E xtensive toxicologic, experimental, and epidemiologic research, largely carried out since the 1950s, has established that active cigarette smoking is the major preventable cause of morbidity and mortality among adults in the United States.\textsuperscript{1,2} The evidence also indicates that the deleterious effects of active smoking extend to the unborn child of the smoking mother; maternal smoking during pregnancy reduces birth weight and increases risk for miscarriage, premature labor and delivery, perinatal morbidity and death. Exposure to environmental tobacco smoke (ETS) has also been found to be a cause of preventable morbidity and mortality in nonsmokers, both children and adults (Box 1). The 1986 reports of the Surgeon General on smoking and health\textsuperscript{3} and of the National Research Council\textsuperscript{4} comprehensively reviewed the data on ETS exposure to tobacco smoke and reached comparable conclusions with significant public health implications; both reports con-
cluded that exposure to ETS causes respiratory disease, including lung cancer, in nonsmokers. In 1992, the U.S. Environmental Protection Agency (EPA) published its assessment of the respiratory effects of ETS exposure and provided population estimates of the burden of malignant and nonmalignant lung disease associated with such exposure. The agency’s report reaffirmed the conclusions of the earlier reports, and its estimates indicated that ETS exposure posed a significant and substantial public health problem for children and adults. The EPA’s classification of “environmental tobacco smoke” as a Class A carcinogen is likely to prompt further efforts to control tobacco smoking in the workplace and in public and commercial environments.

This review considers the effects of involuntary exposures to tobacco smoke on the health of children. These exposures occur to the unborn child as components of tobacco smoke cross the placenta to the fetal circulation and after birth as the child breathes tobacco-smoke-contaminated air at home, in vehicles, and in public places. Estimates of the number of exposed children and the associated morbidity indicate a significant and largely avoidable public health problem for which broad policy initiatives are needed. In formulating policies for ameliorating the health consequences of tobacco smoking, however, involuntary exposure of children to tobacco smoke has received limited attention, perhaps because the home, the dominant locus of exposure, is an environment not typically subject to regulation. In considering approaches for minimizing the exposure of children to tobacco smoke, we emphasize the lessons that have been learned in reducing active smoking and controlling tobacco smoking in public places, and make suggestions for areas where more aggressive actions may be indicated.

The central evidence on smoking and children comes largely from epidemiologic research, scientific investigation conducted in human populations. The epidemiologic evidence is primarily nonexperimental (observational) and subject to biases which may limit interpretation. Consequently, critics of the findings of adverse effects of smoking on health have attempted to dismiss epidemiologic research as observational and, therefore, unable to establish cause-effect relationships. On the other hand, the potential limitations of epidemiologic data have long been recognized and taken into account by the many expert panels that have examined the research findings on smoking and health (see, for example, the 1964 and 1986 reports of the Surgeon General). As the data on involuntary smoking and child health have accumulated during the past 20 years, adverse effects have been found consistently with different investigational approaches and in different countries. This consistency along with demonstration of dose-response relationships between measures of exposure and health effects strengthen arguments that the observed associations are causal. Moreover, the epidemiological studies may underestimate the actual effects of involuntary exposure to tobacco smoke because of the inherent inaccuracy of the exposure measures used in research and the nearly universal exposure to tobacco smoke.

Of necessity, this article is selective in its review of a large body of scientific evidence on child health and involuntary exposure to tobacco smoke. Several recent reports provide comprehensive coverage of the topic of smoking and children. The subject has been addressed in the series of reports on smoking and health of the
Involuntary Exposure to Environmental Tobacco Smoke (ETS)

Characteristics
Nonsmokers inhale environmental tobacco smoke (ETS), a term widely used to refer to the combination of side-stream smoke released from the cigarette’s burning end with mainstream smoke exhaled by the active smoker. The inhalation of ETS is generally referred to as passive smoking or involuntary smoking. The exposures of involuntary and active smoking differ quantitatively and, to some extent, qualitatively. Because the temperature of the burning cone is lower as the cigarette smolders than during active puffing, combustion is less complete in side-stream than in mainstream smoke. Consequently, side-stream smoke has higher concentrations of some toxic and carcinogenic substances than mainstream smoke; however, dilution by room air markedly reduces the concentrations inhaled by the involuntary smoker in comparison with those inhaled by the active smoker. Nevertheless, involuntary smoking is accompanied by exposure to and absorption of toxic agents generated by tobacco combustion and is a biologically plausible cause of disease.

Concentrations
Tobacco smoke is a complex mixture of gases and particles that contains a myriad of chemicals. Not surprisingly, the smoking of tobacco increases indoor levels of respirable particles, nicotine, polycyclic aromatic hydrocarbons, carbon monoxide (CO), acrolein, nitrogen dioxide (NO2), and many other substances. The impact of smoking on indoor air quality depends on the number of smokers, the intensity of smoking, the size of the indoor space, the rate of exchange of the air of the indoor space with the outdoor air, and the use of air cleaning devices.

Several components of cigarette smoke, including particles and gas-phase compounds, have been measured in indoor environments as markers of the contribution of tobacco combustion to indoor air pollution. For example, the contribution of smoking in the home and other places to personal exposure to indoor air pollution has been assessed by placing samplers for particles of the size breathed into the lung (respirable particles) directly on subjects and also in their homes. These studies have shown that cigarette smoking can be a dominant source of exposure to these particles. When homes in six U.S. cities were monitored for respirable particle concentrations over several years, it was found that the presence of a pack-a-day smoker almost doubled the usual indoor level of particles. In homes with two or more heavy smokers, this study showed that standards set for outdoor air quality could be exceeded by smoking-related particle concentrations indoors. Peak concentrations, particularly in proximity to the smoker, are undoubtedly higher than the time-averaged values reported in the study.

