exceed \$1 billion. The federal government is investing more than \$140 million annually on asthma research. Yet critics have raised questions about whether public dollars are being invested wisely in the fight against asthma. While the nation has some capacity to track asthma morbidity and mortality for the population as a whole through surveys, it lacks data on asthma prevalence rates specific to states and localities—the front lines where most public health professionals combat this epidemic.

BACKGROUND

In its authoritative *Guidelines for the Diagnosis and Treatment of Asthma*, the National Heart, Lung, and

Blood Institute (NHLBI) in the National Institutes of Health (NIH) offered the following definition of the disease:

Asthma is a chronic inflammatory disorder of the airways. . . . In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. The inflammation also causes an associated increase in the existing bronchial hyperresponsiveness to a variety of stimuli.⁶

In its *Family Guide to Asthma and Allergies*, the American Lung Association (ALA) points out a defining characteristic of asthma:

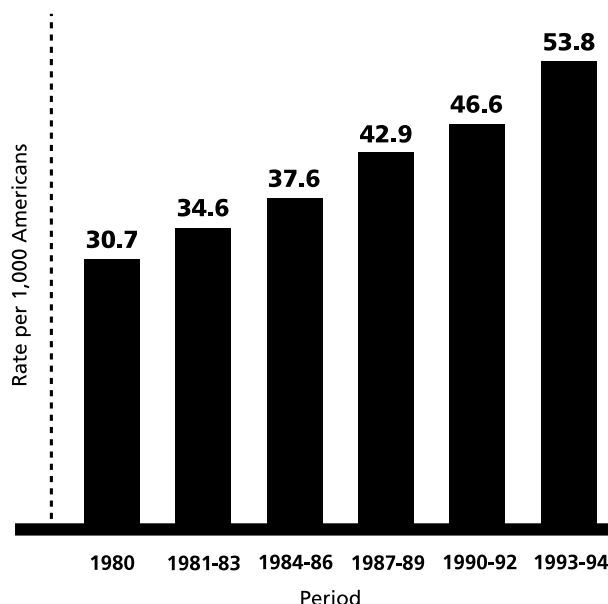
Much has been learned about asthma in recent years, but nothing is more important than the observation that asthma is a disease of airway inflammation. By this physicians mean that people with asthma have chronically inflamed airways that are ever prone to become twitchy and constricted after exposure to an asthma trigger. It is as if the airways of people with asthma are lying in wait for trouble. They stay poised at the edge of a cliff. . . . This means that asthma is both a chronic and an episodic disease.⁷

There are two different forms of asthma. The first, known as *allergic or extrinsic asthma*, is characterized by attacks provoked by exposure to so-called asthma “triggers,” such as pet dander, second-hand tobacco smoke, dust mites, and mold spores. Typically, the onset of this form of asthma occurs before the age 30; indeed, the vast majority of childhood asthma is allergic. The second form, *nonallergic or intrinsic asthma*, manifests itself with the same symptoms as allergic asthma; however, attacks of intrinsic asthma are not triggered by identifiable allergens. While intrinsic asthma can begin at any age, the onset typically occurs in adulthood.

THE ASTHMA EPIDEMIC— A LOOK AT THE STATISTICS

As noted above, the CDC estimates that the prevalence of self-reported asthma among the general population of the United States jumped by 75 percent between 1980 and 1994. Figure 1 illustrates how the prevalence escalated over this period. One of the remarkable things about this escalation is that a substantial increase occurred among all racial and ethnic groups, both genders, and all age groups, with some variations in the rate of increase, which will be discussed below.

Figure 1
Mean Rates of Self-Reported Asthma
U.S. Population, 1980–1994



Source: Centers for Disease Control and Prevention, 1998.
Note: Rates are age-adjusted to the 1970 U.S. Population.

The CDC estimates that asthma affected 14.6 million Americans in 1996. This translates into about 5.5 percent of the total population. (The comparable figure for 1980 was about 3.0 percent.) In its recent report, *Attack Asthma*, the Pew Commission on Environmental Health observes that about half of the cases of asthma in the United States today “are attributable to the rising rates of asthma over the last 20 years.”⁸ In other words, had the escalation in the prevalence of asthma not taken place over the past two decades, only half as many Americans would be experiencing asthma today—in excess of 7 million fewer individuals.

Some might question whether the increased prevalence of asthma can be appropriately characterized as “an epidemic.” One reason is that the term “epidemic” is commonly understood to describe only infectious or communicable diseases, such as tuberculosis or HIV/AIDS. However, the term also encompasses non-communicable diseases such as asthma. *Action Against Asthma*, the strategic plan of the U.S. Department of Health and Human Services (DHHS), notes, “The steady rise in the prevalence of asthma constitutes an epidemic, which by all indications is continuing.”⁹ In his often-cited *Dictionary of Epidemiology*, John Last defines an epidemic as “the occurrence in a community or region of

cases of an illness . . . clearly in excess of normal expectancy.”¹⁰ Thus, the use of the term epidemic seems apt.

The asthma mortality rate has also undergone a dramatic increase. From a low of 8.2 per million Americans between 1975 and 1978, the rate of asthma deaths more than doubled to 17.9 per million for the period 1993 to 1995. As demonstrated in Figure 2, especially noteworthy is the fact that this escalation followed a dramatic decline of over 70 percent in asthma mortality rates from 1960 to 1978. While the number of asthma deaths in the United States—5,637 in 1995—is relatively small in relation to other diseases, it translates into about 15.4 deaths from asthma every day. Furthermore, this trend clearly seems to reflect deficiencies in the delivery of treatment to asthma patients. A securities analyst who specializes in health care observed in the *New York Times* last fall, “Right now, asthma is the only disease category we cover where the death rate is rising. . . . That proves that the disease is not being treated properly.”¹¹