Small numbers of homes have been monitored also for nicotine, another constituent of ETS. In a study of ETS exposure of day-care children, average nicotine concentration during the time that the ETS-exposed children were at home was more than 10 times greater than the exposure of children in homes without smoking. Levels in homes tend to be highly variable even though the smoking intensity of adult smokers is typically stable. Indoor monitoring for 20 volatile organic compounds in homes in several communities showed increased concentrations of benzene, xylenes, ethylbenzene, and styrene in homes with smokers compared to homes without smokers. The 20 compounds were selected as representative of toxins and carcinogens that are released outdoors from industry and motor vehicles.

Biological Markers of Exposure
Biological markers of exposure are substances indicative of exposure that can be measured in body tissues or fluids. The presence of ETS components or their metabolites in body fluids of exposed nonsmokers strengthens the plausibility of links between ETS exposure and disease. Biological markers of exposure to
ETS have been used to describe the prevalence of exposure to ETS, to investigate the doses of potentially toxic agents inhaled during involuntary smoking, and to validate questionnaire-based measures of exposure.

At present, the most valid markers for tobacco smoke exposure are nicotine and one of its metabolites, cotinine. Nicotine and cotinine are almost never present in body fluids in the absence of exposure to tobacco smoke. Nicotine remains in the body for only a short time, and its detection is indicative of very recent exposure. Cotinine remains in the body longer and is, therefore, a better indicator of exposure over several days. Cotinine levels measured in children have shown that smoking by parents is the predominant determinant of the level of children’s exposure to ETS. Urinary cotinine levels in infants and young children tend to increase with the level of parental smoking, particularly that of the mother.

The findings of studies of biological markers have several potential uses in policy development. First, the demonstration of detectable levels of cotinine or other markers provides incontestable evidence of exposure to tobacco, and biomarkers are consequently an informative tool for establishing the prevalence of exposure and for monitoring temporal trends of exposure or evaluating programs to reduce exposures. Second, biomarkers may have utility for health education. Measurement of biological markers offers a potentially effective approach for convincing parents that their smoking may adversely affect their children. Cotinine assays are now widely available, and cotinine can be measured in either saliva or urine, fluids that can be readily obtained from a child without drawing blood. The finding of cotinine in children’s urine or saliva could be used to personalize health education for parents about the impact of their smoking and as an evaluation measure.

Prevalence of Childhood Exposure

Patterns of smoking in the United States have shifted rapidly in recent decades with overall declines among adults and the emergence of strong gradients of smoking by level of education. However, the gains in reducing smoking have been least among young females, particularly those with less education. In 1991, 22% of women aged 18 to 24 years were current smokers as were 28% of women 25 through 44 years. Slightly higher percentages of men in these same age groups were smokers. These prevalence data indicate that a substantial percentage of children are likely to have smoking parents. In fact, data from a 1988 nationwide survey show that about one-half of U.S. children under age five years are exposed to tobacco smoke (Figure 1). For more than a quarter of children, exposure begins before birth. Based on the survey data, 42% of children in this age range were estimated to live in a household with a smoker. The probability of children’s exposure to tobacco smoke doubled from the highest income and maternal education groups to the lowest.

A study of North Carolina children showed that nonhousehold sources of exposure may become important as the child

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Box 1

**Adverse Effects of Involuntary Smoking on Children and Adults**

**Established**
- Increased lower respiratory infections in children
- Increased respiratory symptoms in children
- Reduced lung growth in children
- Increased lung cancer risk in nonsmokers
- Exacerbation of asthma
- Irritation of the eyes, nose, throat, and lower respiratory tract

**Potential**
- Increased respiratory symptoms in adults
- Reduced lung function in adults
- Increased risk of developing asthma
- Increased risk for nonrespiratory cancers
- Increased risk for sudden infant death
- Reduced birth weight
- Heart disease in adults
Percentage Distribution of Children Five Years of Age and Under by Exposure to Smoke Before and After Birth: United States, 1988

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never exposed</td>
<td>49.9%</td>
</tr>
<tr>
<td>Prenatal only</td>
<td>1.2%</td>
</tr>
<tr>
<td>Both prenatal and postnatal</td>
<td>27.6%</td>
</tr>
<tr>
<td>Postnatal only</td>
<td>21.2%</td>
</tr>
</tbody>
</table>


between three weeks and one year of age, the proportion of study children reported to be exposed to ETS increased from 39% to 63%. This increase was accounted for by greater exposure to smoke from both household smokers and non-household smokers, whether at home or in other locations. These findings imply that any control strategy for limiting ETS exposure of children needs to address both the home and other locations.

Adverse Effects of Involuntary Smoking in Children

Exposure to ETS, involuntary smoking, has now been determined to be a risk factor for lung cancer in adults and for nonmalignant lung diseases in adults and children (Box 1).\(^\text{3-5,20}\) It has also been linked to respiratory symptoms, reduced lung growth, irritation of the mucous membranes of the eyes and upper airways, and annoyance. This section reviews the status of the evidence on involuntary smoking and children’s health.

Lower Respiratory Tract Illnesses

Epidemiological investigations conducted throughout the world have linked involuntary smoking by infants and young children to increased occurrence of lower respiratory tract illnesses, such as bronchitis, bronchiolitis, and pneumonia. ETS exposure is thought to increase risk for infection by respiratory pathogens, primarily viruses, rather than to cause illness by a direct toxic effect of the lung. Investigations conducted throughout the world have demonstrated an increased risk of lower respiratory tract illness in infants with smoking parents. These studies indicate a significantly increased frequency of bronchitis and pneumonia during the first year of life in children with smoking parents; the risk has been generally found to increase with the extent of parental smoking.\(^\text{5}\) An Australian study, which used urinary cotinine levels on admission to the hospital as an exposure indicator, confirmed the increased risk for lower respiratory illness associated with tobacco smoke exposure; children admitted with bronchiolitis had significantly higher urinary cotinine than control children.\(^\text{21}\) While most of the studies have shown that maternal smoking rather than paternal smoking is associated with increased risk, studies in China show that paternal smoking alone can increase the incidence of lower respiratory illness.\(^\text{22,23}\) In the studies of household smoking and
Involuntary Smoking and Children's Health

lower respiratory illness, however, an effect of exposure has not been readily identified after the first year of life. The strength of the effect of passive smoking during the first year of life may reflect higher exposures consequent to the time-activity patterns of young infants, which place them in close proximity to cigarettes smoked by their mothers, or heightened susceptibility because of immature defense systems. For school-age children, parental smoking also increases the occurrence of respiratory illness episodes, presumably infectious in etiology. In the Environmental Protection Agency’s risk assessment, an estimated 150,000 to 300,000 cases annually of lower respiratory tract infection were attributed to ETS exposure in children up to age 18 months. The Agency attributed 7,500 to 15,000 hospitalizations annually to ETS exposure. As discussed below, the increased health care costs associated with children’s exposure to ETS should create incentives for interventions by third-party payers to reduce that exposure.

Respiratory Symptoms and Illnesses

Data from many surveys of schoolchildren demonstrate a greater frequency of the most common respiratory symptoms—cough, phlegm, and wheeze—in the children of smokers. The less prominent effects of passive smoking, in comparison with the studies of lower respiratory illness in infants, may reflect the lower exposures to tobacco smoke of older children who spend less time with their parents.

Asthma

Asthma, a condition characterized by increased responsiveness of the lung to environmental stimuli with episodic and sometimes sustained loss of lung function, is one of the most common chronic diseases of children. Although involuntary exposure to tobacco smoke is associated with the symptom of wheeze, evidence for association of involuntary smoking with onset of childhood asthma has not been consistent in the literature. Exposure to ETS might cause asthma as a long-term consequence of the increased occurrence of lower respiratory infection in early childhood or through other pathophysiological mechanisms, including inflammation of the epithelial surface that lines the lung’s airway. Increased responsiveness of the lung to pharmacologic or cold air challenge, the hallmark of asthma, is more often present in children exposed to ETS. Such increased responsiveness can be demonstrated during the first months of life, suggesting that in utero exposure to tobacco smoke components may influence the level of airway responsiveness. Tobacco smoke exposure at home, documented by salivary cotinine concentration, has been found to be positively associated with a first emergency room visit for wheezing in children less than two years of age. On the other hand, the evidence from older children is conflicting. The inconsistencies in the literature cannot be readily explained, and the EPA risk assessment concluded that ETS is a risk factor for asthma but stopped short of characterizing the relationship as causal.

While involuntary exposure to tobacco smoke has not been established as a cause of asthma, there is strong evidence that involuntary smoking worsens the condition of those with asthma. The possibility that ETS adversely affects children with asthma was described as early as 1950 in a case report. A more recent evaluation of asthmatic children demonstrated that indicators of clinical status, including responsiveness on pharmacologic challenge, were adversely affected by maternal smoking. Exposure to smoking in the home has also been shown to increase the number of emergency room visits made by asthmatic children. Asthmatic children with smoking mothers are more likely to use asthma medications, a finding that confirms the clinically significant effects of ETS on children with asthma.

The EPA concluded that involuntary smoking is causally associated with additional episodes and increased severity of the disease in asthmatic children. The agency estimated that the status of at least 200,000 and possibly as many as 1,000,000 asthmatic children is adversely affected by ETS.

An estimated 150,000 to 300,000 cases annually of lower respiratory tract infection were attributed to ETS exposure in children up to age 18 months.
Middle-Ear Disease
Recent studies have also shown that children exposed to cigarette smoke in their homes are at increased risk for middle-ear disease. Both acute otitis media and persistent middle-ear effusions have been associated with involuntary smoking in a number of studies.\textsuperscript{5,20} For example, in a study of children attending a research day care center, serum cotinine concentration predicted the occurrence of episodes of otitis media with effusion.\textsuperscript{36}

General Morbidity
Analysis of data from the National Health Interview Survey for children under six years of age showed that maternal smoking was associated with an increased number of days in bed because of illness, whereas there was no association with paternal smoking.\textsuperscript{37} A survey of schoolchildren in England showed that maternal smoking was associated with an increased risk of absenteeism of about 40\%.\textsuperscript{38}

Lung Growth and Development
The lung develops and completes its maturation during early childhood and continues to increase in size as the child grows. Early childhood may represent a period of particular vulnerability to environmental pollutants, such as ETS, and respiratory illnesses during this time may have lasting consequences.\textsuperscript{27} On the basis of the primarily cross-sectional data available at the time, the 1984 report of the Surgeon General\textsuperscript{11} concluded that the children of parents who smoked had small reductions of lung function in comparison with children of nonsmokers, but the long-term consequences of these changes were regarded as unknown. In the two years between the 1984 and the 1986 reports, sufficient longitudinal evidence accumulated to support the conclusion in the 1986 report\textsuperscript{3} that involuntary smoking reduces the rate of lung function growth during childhood. Subsequent data from a number of longitudinal studies have strengthened the basis for this conclusion. In one study in East Boston, Massachusetts, lifelong exposure of a child to a mother who smoked was estimated to reduce growth of one measure of lung function by about 10\%.\textsuperscript{39}

The reduced lung growth associated with involuntary smoking represents an apparently permanent effect; its permanency and associated reduction of the lung’s reserve as the child enters adulthood could offer a strong deterrent to parents’ smoking, if convincingly shown to parents.

Cancer
The data on childhood cancers and passive smoking are extremely limited, although a larger literature addresses smoking during pregnancy.\textsuperscript{40} Separating effects of \textit{in utero} exposure from those of subsequent inhalation of ETS is problematic. Several studies have suggested links between ETS exposure in childhood and risk for a number of cancers, especially lung cancer among adults.\textsuperscript{20,41} Because cancers are usually seen only after long latency periods, the effects of childhood exposure would probably not be observed until adulthood.