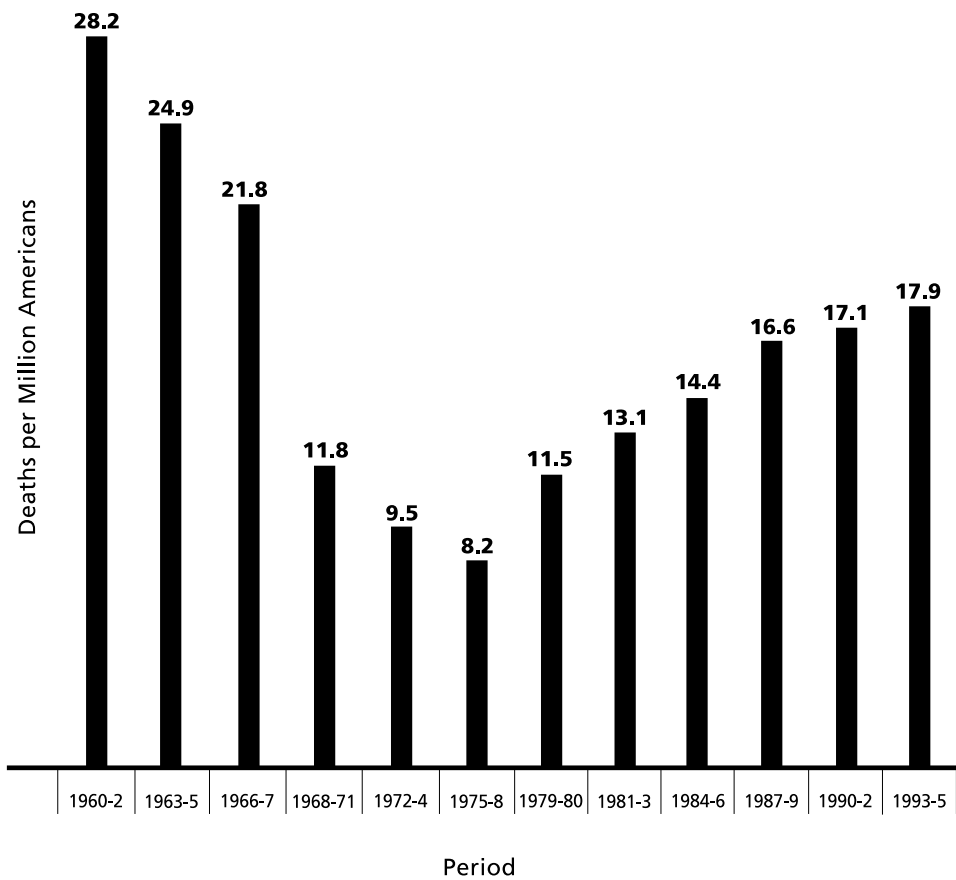
Looking at the nation’s public health goals for asthma as articulated in *Healthy People 2000* and *Healthy People 2010*, U.S. Surgeon General David Satcher observed, “Asthma is one of the areas where we are moving in the wrong direction.”

Trends in Levels of Health Resources Utilization

Both the asthma epidemic and the uncontrolled nature of asthma in many cases are reflected in trends in the levels of the utilization of hospital and other health care resources for asthma patients. CDC data indicate the following:

- From 1975 to 1995, estimated visits to physicians’ offices for asthma more than doubled, from 4.6 million to 10.4 million.¹²
- Between 1979-1980 and 1993-1994, the number of hospitalizations for asthma increased from 386,000 to 466,000—or by almost 21 percent.¹³
- The short-term trend data available for emergency room (ER) visits indicate that, for the three-year

Figure 2
Asthma Death Rates, U.S. Population, 1960–1994



Source: Centers for Disease Control and Prevention.
Note: Rates are age-adjusted to the 1970 U.S. Population.

period 1992 to 1995, there were no major changes in asthma-related ER visits. Nonetheless, asthma was the tenth most common principal diagnosis in ER visits in 1996. (In the same year, asthma was the ninth most frequent diagnosis in hospital outpatient departments.)

Asthma and Vulnerable Subpopulations

CDC data clearly show that, for a variety of reasons, a number of subpopulations of vulnerable Americans are at high risk of developing asthma and/or of suffering from asthma that is poorly controlled. Among these groups are children, the elderly, racial and ethnic minorities, the indigent, people living in urban areas, women, and adults working in certain typically blue-collar jobs.

Asthma among Children. The escalation in the prevalence of asthma among children over the past two decades has been noticeably greater than that among adults. For children under age five, the increase in prevalence between 1980 and 1994 was 160 percent, while the corresponding increase for the general population was 75 percent. Although there are more adult than child asthmatics, the prevalence of asthma among children is higher. Overall, the rate of self-reported asthma for children under 18 in 1995 was 7.5 percent, as contrasted with 5.7 percent for the general population.

Asthma is the most common chronic disease among children. Data from the AMA indicate that asthma accounts for more hospital and ER visits for children than any other reason. Of all age cadres, asthma hospitalization rates are highest for children under age five. (In 1993-94, 49.7 per 10,000 children age four and under were hospitalized for asthma, as contrasted with 18.1 per 10,000 for the population as a whole.)¹⁴

Asthma among the Elderly. Since there is no cure for asthma, it is a disease that many people carry with them into old age, at which time, for a number of reasons, its control is especially difficult. For one thing, both asthma and other diseases with asthma-like symptoms are relatively common among older adults, increasing the difficulty of diagnosis and proper treatment. Among the conditions of old age which are commonly confounded with asthma are emphysema, bronchitis, and chronic obstructive pulmonary disease. Because polypharmacy—the simultaneous use of a number of different prescription drugs—is more common among the elderly, administering asthma medication to them sometimes presents special difficulties related to possible multiple drug interactions and contraindications. Asthma mortality rates are also highest among the elderly, 89.8 per million in 1995, as contrasted with 17.9 per million for the general population.

Asthma, Race, and Ethnicity. In 1995, the rate of self-reported asthma for African Americans was 6.7 percent, as contrasted with 5.6 percent for whites—not a large difference. Yet deaths from asthma are between

two and six times more likely to occur to African Americans and Hispanics than whites.¹⁵

Moreover, hospitalization rates for asthmatic African Americans are almost three times higher than those for whites with asthma. The use of ERs by minorities for asthma care is also markedly higher. These utilization statistics and those for death rates clearly point to less well-controlled asthma among minorities.

Socioeconomic Status, Place of Residence, and Asthma. Clearly, Americans living in poverty face a complex set of variables that predispose them to poorly controlled asthma. As the *New York Times* concisely reported last fall,

The poor tend to have less access to regular medical care, are less able to afford the medications they need and are more likely to be around environmental “triggers” that set off asthma attacks. Also, some researchers have found, families already under great stress are less able to cope with the complicated daily regimen that asthma demands.¹⁶

There are also a number of indications that the asthma epidemic has had a disproportionately heavy impact on urban areas across the country—precisely the areas with some of the greatest concentrations of poverty. The *Atlantic Monthly* in May of this year singled out one of the five boroughs of New York City to report,¹⁷ “[In] the Bronx . . . rates of death from [asthma] are three times as high . . . as they are in the United States as a whole, and hospitalization rates are almost five times as high. In some Bronx neighborhoods, 20 percent of the children have asthma.” The *New York Times* has referred to asthma as “the other inner-city epidemic”—the first being HIV/AIDS. Testimony before the Senate Public Health Subcommittee last fall indicated, “More than 20 percent of U.S. asthma deaths in one year occurred in New York City and Chicago, even though these places had only 7 percent of Americans with asthma.”¹⁸ Dramatically higher asthma death rates also characterize a number of other urban areas across the country.

Among the possible reasons suggested for the seemingly greater susceptibility to severe asthma of Americans living in urban areas—especially poor inner-city children—are greater exposure to outdoor air pollutants (especially diesel fuel fumes), less time spent outdoors (partly because of concerns over crime), substandard housing (including poor ventilation, dampness, and infestation by pests, particularly cockroaches), and greater reliance on hospitals for urgent and emergent care. The associate commissioner of the New York City Department of Health voiced concern

about a pervasive indifference to asthma control by urban parents: “Our major concern was that people were accepting a level of symptoms as being ‘normal.’”

Asthma and Gender. Asthma is more common among boys than girls but becomes more common among women than men as people age. The most recent self-reported rates were 6.7 percent for women and 5.2 percent for men. Between 1980 and 1994, asthma increased 92 percent among women but only 60 percent among men. In the 1993 to 1995 period, asthma death rates for women were slightly higher than those for men (20.0 per million versus 15.1 per million). Hospitalization rates for asthma are also higher among women than men (20.0 versus 15.9 per 10,000 in 1993-94).

Occupational Asthma. Occupational asthma is characterized by development of the disease because of exposure to asthma sensitizers on the job. Since these sensitizers generally include various types of chemicals, industrial and farm workers (particularly animal handlers) are most likely to develop occupational asthma. The leading work-related lung disease, occupational asthma accounts for at least 21 percent of adult-onset asthma.

ASTHMA AS A DISEASE ENTITY

Asthma attacks—especially severe asthma attacks—exact a heavy physical toll. Patients liken asthma attacks to suffocating. *Action Against Asthma* features two graphic descriptions of the experience:

- It’s a full body workout to take each breath. My chest tightens up a lot and it either feels like I have 1,000 pounds of bricks on my chest or that someone has their hands on my lungs and is squeezing with all their might.

—An 18-year-old asthma sufferer

- It means that everyday events like soccer practice, visits with friends who have cats, and even hay rides require vigilance. Most of all, it means a cough is not just a cough. It can be the first cough in a long day and night punctuated every 10 seconds with another sharp little cough.

—A young mother

Or, as the author of an article in May’s *Atlantic Monthly* commented, “What the condition lacks in lethality, it more than makes up for in morbidity: it wears people down, crushes their spirits, and threatens their livelihoods.”

Noreen Clark, dean of the University of Michigan School of Public Health and a prominent researcher in asthma management, elaborates,

Patients and caretakers often become frustrated or even angry because of the burdens that asthma imposes. Episodes of symptoms can be frightening events. A study by our group of children’s asthma attacks found that, during an attack, among low-income mothers of children with asthma, 62 percent felt frightened, 33 percent felt desperate, and 44 percent lacked the confidence to manage the attack. Learning how to cope with fear and anxiety is an important part of patient education.¹⁹

The Mechanics of Asthma

Physiologically, there are three ways in which asthma constricts the airways during an asthma attack:

- Tightening of the muscles encircling the airways, causing the airways to narrow—a phenomenon called bronchospasm.
- Inflammation of the airways, because of the entrance of fluid, blood cells, and irritating chemicals.
- Secretion of abnormal amounts of mucus, sometimes forming what is called a “mucus plug,” which further restricts the passage of air.

As noted above, however, asthma is a chronic condition, and these acute manifestations of the disease are only one element of what needs to be controlled in effective asthma management.

There are gradations in the severity of asthma. These relate to variations in (a) the severity of the chronic disease, (b) the gravity of acute attacks, and (c) both factors over time in an individual.

Diagnostic Challenges

Asthma is often difficult to diagnose. As a result, it is frequently undiagnosed or misdiagnosed. The AMA itself concedes, “Part of the problem lies with doctors who do not keep up with developments in the field of asthma; they may misread asthma symptoms or cling to outdated or inaccurate information.”

But there are several inherent features of the disease which make its diagnosis especially challenging. For one thing, because the disease is both episodic and chronic, diagnosis has a lot to do with timing of patient visits to providers. Symptoms that may be quite evident when an appointment was made may have subsided by the time a practitioner examines a patient. Secondly, asthma is frequently confused with other chronic disorders, such as emphysema, bronchitis, heart disease, cystic fibrosis, and chronic obstructive pulmonary disease. (There is one basic difference, however—most of the airway obstruction caused by asthma can be reversed with medication.)

Diagnosis of asthma in children under age six or seven is fraught with particular difficulties. Such young children often have special difficulty in following directions about the use of equipment to measure lung function, which requires them to exhale continuously at their utmost capacity.

Finally, symptoms vary among patients. For example, while wheezing is thought to be a general characteristic of asthma, not all asthmatics wheeze. It is for reasons like this that the Institute of Medicine (IOM) concluded in its recent report on asthma and indoor air exposures, "These findings raise the question of whether asthma is best thought of as a single disease entity, a syndrome, or a final common manifestation of several different disease processes."²⁰

POSSIBLE CAUSES OF ASTHMA AND THE EPIDEMIC

There are at least three fundamental questions about asthma and the public's health. First, what causes asthma? Second, what has caused the sharp escalation in the prevalence of asthma? Third, what causes the exacerbation of asthma symptoms in some people? Unfortunately, there are no conclusive answers to either of the first two questions; at best, there is suggestive evidence. However, a great deal is known about what exacerbates symptoms for some asthmatics, how those symptoms can be controlled on a short-term basis, and how asthma can be managed to prevent symptoms from occurring over time.

With respect to the first question, the recent IOM report concluded, "No single agent or factor has yet been identified as a necessary or sufficient cause of asthma." Reflecting on the asthma epidemic, Satcher commented, "Until you understand why you have an increase, and you have documented it, it is very hard to say you have a strategy that is going to make a difference." The Pew Commission on Environmental Health succinctly described the state of current science: "While little is known about the factors that cause asthma to develop (and even less about why prevalence rates are going up), more is known about the factors that cause exacerbation of asthma."

Genetic Factors

For some time now, there has been widespread speculation that genetic factors predispose some individuals to asthma. But until very recently, discussion of genetic influences on asthma have remained largely conjectural. The IOM could at best conclude:

Most scientists believe that some individuals have a prior underlying predisposition that permits the evolution of clinical asthma. The development of this predisposition to asthma is dependent on a complex—and at present poorly understood—combination of factors, which are partially inherited and partially acquired later in life. [However,] genetic influence . . . explains only 30-80 percent of the asthma risk. The remaining risk seems to be related to environmental exposure.