Other Adverse Effects
A recent study suggests that even the cardiovascular systems of children may be adversely affected by passive smoking.\textsuperscript{42} Laboratory analyses of blood from 216 11-year-old twin pairs suggested unfavorable lipid levels and impaired oxygen transportation in the twins with smoking parents. The EPA risk assessment reviewed eight studies of maternal smoking and sudden infant death syndrome (SIDS) and found strong evidence for increased risk for infants whose mothers smoke.\textsuperscript{5} Because we still lack an understanding of the underlying mechanisms leading to SIDS, the agency did not assess the causality of this association. A lower birth weight for infants of nonsmoking women passively exposed to tobacco smoke during pregnancy has also been reported.\textsuperscript{43,44} A recent study of children with cystic fibrosis suggested that exposure to ETS at home adversely affects growth.\textsuperscript{45} Parental smoking may also increase risk for allergic sensitization.\textsuperscript{46}

Milk production by breast-feeding mothers is also adversely affected by maternal cigarette smoking.\textsuperscript{47,48} Although this adverse effect of cigarette smoking is
not mediated by inhalation of ETS, it represents another avoidable consequence of maternal smoking. In a study of mothers of preterm infants, 24-hour milk volumes were approximately 20% less for smoking compared with nonsmoking mothers, and milk volume did not increase from two to four weeks postpartum in the mothers who smoked.48

**Adverse Effects of Smoking Before and During Pregnancy**

Cigarette smoking has been associated with reduced fertility, increased risk for spontaneous abortion, and reduced birth weight. There are multiple postulated mechanisms, both direct and indirect, for these adverse effects of smoking.49 Tobacco smoke components, including carbon monoxide and nicotine, cross the placenta and enter the fetal blood circulation. Carbon monoxide, by binding to the oxygen-carrying hemoglobin in the blood, reduces the amount of oxygen available to fetal tissues. Maternal smoking has also been linked to adverse effects on child development, although the biological bases for such effects remain unclear.50

**Reduced Fertility**

There is consistent evidence indicating that women who smoke at the time of attempting to conceive have lower fertility.49 Smoking may also increase risk for ectopic pregnancies (that is, implantation of the ovum at a site other than the uterus).51 Smoking cessation returns fertility to that of never smokers.49

**Spontaneous Abortion and Perinatal Mortality**

Maternal smoking is associated with increased risk of spontaneous abortion (miscarriage up to 28 weeks of gestation) and perinatal mortality (from 28 weeks gestation up to 7 days of life).52 Whether smoking cessation during pregnancy reduces the risk is uncertain.49

**Reduced Infant Birth Weight**

Maternal smoking reduces infant birth weight, perhaps because of reduced oxygen delivery to the fetus.49 The average reduction is approximately 200 grams, and the proportion of low birth weight infants (birth weight less than 2,500 grams) is approximately doubled by maternal smoking; the adverse effect of smoking on birth weight increases with the number of cigarettes smoked by the mother. Lower birth weight is associated with higher risk of death in the neonatal and perinatal periods. The 1990 report of the Surgeon General concluded that smoking cessation up to 30 weeks of gestation leads to increased birth weight compared to continuing to smoke.49

**Stunted Growth and Development**

The results of a number of studies suggest that maternal smoking could have lasting adverse effects on physical and mental development during childhood.50 The children of smoking mothers tend to be shorter by 1 to 2 centimeters and to perform less well on achievement and intelligence tests.50 Other studies indicate that maternal smoking may increase risk for hyperactivity.50,52 Such effects might arise from smoking-induced changes in germ cells of the parents or through transplacental exposure rather than as a direct effect of smoke inhalation.53,54

**Policy Options**

Eliminating or significantly reducing the adverse effects of involuntary smoking on children requires a multifaceted strategy that addresses exposure in utero and after birth, in the home and outside the home. Three types of strategies can be identified, each with favorable impact on child health: broad programs for smoking prevention and cessation; initiatives to reduce exposures to ETS generally, and policies to specifically limit children’s exposure to tobacco smoke. We focus on the last set of strategies, acknowledging that substantial effort is currently directed at reducing active smoking and at controlling ETS exposure in public, commercial, and workplace environments.

Some elements of a strategy to control children’s exposure to tobacco smoke are straightforward and may be accomplished through a regulatory solution; for example, governments have the authority to prohibit smoking in public places fre-
quented by children, such as schools and child care facilities. It will be quite difficult to accomplish other desirable elements of an ETS control strategy directed at children through regulatory approaches. A notable example is reduction of children’s exposure to ETS in their own homes from cigarettes smoked by parents or others, the most common form of exposure of children to ETS. Accordingly, it will be necessary to develop other less coercive, but effective approaches to reduce exposure in the home.

Beyond official reports and brochures, the mass media may be a particularly appropriate channel to use to educate the public on the dangers tobacco smoke poses to young children and fetuses.

Interventions to control children’s exposure to tobacco smoke may arise from activities in the public sector at federal, state, and local levels of government, and in the private sector through the actions of health care providers, educators, voluntary organizations, and parents or other caretakers. The potential for substantial synergy and reinforcement among activities in these various spheres is great and holds the promise of substantially reducing the exposure of children to tobacco smoke with a concomitant improvement in their health.

Public Policies

Governments can take a range of actions that may reduce the exposure of children to tobacco smoke. Current approaches include information dissemination, mandatory warning labels, and restrictions on smoking in various places where children congregate. These policy options are discussed in this section. All these interventions could be intensified from current levels. Recent federal legislation to ban smoking in schools and some other facilities which receive federal funding is a sign of increased attention to the problem of children’s exposure to ETS.

Dissemination of Information

Dissemination of the findings of scientific evaluations of the health consequences of children’s exposure to tobacco smoke is a legitimate and perhaps even necessary role of governments. It is the least coercive of government interventions but is basic to the formulation of all other policy in a democratic society. Without appropriate information, it will be difficult to form the popular consensus necessary to develop and enforce more restrictive policies. In addition, information dissemination facilitates voluntary action on the part of parents, caretakers, educators, health care providers, and children themselves to protect children from the hazards of tobacco smoke.