As in so many areas of medicine, recent genetic research holds promise for unlocking some of the mysteries of asthma. In June 1999, the *American Journal of Public Health* ran an editorial that reported,

Research focused on gene-environmental interactions holds great promise in treating, managing, and ultimately curing or preventing asthma. . . . Substantial evidence exists for linking several chromosomal regions with the development of asthma. . . . Many of these areas contain genes whose functions may be important to the development of airway inflammation and asthma. Candidate genes . . . that may be important to the pathophysiology of asthma are currently being selected and examined.²¹

Environmental Factors

Despite the promising research on genetic causation of asthma, there is consensus that the human genome could not possibly have changed so radically over recent decades as to explain the escalation of asthma morbidity and mortality over that period. Since there is also general agreement that some combination of genetic and environmental factors eventuates in individual cases of asthma, a number of observers have induced that some sort of dramatic change in the indoor and/or outdoor environments lies at the root of the asthma epidemic.

Discussing the interrelationship of the immune system and the environment in asthma, the AMA's *Essential Guide to Asthma* notes, "In asthma, the immune system overreacts to elements in the environment." Or, as the Pew Environmental Health Commission expresses it, "Genetics loads the gun [through its effects on the immune system] . . . but environment pulls the trigger."

After its exhaustive review of indoor air particulates that might cause asthma, the IOM was compelled to conclude, "We still do not know whether or to what extent the reported increases in asthma can be attributed to indoor exposures."²² However, they reached three strong positive conclusions, namely that there is sufficient evidence of causal relationships between the following:

- Exposure to house dust mite allergen and the development of asthma in susceptible children.

- Exposure to the allergens produced by cats, cockroaches, and house dust mites and exacerbation of asthma in sensitized individuals.
- Environment tobacco smoke exposure and exacerbations of asthma in preschool-aged children.

There is limited evidence that exposure to some of these factors may have increased over the past few decades. For example, it is known that dust mites thrive in indoor environments where air does not circulate. Since the energy crisis of the 1970s, much residential and office building construction has emphasized energy conservation; in general, this means many buildings without windows that open and/or a degree of insulation that allows little air to circulate from the outside. The AMA reports that the number of household pets is on the rise. It is estimated that around 28 percent of U.S. households have cats. The IOM report suggests that one means of reducing risks of asthma exacerbations is to remove cats from the homes of asthmatics. There is also general evidence that people in advanced industrial countries like the United States are spending increasing time indoors, thus elevating the exposure of susceptible individuals to those indoor agents that might cause or exacerbate asthma.

No study has been done of the influence of outdoor air quality on asthma that approximates the recent IOM study in either scope or size. Many observers point to the fact that air quality has been generally improving in recent years as a reason that outdoor air pollution has probably not contributed to the asthma epidemic. However, there is some speculation that the increased usage of diesel fuel may have contributed in some as-yet-to-be-determined manner to the upsurge in asthma, especially in urban areas.²³ The NHLBI *Guidelines for the Diagnosis and Treatment of Asthma* cautions about outdoor air pollution as a cause of asthma exacerbations: “Increased air pollution of respirable particulates, ozone, SO₂ [sulfur dioxide], and NO₂ [nitrogen dioxide] have been reported to precipitate asthma symptoms and increase emergency department visits and hospitalizations for asthma.”

Asthma, Allergies, and the Immune System

Some asthma seems to be rooted in a malfunctioning immune system that overreacts to benign substances in the environment. A British discussion of the asthma epidemic explains this phenomenon as follows:

We all have an immune system which is similar to a defensive army, and this protects us from a huge range of insults which our environment is inclined to throw at us. These include bacteria, viruses, fungi,

yeasts, toxins, and allergens. The prime function of the immune system is to distinguish between invaders that may be harmful from those that are harmless. Thus the immune system should act effectively against microbes which may cause disease, but not react against harmless items such as pollen, dust, dust mite and food molecules.²⁴

Yet it is precisely such “harmless items” that precipitate asthma attacks among those with allergic asthma. In general, allergic reactions are caused by changes or abnormalities in the immune system—hence, the medical subspecialty of allergy and immunology.

“Does Civilization Cause Asthma?”

Last May’s *Atlantic Monthly* article on asthma sums up one recent school of thought about the asthma epidemic:

A number of specialists . . . believe that modern life may be responsible for the developed world’s asthma rates—but in a very unexpected way. [They] believe . . . modern hygiene practices and antibiotics . . . foreclose the need for the young immune system to tackle microbial and parasitic challenges. . . This could explain why children in the developing world, who are repeatedly infected by bacteria and parasites, are unlikely to contract asthma, whereas children in the developed world, who are inoculated against infectious diseases and frequently given antibiotics, are contracting asthma in ever greater numbers.

Related variations of this theory are that children are getting less healthy outdoor exercise—what might be called the “couch potato corollary”—that the migration of people from rural to urban areas has reduced their exposure to organic factors that strengthen the immune system, and that the widespread use of antibiotics, while reducing the incidence of some infections, may be contributing to the upsurge in asthma by retarding the development of immune responses.

These theories are still highly conjectural at this stage. Research is currently under way to test these hypotheses.²⁵

MEDICAL PRACTICE AND HEALTH CARE COVERAGE ISSUES

Nevertheless, despite the somewhat rudimentary stage of the knowledge about the etiology of asthma and the reasons for the current epidemic, there seems to be consensus that all but the most severe cases of asthma can be controlled and that almost every American with asthma can enjoy a life largely free of symptoms. Yet there are troublesome signs that the health care delivery system is not keeping up with the epidemic, with attendant costs for

both the national economy and for asthmatics themselves. As Michael Rich, a pediatrician and child health researcher at Harvard Medical School, remarked, “Billions of dollars are being spent on [asthma], and we know a lot about it, yet it’s getting worse, because we’re not asking the right questions. The real question is, what stands in the way of knowledge being translated into behavior?”²⁶

Changing Science and Changing Therapies

There has been continued progress in developing new asthma therapies—particularly pharmaceuticals and devices—both making the control of asthma far easier and reducing possible side effects. Unfortunately, for a number of reasons, these therapies are not being made available to all Americans with asthma.

One prominent researcher has likened the introduction of inhaled steroids for asthma to the discovery of penicillin: “It turned treatment of asthma around completely.” Corticosteroids were first prescribed for asthma patients in the 1960s and have proven very effective in long-term asthma control. In the early 1980s, steroid inhalers were first introduced—a major technological advance that targeted the lungs with the drug, pumped less of it into the rest of the body, and made daily use easier. The ALA declares, “Gone are many of the side effects and cumbersome delivery devices that complicated early asthma medications.”

In essence, corticosteroids suppress the activity of immune system cells that release inflammatory chemicals. It was not until the 1990s, however, that the salience of inflammation as a factor in asthma attacks was fully appreciated and the key role of corticosteroids in suppressing inflammation was completely understood. Furthermore, a significant problem with these drugs—which should not be confused with anabolic steroids, the controversial drugs used by some athletes—is their potential long-term side effects, which include growth retardation (obviously a special concern for pediatric patients), glaucoma, hypertension, and osteoporosis.

Another important development has been the formulation and issuance of national clinical practice guidelines for asthma. In 1991, following a process of broad consultation with experts in the field, the National Asthma Education and Prevention Program (NAEPP) in the NHLBI released its *Guidelines for the Diagnosis and Management of Asthma*, which translate advances in the scientific understanding of asthma—particularly the role of chronic inflammation—into practical recommendations for controlling persistent asthma. An updated edition of the guidelines was issued in 1997.

The NAEPP/NHLBI guidelines establish a number of goals for asthma therapy:

- Preventing chronic and troublesome symptoms.
- Maintaining (near) “normal” pulmonary function.
- Maintaining normal activity levels (including exercise and other physical activity).
- Preventing recurrent exacerbations of asthma and minimizing the need for emergency department visits or hospitalizations.
- Providing optimal pharmacotherapy with minimal or no adverse effects.
- Meeting patients’ and families’ expectations of and satisfaction with asthma care.

The guidelines proceed to offer health care professionals detailed advice on how best to meet these goals. They stress the importance of teaching asthma self-management and prevention to patients and underscore the key role of the partnership between patients and physicians.

The most recent edition of the guidelines is 146 pages long and quite detailed. To make their content more accessible to practitioners, the NAEPP has issued a more convenient *Practical Guide for the Diagnosis and Management of Asthma*, which is published in a larger print, bulleted format and totals only 52 pages.²⁷

Deficient Medical Practice

A number of sources speculate that primary care physicians may not be as knowledgeable about asthma or as up-to-date as they should be about advances in asthma treatment. For example, the DHHS strategic plan, *Action Against Asthma*, suggests, “Recent evidence indicates that many health care providers do not follow the *Guidelines* for the diagnosis and treatment of asthma. Failure to follow clinical guidelines stems in part from factors related to knowledge, attitudes, and behavior.”

There is also general concern that many physicians are addressing asthma on only a short-term, palliative basis. That is, they are helping patients address asthma attacks without getting at the underlying disease through a course of long-term therapy. May’s *Atlantic Monthly* asserts, “Some physicians are unaware that asthma is a chronic disease requiring constant vigilance. Many doctors seem to be prescribing drugs to curtail asthma episodes rather than caring for the patient who suffers them.”

Problems in primary care physician relationships with their asthmatic patients seem to be underscored by

statistics cited at the Senate Public Health Subcommittee hearings on child health last fall:

More than 90 percent of children who present to the emergency department with an asthma attack have a primary care provider. Despite this, two-thirds go directly to the emergency department when having problems with their asthma and one-third rely on the emergency department for *all* of their asthma medications.²⁸

Furthermore, financial pressures may in some instances be undercutting the ability of physicians to invest the amount of time in patient education needed by asthmatics. One physician observed,

When I first see a patient [who has asthma], I spend an hour with him. . . . I can do this because I'm an academic physician who gets paid by the year, not by the patient. A general pediatrician working under managed care has to see four to six patients an hour—he doesn't have the time to talk about diet, exercise, the kid's environment. And that's why these kids keep ending up in the ER.

Finally, there is speculation that some physicians may not be as up-to-date on current asthma medications as they should. The *AMA Essential Guide to Asthma* emphasizes,

Different medications with serious side effects are introduced each year. New studies document asthma triggers and evaluate drug reactions. Your doctor needs up-to-date expertise to integrate this information into the long-term program that works best for you.

Confused, Uninformed, or Noncompliant Patients

A number of observers emphasize the difficulty patients experience in adapting to an asthma treatment regimen. For severe asthma, some have likened the complexity of therapies to those for treating HIV/AIDS. Yet even treatment for routine asthma can be burdensome. A prominent physician-researcher observed to a *New York Times* reporter,

Asthma takes a lot of work. . . . You have to take daily medication, at fixed intervals, and sometimes in response to changes in symptoms. And inhalers are fundamentally unpleasant devices. Many patients have at least two inhalers that have to be taken at different times. The more you ask patients to do, the less they do.

He went on to express concern that many patients and parents do not get appropriate guidance on how to treat the disease: "They're just handed a prescription and told to use it, without an in-depth explanation of the disease."²⁹

Noreen Clark underscores the crucial role of patient judgment in the management of asthma:

Asthma management requires a high degree of judgment on the part of the patient. There is no absolute recipe for successful control. Sometimes asthma symptoms are predictable and sometimes they are not. A patient needs to be highly self-regulating, that is, have the ability to observe, judge, and act on the basis of subtle changes in symptoms or peak flow [respiratory] values or functional status. It may be that developing skills of self-regulation is more important than learning asthma facts.

Patients who experience symptoms more than twice a week generally need two different types of drugs, a "long-term control medication" that suppresses inflammation over a lengthy period (for example, a corticosteroid) as well as a "quick-relief medication" that opens airways and facilitates breathing when an asthma attack occurs. Getting patients to adhere to this treatment regimen—especially indigent patients who lack adequate third-party coverage—has proven difficult. Many patients tend to rely solely on the "quick-relief" drug.

The *Washington Post* reports that fewer than 20 percent of Americans with asthma use anti-inflammatories, as contrasted with 65 percent of asthmatics in Europe. In general, physician failure to prescribe the medication seems to be at the root of the problem. However, patient nonadherence to prescriptions may also play a role. According to a physician at the Institute for Asthma and Allergy at the Washington Hospital Center,

Corticosteroids don't make you feel better immediately. The emergency medicine makes you feel better but doesn't address the underlying problem. . . . [As a result,] the most important medicine is the one people feel they don't need, so they stop taking it and get into trouble.³⁰

Action Against Asthma declares without qualification, "Effective medical management and patient education reduces the use of emergency services and improves quality of life." Thus, the bottom line issue appears to be in part how to promote effective patient education.

Poverty-Related Barriers to Diagnosis and Management of Asthma

At its hearing last fall, the Senate Public Health Subcommittee was informed about a basic complex of obstacles to patient compliance: "Poverty, single parent families, and multiple caregivers are major barriers to adherence with complex chronic treatment regimens." A physician who practices in a low-income section of Washington, D.C., expressed the same thought some what differently: "To manage asthma well you need a

functioning medical system, society, and family.” A *Washington Post* reporter observes, “Good care is a cumbersome, labor-intensive, costly process—which is why so many financially hard-pressed families end up doing little or nothing until a crisis hits and they must rush their kids to the emergency room.” Even such structural barriers as deficient or inconvenient public transportation systems contribute to impeding access by poor families to needed ongoing asthma care.

But the problem seems tied to something more basic than any of these poverty-related variables. Access to medical care of acceptable quality is a basic problem for indigent patients. Irwin Redlener, M.D., president of the Children’s Hospital at Montefiore Medical Center in the Bronx points out,

If you cannot at the end of the day provide the medical care that you have educated people about, you have only completed half the bargain and you end up with some very frustrated families. . . . We have patients coming to us who have learned from the public education campaign who say to us, ‘But we need a doctor.’