Important initial efforts to inform the public of the dangers of ETS were the two major reports on the health consequences of involuntary smoking issued by the U.S. Surgeon General and the National Research Council in 1986. A more recent report by the U.S. Environmental Protection Agency has reinforced public concern about the dangers of ETS and served as a springboard for regulatory initiatives, discussed below, designed to restrict exposure of children and nonsmokers generally to ETS.

In addition to issuing rigorous scientific reports, government and/or voluntary agencies can disseminate information on the dangers of ETS through more publicly accessible media. For example, in conjunction with its major 1992 report, the EPA released a colorful pamphlet on what parents and others can do about second-hand smoke. Recommendations from this pamphlet on protecting children in and outside the home are summarized in Box 2. In addition, the booklet contains a special message for smokers which states in part: “If you have to smoke, here are some things you can do to help protect the people close to you: Don’t smoke around children. Their lungs are very susceptible to smoke. If you are expecting a child, quit smoking.”

Beyond official reports and brochures, the mass media may be a particularly appropriate channel to use to educate the public on the dangers tobacco smoke poses to young children and fetuses. Since the 1964 Surgeon General’s report on smoking and health, the public has received many antismoking messages in one form or another. Few messages, however, have specifically addressed the relationship between exposure to ETS and children’s health, and overall efforts to use
the media to convey anti-tobacco messages of all kinds have been meager compared with the well-funded marketing efforts of tobacco manufacturers. Research on the potential uses of the media to control tobacco use have likewise been limited and inconclusive. In general, many observers credit the decline in tobacco use over the past several decades to a growing public awareness of the many hazards of tobacco use. It is likely that targeted media campaigns have played some role in enhancing public awareness of the dangers of tobacco, but it has been difficult to quantify the media’s contribution, and no assessments have been made of the effect of the media campaign on protecting children and fetuses from involuntary exposure to tobacco smoke.56

Warning Labels on Tobacco Products

Warning labels are frequently used with products associated with a potential risk for users, and requiring that tobacco products provide health-related information on packages and in advertising is another vehicle through which governments can further the dissemination of this important information. Package warning labels can include either brief statements printed directly on tobacco packages or more detailed information on package inserts. Beginning in 1965, federal law required that all cigarette packages carry the following health warning: “CAUTION: Cigarette Smoking May Be Hazardous to Your Health.”56

Warnings of the dangers of cigarette smoke to children and fetuses were not mandated until the Comprehensive Cigarette Education Act became effective in 1984. This law required that four warnings be rotated periodically on all cigarette packages and in all cigarette advertising. Two of these warnings (see Figure 2) specifically refer to the dangers posed to the fetus by smoking during pregnancy; however, these warnings do not call attention to the hazards ETS poses to children after birth.56

Research on consumers’ response to warning labels generally has yielded mixed results. There have been no controlled studies that look definitively at the independent effects of cigarette warning labels on knowledge, attitudes, beliefs, or smoking behavior. Some studies suggest that little attention is paid to the warnings. In fact, warning labels may not be readable in some advertising media. Clearly, the current warnings are of little value in reaching those who cannot read or understand English.2

There have been numerous suggestions for improving cigarette labeling in the United States. Up to 16 different warnings have been proposed by the Federal Trade Commission (FTC), and it has been suggested that the visibility and effectiveness of the labels be improved by adding pictures, using different languages, and increasing the size of the warnings.2

Labeling requirements from other countries provide some guidance for modification of current U.S. practice. As also illustrated in Figure 2, Iceland combines several aspects of these suggestions in a rotational warning requirement which

Box 2

Advice from the EPA to Parents on What They Can Do About Secondhand Smoke

In the Home

- Don’t smoke in your house or permit others to do so.
- If a family member insists on smoking indoors, increase ventilation in the area where smoking takes place. Open windows or use exhaust fans.
- Don’t smoke if children—particularly infants and toddlers—are present. They are especially susceptible to the effects of passive smoking.
- Don’t allow baby-sitters or others who work in your home to smoke in the house or near your children.

In Other Places Where Children Spend Time

EPA recommends that every organization dealing with children have a smoking policy that effectively protects children from exposure to environmental tobacco smoke.

- Find out about the smoking policies of the day-care providers, preschools, schools, and other caregivers for your children.
- Help other parents understand the serious health risks to children from secondhand smoke. Work with parent-teacher associations, your school board and school administrators, community leaders, and other concerned citizens to make your child’s environment smoke free.

In Automobiles

- Don’t smoke in an automobile with the windows closed if passengers are present. The high concentration of smoke in a small, closed compartment substantially increases the exposure of other passengers.

Figure 2

Examples of Child-Related Health Warnings on Cigarette and Tobacco Packages

<table>
<thead>
<tr>
<th>United States (since 1985)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgeon General’s Warning:</td>
</tr>
<tr>
<td>• SMOKING BY PREGNANT WOMEN MAY RESULT IN FETAL INJURY, PREMATURE BIRTH, AND LOW BIRTH WEIGHT.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Canada (since 1994, printed in English and in French)b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Ministry of Health and Welfare Warnings:</td>
</tr>
<tr>
<td>• TOBACCO SMOKE CAN HARM YOUR CHILDREN.</td>
</tr>
<tr>
<td>• SMOKING DURING PREGNANCY CAN HARM YOUR BABY.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Iceland (since 1985)c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director General of Public Health’s Warning:</td>
</tr>
<tr>
<td>Smoking during pregnancy endangers the health of mother and child.</td>
</tr>
<tr>
<td>Protect children from tobacco smoke.</td>
</tr>
</tbody>
</table>


specifically addresses concerns about the effects of smoking on children. Canada has also recently modified its cigarette labeling requirements to highlight the risks of tobacco smoke to children. Restrictiveness of these laws has risen significantly over time. During the 1980s, the locus of smoking control shifted from the state and federal level to the local level. In 1990, 468 local communities restricted smoking, compared with 89 only four years earlier. The rapidity with which smoking control has spread in the workplace has verged on the breathtaking: in 1985, only 27% of workplaces prohibited or severely restricted smoking; in 1992, the figure had grown to 59%. Children also would benefit from regulations to protect them from ETS exposure when they are outside their homes in
licensed child day-care centers, family day-care homes, schools, and other public places where they spend a substantial amount of time.