The end results are evident in one study of asthma care in New York City, which found that there were 223 ER visits for asthma for every 10,000 Spanish Harlem residents, while certain wealthy lower Manhattan districts had no ER visits for this problem.³¹

Health Insurance Practices and the Managed Care Revolution

This year, the Administration for Healthcare Research and Quality (AHRQ) issued a study indicating that in 1996 about 78,000 hospital admissions for asthma among children were covered by Medicaid, 68,000 admissions were paid for by private insurance, and 8,000 children without insurance were admitted for asthma. Hospital admissions for asthma were proportionately lower for children with private insurance than for either children with Medicaid or uninsured children—2.1 percent, 3.2 percent, and 2.6 percent, respectively.³²

Even those who have private insurance coverage face certain barriers to care for their asthma, including restrictions on the number or length of preventive or follow-up visits, limits on reimbursements, and lack of coverage for patient education or case management. The obstacles faced by those covered by managed care may be even more challenging, insofar as they relate to gatekeeping requirements and limits on provider panels.

For routine cases of asthma, most primary physicians should be able to treat patients appropriately. (As noted

above, this supposes that they are both knowledgeable and not confronted by productivity constraints that prevent them from spending adequate time with asthmatic patients.) However, for more severe cases of asthma, treatment by *experienced* providers—or in some cases, specialists such as pulmonologists or allergists—is necessary. Insofar as managed care physician panels lack sufficient numbers of such experienced providers or specialists, or if managed care gatekeeping impedes the access of severely asthmatic patients to such providers, managed care poses an obstacle to acceptable quality asthma care. Similarly, some managed care plans may steer patients with serious asthma away from tertiary care hospitals because of perceived higher costs.

On the other hand, managed care holds significant promise for asthma treatment. Along with diabetes, asthma has been singled out by a number of managed care organizations (MCOs) for special disease management initiatives. This is partly because of the dividends to health plans’ case management initiatives from even relatively short-term interventions to prevent asthma attacks from escalating to the point of a need for emergency care. By offering asthmatics a “medical home” with continuity of care, managed care can also make an important contribution to controlling asthma.

Furthermore, the National Committee for Quality Assurance (NCQA), an accrediting organization whose proclaimed mission is “to evaluate and report on the quality of the nation’s managed care organizations,” has incorporated an asthma measure in its most recent edition of HEDIS (the Health Plan Employer Data and Information Set), its performance measurement tool for MCOs. This new asthma indicator, “Appropriate Medications for People with Asthma,” measures the percentage of MCO members with asthma who receive medications recommended as primary therapy for long-term control of the disease, including inhaled corticosteroids. (NCQA explains that addition of another proposed HEDIS asthma measure, “Emergency Room Visits for People with Asthma,” was “postponed due to technical considerations.”)

ECONOMIC IMPLICATIONS OF ASTHMA

Testimony presented to the Senate Public Health Subcommittee last fall indicates:

More than 80 percent of the total direct costs of asthma result from the 20 percent of the asthma patients who have significantly greater morbidity measures and who are readily identifiable as the

highest users of hospital-based asthma services. In 1990, nearly half of all asthma health care costs were due to severe illness consequences such as hospitalizations and emergency room visits.³³

This evidence suggests the possible merits of targeting asthma cost-containment efforts on the minority of high-cost patients.

Direct and Indirect Costs

An analysis done of medical expenditures for asthma in 1990 indicates that the estimated \$3.64 billion in direct costs were broken down approximately as follows:³⁴

- Inpatient hospitalization, 43 percent.
- Prescription medications, 30 percent.
- Physician-related services, 14 percent.
- ER visits, 8 percent.
- Outpatient hospital visits, 5 percent.

This evidence suggests that asthma cost containment efforts ought to focus on inpatient hospitalization, prescription drugs, and ER visits, assuming that physician services and hospital outpatient care are for the most part necessary and efficiently delivered.

Of the estimated \$11.3 billion total costs of asthma in 1998, \$3.8 billion, or roughly 34 percent, were calculated to be indirect costs. These indirect costs included lost work time, missed school days, and limitations on daily activity. *Healthy People 2010* indicates that 19.5 percent of people with asthma in the period 1994 to 1996 had activity limitations. It also points out that asthma ranks as the fourth most common chronic condition in the United States.

It is estimated that children with asthma miss three times as many school days as their classmates without the disease. A school director from East Harlem characterizes asthma as “an assault on the children” and describes the consequences for their education: “The time that is lost from the classroom, you can’t recover that time. . . . With kids that are coming in with several strikes against them to begin with, this just complicates matters.”

Potential Cost Avoidances

No one appears to have developed an estimate of how much might be saved if asthma in the United States were truly under control—if the disease were being optimally diagnosed and managed in keeping with available guidelines and technology. However, using the percentages cited above, it is at least concep-

tually possible to estimate that eliminating unnecessary emergency room visits and inpatient hospitalizations is likely to save billions of dollars. Obviously, there would be additional savings in such indirect costs as reduced productivity and lost school and work days, as well as added years of life for those who would otherwise die as a result of asthma.

One of the physicians testifying before the Senate child health hearing last fall pointed out,

Approximately 50 percent of the economic impact [of asthma] is associated with emergency department visits, hospitalization, and death—in other words, expenditures related to asthma exacerbations rather than the management of chronic stable asthma.³⁵

The AMA *Essential Guide to Asthma* notes, “The key to living a healthy life with asthma appears to be preventing emergencies; a comprehensive medical plan along with monitoring of the person’s condition are the keys to stopping asthma attacks before they start.” The same observation might be made about the centrality of preventing emergencies to avoiding unnecessary costs of asthma. The interventions needed to prevent asthma emergencies are spelled out in the NAEPP’s asthma guidelines.

Here again, effective patient education is a linchpin of successful asthma management. Clark points out,

Outcomes achieved through well-conceptualized and well-delivered patient education have been shown to include reductions in school absences and use of emergency department and hospital services, increases in patient self-efficacy, and use of asthma-management strategies, less frequent wheezing, and improved academic performance.

ASTHMA AND PUBLIC HEALTH IN THE UNITED STATES

There are a number of different reasons why asthma warrants the attention of health policymakers at all levels of government. Among these are the overall costs of treating the disease; the effects on citizens’ lives, education, and incomes; the promise of available therapies and patient and provider education for reducing these costs; and the practices of third-party payers that may result in inefficient and/or inappropriate asthma coverage limitations.

Surveillance for Asthma

One of many impediments to developing a coherent national asthma strategy is the highly-decentralized

nature of the nation's public health system. The loci of most of the nation's public health activity related to asthma and many other major diseases are state and local (primarily county) governments. As might be expected, given such a large element of state and local control, the capacity of the public health system to confront a challenge like the asthma epidemic is extremely uneven. Local health departments vary from storefront operations with a staff of only a few professionals in rural areas to large, complex bureaucracies like those in New York and Los Angeles.

A related problem is that surveillance is largely a matter of state volition. Because epidemics like asthma are no respecters of state boundaries, this yields a public health dilemma—states with aggressive surveillance systems for asthma and other diseases may find the effectiveness of their efforts compromised by neighboring states that choose not to engage in surveillance. This problem is especially likely to affect multi-state metropolitan areas.

It is therefore not surprising that one of the major factors standing in the way of a national asthma strategy is the lack of a strong surveillance system to track changes in the prevalence of asthma at the subnational level. While a number of other diseases are reported through state and local health departments to the CDC, which tracks trends in these diseases and reports them back to state and local governments, no such system exists for asthma. A 1996 CDC survey showed that 27 states had no ongoing asthma monitoring or tracking systems.

Satcher has stated, "In public health, we can't do anything without surveillance. . . . That's where public health begins." Indeed, one of the basic principles of public health is that "to measure is to get it done." If a public health agency does not know the specifics of what it is tracking, it cannot measure the progress it has made. To employ a mixed metaphor used by Health-Track, a Georgetown University environmental health project, in its recent report on asthma surveillance, "In our fight against asthma, we have given public health professionals not radar, but a blindfold, and then asked them to perform like a circus knife-thrower."³⁶

Most indications are that the costs of putting a national asthma surveillance system in place would be more than offset by the savings resulting from better control of the disease. Among the very real impediments to implementing such a system, however, are the demands it would place on physicians, hospitals, and other health care providers to report asthma cases.

DHHS Strategic Plans and Asthma

Asthma is a major focal point for *Healthy People 2010*, the federal government's strategic public health plan for the next ten years. The plan has eight goals related to asthma, among them sizable reductions in the rates of asthma-related deaths, hospitalizations, and ER visits. Somewhat more nebulous are goals related to reducing the rate of activity limitations among people with asthma and increasing the ratio of people with asthma who receive patient education. Labeled "developmental" are goals addressing reduction in the number of missed school or work days, increasing the proportion of people with asthma who receive care in accordance with the NAEPP guidelines, and establishing a surveillance system for tracking asthma in at least 15 states, which would include data on asthma deaths, rates of illness, levels of disability, and the impact of occupational and environmental factors on asthma. (The goals designated "developmental" are contingent on the development of data sources.)

Healthy People 2000 also had three asthma-related objectives: (a) a reduction in asthma hospitalizations from 188 per 100,000 in 1987 to no more than 160 per 100,000 in 2000, (b) a reduction in activity limitations among people with asthma from 19.4 percent in 1986-1988 to 10 percent, and (c) a general increase in the proportion of people with chronic and disabling conditions who receive patient education from a baseline of 9 percent in 1991 to 50 percent in 2000. Limited progress was reported in increased patient education rates, while the rates of hospitalization and limitations on activity both increased—in part, perhaps, because of the increased prevalence of asthma.

Action Against Asthma, the DHHS strategic plan issued in May 2000, identifies four relatively broad "priorities for investment":

- Determine the causes of asthma and develop interventions to prevent its onset.
- Reduce the burden of asthma for people living with the disease.
- Eliminate the disproportionate burden of asthma in minority populations and those living in poverty.
- Track the disease and assess the effectiveness of asthma programs.

These sweeping, rather all-encompassing priorities from *Action Against Asthma* seem to complement the more specific, quantified goals set forth in *Healthy People 2000* and *Healthy People 2010*.

WHAT DO CURRENT TRENDS PORTEND?

In its report on asthma last year, the Pew Commission on Environmental Health projected a rather bleak scene in the face of no substantial change in public policy:

By the end of this decade, if no action is taken to reverse this trend and it continues its current pace, the Commission calculates that 22 million Americans will suffer from asthma—eight million more than at present. That’s one in 14 Americans and one in every five families forced to live with the disease. By 2020, the Commission estimates that the number could increase to 29 million—more than twice the current number.

In response to these projections, the commission recommends a set of ambitious goals, including cutting the number of asthma cases in half by 2020; implementing a national surveillance system within five years; investing the surgeon general with line authority to oversee all federal asthma efforts; instituting a system within one year at CDC that would track and investigate every asthma death in the country; and establishing a comprehensive public education campaign on asthma within two years.

Yet there is reason to question the short-term feasibility of not just these recommendations, but also those of DHHS. Last year’s Senate hearing on child health heard testimony from a leading authority about just what currently can be done about asthma:

We currently do not have the basic knowledge needed to prevent asthma. What we do now have is the knowledge to prevent the major impact of asthma on children; the knowledge to prevent deaths, frequent hospital admissions and emergency room visits, school absences, and prevent other adverse consequences of poorly controlled asthma such as lack of participation in school physical education and sports. Thanks to efforts of the [NAEPP], we have guidelines on how childhood asthma should be treated. We have effective medications, and we know what children can do to reduce the burden of asthma on their lives.³⁷

While the testimony addresses asthma among children, the points made in it seem equally applicable to the nation’s capacity to address asthma among the adult population.

ENDNOTES

1. Sheryl Gay Stolberg, “Poor People Are Fighting Baffling Surge in Asthma,” *New York Times*, October 18, 1999, A1, A18.

2. David M. Mannino et al., “Surveillance for Asthma—United States, 1960-1995,” *Morbidity and Mortality Weekly Report*, 47 (April 24, 1998), SS-1, 1-30. In the executive summary of its recent report, *Clearing the Air: Asthma and Indoor Air Exposures*, the Institute of Medicine notes: “The prevalence of asthma in some other parts of the world—including Australia, New Zealand, Ireland, and the United Kingdom—exceeds that of the United States.”

3. American Medical Association. *Essential Guide to Asthma* (New York: Pocket Books, 1998), 1.

4. G. Pappas et al., “Potentially Avoidable Hospitalizations: Inequalities in Rates between U.S. Socioeconomic Groups,” *American Journal of Public Health*, 87 (1997): 811-16.

5. National Health, Lung, and Blood Institute, *Morbidity and Mortality: 1998 Chartbook on Cardiovascular, Lung and Blood Diseases* (Bethesda, Md.: National Institutes of Health, October 1998).

6. National Heart, Lung, and Blood Institute, *Guidelines for the Diagnosis and Management of Asthma*, Expert Panel Report 2, Clinical Practice Guidelines, NIH Publication 97-4051 (Bethesda, Md.: National Institutes of Health, July 1997), 8.

7. American Lung Association Asthma Advisory Group with Norman H. Edelman, *Family Guide to Asthma and Allergies* (Boston: Little, Brown, and Co., 1997), 11.