A 1990 national survey of licensed child day-care centers found that, although strong smoking policies were in effect at the majority of centers, hundreds of thousands of children in the United States are at risk for exposure to ETS in these settings. The survey found that 99% of the centers had employee smoking policies that were in compliance with appropriate regulations; however, only 40 states regulated employee smoking in licensed centers, and only 3 states required that centers be smoke free indoors. Overall, 55% of centers reported being smoke free indoors and outdoors, and 26% were smoke free indoors only.

Children appear to be at greater risk for exposure to environmental tobacco smoke in informal family child care arrangements involving relatives, friends, or others who may care for children in their homes. Such arrangements may involve before- and/or after-school programs for older children, as well as preschool-age children. There is little information on smoking in these facilities. A report from Australia found that only 35% of organizations which provided such care for children had formal no-smoking policies. Overall, 10% of caregivers were reported to smoke actively while caring for children; in some centers, 60% of caregivers smoked while caring for children. Data from the United States suggest that, among children from birth to three years old, more than 25% of nonparental caregivers in the child’s home or in another home setting smoke. These same data suggest that significantly more caregivers smoke than mothers who are at home with their own children. Even in family day-care situations where caregivers do not smoke, children may be exposed to ETS if other household members smoke when children are present.

Governments’ ability to take action to protect children from exposure to ETS in family day care may be quite limited as many of these facilities are unlicensed and unregulated. The most effective activity may be to educate parents about the hazards of ETS exposure and recommend that parents take appropriate action to determine the smoking environment in the centers they use and either remove children from a smoke-filled environment or request that the caregiver protect the child.

**Smoking in Schools**

Schools are another venue where children spend a substantial part of their time and where they may be exposed to ETS. Smoking restrictions in schools should not only protect students from exposure to ETS, but also discourage smoking by children and adolescents.

A 1988 survey of school smoking policies in a random sample of public school districts found that 95% of respondents had a written policy or regulation on tobacco smoking in schools. Most districts restricted smoking by students, faculty, staff, and administration, and other adults; however, only 17% totally banned smoking at all times on school premises, and only 24% prohibited smoking by school personnel in school buildings. In general, policies which restrict smoking in schools to designated areas may not protect children from ETS. Unless smoking areas are adequately ventilated, ETS may circulate throughout a building, especially via a common heating or ventilation system, and expose children to ETS even in non-smoking areas.

**Data from the United States suggest that, among children from birth to three years old, more than 25% of nonparental caregivers in the child’s home or in another home setting smoke.**

**Recent Legislation**

In March 1994, Congress took the unprecedented step of outlawing smoking in most of the nation’s schools, except in areas that are closed off to children and have outside ventilation. This provision is part of the Goals 2000: Educate America Act, which sets national education goals. It would ban smoking not only in schools which receive federal funding (all public and some private schools), but also in other programs for children with federal funding including Head Start centers, day-care centers, and most community health centers. The law could go a long way in protecting children from exposure to ETS in those places outside the home.
where they spend most of their time. What is unknown at this time is how vigorously the law will be enforced and what the level of compliance with the law will be in practice. Very limited research concerning the sanctity of the family unit and the home considerably restricts the ability of government action to diminish exposure. . . [C]oercive legal and regulatory measures appear to be of limited practical usefulness in this area.

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legal restrictions on smoking in public places indicates that compliance can be spotty and enforcement limited,63 but it is encouraging that the compliance of public school personnel with restrictions on smoking in schools has been reported as generally quite good.57

Other Public Smoking Restrictions
In addition to schools and child care centers, children frequent other specific locations outside the home and may need protection from ETS in these locales, specifically, restaurants, sports facilities, and shopping malls.

Restrictions on smoking in restaurants have long been controversial.62 A majority of states and localities with populations of at least 25,000 have enacted some restrictions in restaurants.2 Until recently, however, many restaurants, even those that make specific marketing appeals to children, have not been smoke free.65 The publication of the EPA’s findings on the effects of ETS on children resulted in calls from a variety of groups to eliminate smoking sections in fast-food restaurants.64 In February 1994, the McDonald’s Corporation announced that it was banning smoking in all company-owned restaurants and actively encouraging franchisees to make their restaurants smoke free as well.65 Other restaurant chains have followed suit, and a national trade association of restaurant chains is backing a national bill to end smoking in all restaurants. Clearly, parents and others who make decisions about where children eat out can reinforce the importance of a non-smoking environment for children’s health by frequenting smoke-free establishments.

Sports arenas and private enclosed shopping malls are also gradually adopting restrictions on smoking.56 Many of these facilities should be subject to state and local restrictions on smoking in public places, but the level and effect of enforcement of these laws for these facilities is unknown.

Smoking in the Home
The sentiment favoring protection of children can conflict with long-established tenets when the locus of protection is also the principal source of children’s exposure to ETS; parents who smoke. The sanctity of the family unit and the home considerably restricts the ability of government action to diminish exposure. Any legal attempts to compel nonsmoking in the home are and will be highly controversial. While such attempts have been few in number to date, those few have attracted considerable attention. For example, in recent divorce cases, judges have awarded the custody of children to the nonsmoking parent and have prohibited smoking by the other parent during visitations.66

These extreme examples aside, coercive legal and regulatory measures appear to be of limited practical usefulness in this area of ETS control, and less coercive approaches to diminishing ETS exposure in utero and in the home warrant special consideration. Health care providers would appear to have a central and critical role to play as they interact with parents at key
times: during pregnancy, at birth, at well-child visits, and at visits for illnesses which may be ETS related.

**Counseling During Pregnancy**

Prevention of smoking during pregnancy is of great value because the fetal outcome is improved when the mother does not smoke. Yet one in five women continue to smoke during pregnancy. Because prenatal smoking cessation could substantially improve maternal and infant health and save millions of health care dollars, a rate of 90% smoking abstinence during pregnancy has been established as a national goal for the year 2000. Yet, it appears very unlikely that this objective will be achieved.

During the past 10 years, a number of smoking cessation interventions for pregnant women have been developed and tested among patients and prenatal care professionals in a variety of settings. The behavioral impact of these interventions, their contribution to improved pregnancy outcomes, and their cost-effectiveness have been reported in a number of published reports. Based on these reports, it appears that available methods can produce smoking cessation rates of 14% to 27% in pregnant women.

A recent review of smoking in pregnancy found that many factors seem to account for the variability in success rates reported in the literature. In general, it appears that information about the risk of smoking during pregnancy may increase cessation rates above those found in patients receiving “usual” prenatal care. Higher quit rates can be obtained with the addition of specific components to teach cessation skills and materials specifically targeting the pregnant smoker. Low-intensity cessation programs which use a standardized health education counseling session and provide patients with inexpensive self-help manuals have proved effective. Training time and the costs of personnel and materials in these low-intensity interventions appear modest, and studies suggest that the interventions are cost saving, returning at least three dollars on the cost of neonatal care for every one dollar spent on prenatal smoking cessation activities. This return should be particularly attractive to HMOs, Medicaid programs, and even indemnity insurers, who will be able to recoup their investment in intervention costs with savings on neonatal care in a very short period of time.

An added benefit of prenatal smoking cessation may be that the mother will be able to remain abstinent after the birth. This outcome will have a positive effect not only on her health, but also on the health of the infant and other children in the household, who will be less likely to be exposed to ETS if the mother does not smoke. A study of English-speaking women in a large HMO in California found that 37% of women who had quit smoking before the 26th week of pregnancy and continued abstinent through delivery maintained their nonsmoking status at six months postpartum. Other studies have found somewhat lower rates of maintenance postpartum. All work in this area suggests that concentration on smoking cessation during the prenatal period is not enough. Attention should also be directed toward developing successful intervention strategies for late pregnancy and the early postpartum period. Further work also needs to be done in refining strategies for application early in pregnancy and in customizing interventions for particular populations. For example, it appears that, while minimal contact programs with serial mailings of materials and telephone follow-ups work with higher socioeconomic groups, programs for lower socioeconomic women may require more individualized counseling and follow-up and frequent cessation cues from multiple sources. Successful programs will also have to adapt to different languages and cultures. Dealing with women who live in households and communities where smoking is very prevalent will be a real challenge not only because of the many personal interactions that support and provide cues to smoking, but also because recent studies report that constituents of ETS can cross the placental barrier and pose a danger to fetuses of nonsmoking mothers.

One problem that has come to light in studies of smoking cessation programs during pregnancy is that emphasis on
smoking cessation during prenatal care can lead to increasing rates of nondisclosure. Nondisclosure of smoking status poses a problem for researchers and practitioners alike. For research studies, some form of biochemical validation is recommended for measuring outcomes. This can be expensive and raise issues of consent. An alternative approach, which can also be applied in clinical settings, is to use questions that allow respondents to choose partly favorable responses, such as “I smoke now, but I have cut down since I found out that I was pregnant.”

Unfortunately, it appears that, given the success rate of tested prenatal smoking cessation programs, the vast majority of women smokers will continue to smoke throughout pregnancy even if these techniques are widely disseminated and applied. Therefore, prenatal smoking cessation will require more research; however, dissemination and implementation of existing knowledge and practice are also called for. Clinicians need to be persistent in applying proven techniques, and financing mechanisms need to be established to support the effort.

**The goal should be a non-smoking mother not only during pregnancy, but also after birth.**

Nicotine Replacement Therapy

Two forms of nicotine replacement therapy (NRT) have been approved for nonexperimental use to help smokers achieve abstinence from cigarettes: nicotine gum and the transdermal nicotine patch. Considerable evidence has accumulated that these products can substantially increase the likelihood that a smoker will be able to quit and remain abstinent for at least six months. The more recently developed patch is generally regarded as the method of choice because it is easier to use than the gum.

Until recently, NRT has been considered to be contraindicated in pregnant women despite the evidence of its effectiveness in improving smoking cessation rates in nonpregnant subjects. Because nicotine is a potentially toxic drug, perhaps even a teratogen, it was felt that providing pregnant women with NRT raised important ethical, medical, and medicolegal questions. Although there have been no published studies of the efficiency or safety of NRT in pregnant women, some experts believe it is less harmful to expose the fetus to nicotine alone than to the thousands of potentially noxious chemicals in cigarette smoke.

It appears likely that some physicians are prescribing NRT for their pregnant patients. Even an expert panel convened by the American Medical Association advises that “physicians must consider the risk-benefit issues in the individual patient situation.” Accordingly, it would appear appropriate to consider a clinical trial of NRT in smoking pregnant women to judge both its efficacy and safety and potential contribution, if any, to improved outcomes for infants exposed to maternal smoking during pregnancy.

Even if NRT is judged too risky to be used routinely during pregnancy, it might be effective and appropriate during the preconception period. In 1989, the Public Health Service Expert Panel on the Content of Prenatal Care recommended that a preconception visit be part of the prenatal process. Such a visit permits the identification of medical and behavioral problems before conception and offers mothers-to-be and clinicians a wider choice of responses to potential problems than would be available after conception. For a smoker, the preconception visit affords an opportunity to counsel the mother on the dangers of smoking to the fetus and on the techniques available to facilitate cessation. It would appear that NRT could be considered and offered during the preconception period. If smoking cessation is achieved after 6 to 10 weeks of therapy, it would likely be necessary to offer some supportive nonpharmacologic therapy during pregnancy to sustain abstinence. The goal should be a nonsmoking mother not only during pregnancy, but also after birth. Again, although this strategy seems reasonable, this intervention has yet to be developed explicitly or investigated scientifically. It appears, however, that such investigations would be worthwhile.