8. Pew Environmental Health Commission, “Attack Asthma: Why America Needs a Public Health Defense System to Battle Asthma Threats,” Baltimore, 1999, 10; accessed June 30, 2000, at <http://www.pewenvirohealth.jhsph.edu>.

9. U.S. Department of Health and Human Services, *Action Against Asthma*, Department of Health and Human Services, Washington, D.C., May 2000, 1; also available at <http://aspe.hhs.gov/sp/asthma>.

10. John M. Last, *A Dictionary of Epidemiology* (New York: Oxford University Press, 1995).

11. David J. Morrow, “New Treatments Lag in Fighting Asthma,” *New York Times*, October 19, 1999, D5.

12. Repeat visits could not be netted out from these totals, so the number of individual patients involved could not be determined. Furthermore, while it may be assumed that most of these ambulatory visits were for appropriate reasons, some may have been urgent visits for uncontrolled asthma that might have been unnecessary if the patients’ asthma had been under control.

13. Again, there is no way of determining how many individual asthma patients were involved. However, with inpatient hospitalization, it can be assumed that a sizable number entailed admissions for uncontrolled asthma that might have been handled on an ambulatory basis if intervention had occurred early enough. Nevertheless, in light of the concurrent increase in the prevalence of asthma—which increased by about 75 percent over the same period—the rate of hospitalizations across the asthmatic population has actually

declined over this period.

14. With respect to childhood asthma being treated on an ambulatory basis, the *New York Times* notes, "Asthma has become so prevalent that some states, including New York, have begun passing laws allowing children to carry the medication with a doctor's permission, bypassing the usual requirements that drugs be administered by a nurse." In many states where such legislation has not been enacted, child advocates are working for its passage.

15. It is important to note, however, that the Hispanic population is hardly homogeneous in its experience with asthma. Asthma morbidity and mortality tend to be higher among Puerto Ricans than among Mexican-Americans or Cubans. See David M. Homa, David M. Mannino, and Marielena Lara, "Asthma Mortality in U.S. Hispanics of Mexican, Puerto Rican, and Cuban Heritage," *American Journal of Respiratory Critical Care Medicine*, 161 (2000): 504-509. See also Marielena Lara et al., "Elevated Asthma Morbidity in Puerto Rican Children: A Review of Possible Risk and Prognostic Factors," *Western Journal of Medicine*, 170:2 (2000), 75-84.

16. Stolberg, "Poor People."

17. Ellen Ruppel Shell, "Does Civilization Cause Asthma?" *Atlantic Monthly*, May 2000.

18. Carlos Camargo, M.D., Dr.P.H., Department of Emergency Medicine, Massachusetts General Hospital, and research epidemiologist, Harvard Medical School, testimony before U.S. Senate Committee on Health, Education, Labor, and Pensions, Subcommittee on Public Health, hearing on "Children's Health: Protecting Our Most Precious Resource," September 16, 1999; accessed April 28, 2000, at <http://www.senate.gov/~labor/hearings/septhear/091699wt/091699wt.htm>.

19. Noreen M. Clark, "Management of Asthma by Parents and Children," in *Self-Management of Asthma*, ed. Harry Kotses and Andrew Harver (New York: Marcel Dekker, Inc., 1998), 276-77.

20. Division of Health Promotion and Disease Prevention, prepublication copy/uncorrected proofs, "Clearing the Air: Asthma and Indoor Air Exposures," Institute of Medicine, Washington, D.C., 2000, 1-4.

21. Rachel L. Miller, "Breathing Freely: The Need for Asthma Research on Gene-Environment Interactions," *American Journal of Public Health*, 89 (June 1999): 820.

22. The IOM study meticulously reviewed available scientific evidence related to asthma causation. The authors carefully sifted through these data to rank causal factors as to whether there was (a) sufficient evidence of a causal relationship, (b) sufficient evidence of an association, (c) limited or suggestive evidence of an association, (d) inadequate or insufficient evidence to determine whether or not an association exists, or (e) limited or suggestive evidence of no association.

23. Recently, for example, the director of environmental health for the District of Columbia asked the area transportation authority "to test expensive, cleaner-burning buses and move away from its all-diesel fleet," because of a belief that diesel buses are linked to a higher asthma rate among District residents. See Lindsay Layton, "Drive against Diesel Buses Armed with Asthma Data," *Washington Post*, July 6, 2000, B4.

24. John Mansfield, *Asthma Epidemic: Tackle the Causes, Find Relief Without Drugs* (London: Thorson's, 1997), 10.

25. As this background paper went to press, research findings from Arizona suggesting that exposure of young children to older children at home or to other children at day care protects against the development of asthma were published in the *New England Journal of Medicine*. See Thomas M. Ball et al., "Siblings, Day-care Attendance, and the Risk of Asthma and Wheezing during Childhood," *New England Journal of Medicine*, 343 (August 24, 2000), 538-43.

26. Shell, "Does Civilization."

27. National Heart, Lung, and Blood Institute, *Practical Guide for the Diagnosis and Management of Asthma*, NIH Publication 97-4053 (Bethesda, Md.: National Institutes of Health, October 1997).

28. Camargo testimony.

29. Denise Grady, "Perseverance Is Key to a Good Life With Asthma," *New York Times*, October 19, 1999, D1, D5.

30. Arthur Allan, "Breath of Life: Childhood Asthma Has Skyrocketed in the Past Two Decades," *Washington Post Magazine*, October 31, 1999, 8ff.

31. Allan, "Breath of Life."

32. Marie C. McCormick et al., "Annual Report on Access to and Utilization of Health Care for Children and Youth in the United States, 1999," *Pediatrics*, 105, no. 1 (January 2000): 219-230.

33. John C. Carl, M.D., assistant professor of pediatrics, Case Western Reserve University School of Medicine, and member, Division of Pediatric Pulmonology, Rainbow Babies and Children's Hospital, Cleveland, Ohio, testimony before U.S. Senate Committee on Health, Education, Labor, and Pensions, Subcommittee on Public Health, hearing on "Children's Health: Protecting Our Most Precious Resource," September 16, 1999; accessed April 28, 2000, at <http://www.senate.gov/~labor/hearings/septhear/091699wt/091699wt.htm>.

34. Kevin B. Weiss, Peter J. Gergen, and Thomas A. Hodgson, "An Economic Evaluation of Asthma in the United States," *New England Journal of Medicine* 326 (1992): 862-866. The percentages sum to more than 100 because of rounding.

35. Camargo testimony.

36. Health-Track, *Blindfolding Public Health in the Fight against Asthma*, Health-Track, Washington, D.C., May 22, 2000.

37. Dennis C. Stokes, M.D., testimony before U.S. Senate Committee on Health, Education, Labor, and Pensions, Subcommittee on Public Health, hearing on “Children’s Health: Protecting Our Most Precious Resource,” September 16, 1999.