**Other Opportunities for Health Care Providers**

Even after the prenatal period, health care providers have the responsibility and opportunity to counsel patients on the dangers posed to children by exposure to ETS. The recommended series of 12 well-child
visits during the first six years of life can provide the occasion for pediatricians, nurse practitioners, and others not only to warn of the dangers of ETS, but also to inquire into the smoking habits of parents and other adults who come in contact with young children and to suggest strategies to reduce exposure. Similar opportunities exist for dentists who see children regularly for preventative care.

Physician visits with sick children, particularly for those with respiratory ailments associated with smoking, may provide a particularly opportune time to counsel parents on the dangers of ETS. There has been little research into how to counsel parents effectively and into the consequences of counseling. A recent study from Canada suggested that asthmatic children were exposed to fewer cigarettes and their asthma was less severe when doctors advised their parents not to expose the children to tobacco smoke. Parents reported that they attempted to avoid exposing children to smoke by smoking outdoors or in another room or by smoking by an open window or blowing their smoke through exhaust vents. Another study found that counseling of parents of asthmatic children in San Diego was associated with substantial reduction in the children's exposure to ETS. The study looked at only five children, however, and the intervention consisted of an intensive series of five biweekly, 30-minute, counseling/instructional sessions for parents. These sessions focused on practical ways that parents could reduce children’s exposure to ETS. This appears to have been a costly and time-intensive intervention. In fact, 4 of the 11 families eligible to participate in the study refused because of time constraints or lack of interest. Whether such elaborate interventions are sufficiently more effective than simple physician advice to warrant their general implementation is unknown. Also unknown is what works with parents of children who are adversely affected by ETS but who do not have chronic and severe disease such as asthma.

It appears that much remains to be done to develop, test, and implement procedures that assure frequent and effective counseling of parents on reducing their children’s exposure to ETS not only in the home but in out-of-home settings such as child care facilities. Such interventions hold the promise, however, of reducing substantially the incidence and severity of many common pediatric illnesses and of also reducing the costs associated with those illnesses. Accordingly, such interventions may be of particular interest to managed care plans which may be able to offset the added costs of counseling with the savings from reduced levels of illness-related health care.

**Conclusion**

As this article goes to press, the news on protecting children from the hazards of other people’s tobacco smoke is good. The dangers have been identified in the scientific literature, and validated and quantified in well-publicized government reports. Policies to protect children from exposure to ETS outside the home have a strong base of public support, have been enacted into law, and are being adopted by private businesses that market to families with children. Even the major tobacco companies recognize that opposition to policies designed principally to protect children is a bad strategy. Yet much remains to be done, especially to address the issue of exposure of children during pregnancy and in their own family units.

One conceptually easy but politically difficult action would be to include a warning on the danger to children of ETS exposure on cigarette packages as is done in other countries (see Figure 2). Even if such a requirement were not enacted, the publicity attendant to the debate over its implementation, might raise public awareness of the issue.

Other educational interventions—in the media, in health care settings, and elsewhere—may constitute the most feasible method of attacking the problem. One obvious model is the cooperative effort of pediatricians, hospitals, and car safety seat manufacturers to encourage new parents to use safety seats for their babies and young children. Although
cooperative educational interventions might be desirable, widespread application may not develop easily. Particularly discouraging is the limited evidence that many physicians do not routinely and effectively counsel parents and pregnant women on the dangers of tobacco smoke to children. It is difficult to know the reasons for this oversight. It may be that some physicians and other health professionals are too busy to engage in an activity for which they are not financially rewarded. They may also not be aware of the evidence on ETS exposure and child health, although a number of professional societies have prepared statements on ETS and health. More likely they are unaware of effective interventions. It would probably be helpful to place greater emphasis on environmental causes of disease and their control during the training of physicians and other health care providers. A recent study showed that a brief course on pediatric environmental health assessment increased awareness of pediatric residents of environmental health problems; identification of smoking in the home of asthmatic children was one of the indicators favorably affected.

Any educational interventions need to appropriately take account of the changing demographics of smoking. With smoking increasingly concentrated among less-educated, lower-income Americans, educational appeals, particularly those designed by and for a highly literate population, will need to be redesigned and targeted to today’s smokers. Lower-income individuals are also less likely to have a regular source of primary care, further complicating the problem of delivering and following up on educational interventions.

Outside health care delivery, media interventions deserve attention as well. Whether sponsored by medical and voluntary health organizations or paid for by government, media campaigns have succeeded in raising awareness levels and contributed to behavior change. A recently released evaluation of California’s excise-tax-financed tobacco control program suggests that the state’s unprecedented anti-tobacco mass media campaign may have contributed to an increase in the number of smoke-free homes in the state. Households with preschool-aged children were more likely to be smoke free than households without children. It is too early to tell whether this initial response to the mass media campaign will be sustained, particularly if the campaign is substantially scaled back.

The true “frontier” of smoking control, and perhaps one of the most important determinants of the health damage wrought by ETS, is how society will deal in the future with parents’ smoking in the presence of their children. Given the sanctity of the home, this most important locus of ETS exposure remains the one least likely to be drawn significantly into the battle. Recent court actions indicate that the home front will not remain exempt from attention. The practical challenge, however, is to develop educational interventions that are at once effective and noncoercive.


56. For more information about the use of tobacco among young people, see note no. 8, U.S. Department of Health and Human Services.


72. American Medical Association. *How to help patients stop smoking: Guidelines for diagnosis and treatment of nicotine dependence.* Chicago: AMA, 1994. Other forms of NRT include nicotine sprays and inhalers which have not yet been licensed for general clinical use. Experimental work is also under way using a combination of NRT modalities. See note no. 71, Silagy, Mant, Fowler, et al.


79. Murray, A.B., and Morrison, B.J. The decrease in severity of asthma in children of parents who smoke since the parents have been exposing them to less cigarette smoke. *Journal of Allergy and Clinical Immunology* (January 1993) 91:102.


