The Health Risks of Passive Smoking*

The Growing Case for Control Measures in Enclosed Environments

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Inhalation of atmospheric pollutants from the smoke of tobacco products is referred to as passive (involuntary, secondhand) smoking. The results of environmental studies, as well as studies of involuntary smokers, both healthy and diseased, are now rapidly accumulating. Pertinent findings have emerged concerning (1) levels of specific substances (e.g., carbon monoxide, particulates, and nicotine) found in various environments where smoking occurs, (2) concentrations of specific substances in passive smokers, (3) effects of passive smoking on healthy children and adults, and (4) effects of passive smoking on persons with preexisting diseases.

Levels of Specific Substances

Carbon Monoxide

Carbon monoxide is one of the important constituents of cigarette smoke, averaging 5 volumes percent in mainstream and 10 to 15 volumes percent by weight in side-stream smoke.

Nicotine

Although it is carried in the particulate phase of cigarette smoke, nicotine has been measured separately, since it is produced in pharmacologically important quantities and has short-term and long-term effects upon those exposed to tobacco smoke. Ambient air levels of nicotine measured in unventilated areas also have been found to exceed even maximum threshold limit values for industrial exposure (500μg/cu m).

Total Particulate Matter

Under many circumstances where tobacco is burned, total particulate concentrations (particles per cubic meter) have been shown to be very high in ambient air. The particulates contained in tobacco smoke peak in a size range of 0.1 μ to 1 μ, a highly respirable range, since almost all of these particles will reach deep pulmonary spaces. The few measurements of total particulate material under conditions of indoor smoking that are reported in the literature indicate tremendous variations in counts. At least two reports provide evidence of situations where ambient air quality standards have been exceeded.

In a recent epidemiologic study, particles inside and outside homes in six US cities were sampled, and sites were analyzed according to heating systems, cooking fuels, ventilation, and traffic. Indoor air pollution was found to stem from internal sources, mainly tobacco smoke. The authors note that Americans spend about 95 percent of their time indoors. Thus, the major role that cigarette smoke plays in indoor pollution assumes even greater significance.

Other Substances

A fair weight of the argument against smoking in indoor conditions is based on irritation of eyes and respiratory mucous membranes, on a short-term basis. Acrolein and other irritating substances emanate from cigarette smoke and persist in indoor air, and acrolein has been found to exceed threshold limit values. For the most part the effects of the hundreds of other substances, many of them highly toxic in other situa-

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90 Health Risks of Passive Smoking (Lefcoe et al)
tions in more concentrated forms, have not been evaluated under passive smoking conditions; however, many are known carcinogens, cocarcinogens, and respiratory membrane irritants, to which exposure may be harmful. As cited by Wige, the 1981 edition of Threshold Limit Values published by the American Conference of Governmental Industrial Hygienists indicates that for human carcinogens, "no exposure or contact by any route—respiratory, skin or oral, as detected by the most sensitive methods—shall be permitted." A complete listing and review of the hundreds of substances found in cigarette smoke is well beyond the scope of this report. For a comprehensive tabulation of the volatile and nonvolatile constituents, the reader is referred to the 1979 Surgeon General's report.

There is now firm evidence that cigarette smoking in various indoor environments—automobiles, buses, offices, homes, restaurants, etc.—may give rise to levels of specific pollutants well above those normally found in everyday situations in the absence of cigarette smoke. These levels often exceed standards for human exposure, where such standards exist. In passive cigarette smoking situations, the long-term effects of exposure to many identified smoke constituents, which occur in lower and trace amounts, are not known.

Concentrations in Passive Smokers

Several studies provide data on the concentration of specific substances found in the blood, urine, saliva, and amniotic fluid of passive smokers. Huch et al studied carboxyhemoglobin (COHb) in the blood of 12 passive smokers. The experimental conditions were likened to a pub in which people were exposed to tobacco smoke. The order of magnitude of percent increase in COHb approximated the increase found after the active smoking of one cigarette. In earlier experiments, Seppanen studied the COHb levels of passive smokers in smoky environments (carbon monoxide concentration about 30 ppm) and concluded that the mean increase of COHb extrapolated over an eight-hour period would be equivalent to the exposure obtained from voluntarily smoking about five cigarettes. Feyerabend et al studied nicotine concentrations in the saliva and urine of 82 smokers and 56 nonsmokers after a morning at work. All nonsmokers had measurable amounts of nicotine in both saliva and urine. Thus, under the natural conditions of a typical working environment, the amount of tobacco smoke absorbed by nonsmokers produced salivary and urinary concentrations similar to those found in "light" smokers.

Andresen et al found appreciable levels of cotinine (nicotine metabolite) in the amniotic fluid of two of 25 nonsmokers who indicated passive exposure to smoke. Smith et al also have reported evidence of "tertiary" smoking by the fetus. The significance of these limited findings is not known.

Effects in Healthy Persons

Children

In an uncontrolled survey, Cameron et al were the first to suggest a relationship between the prevalence of childhood respiratory illness and parental smoking habits. Colley et al reported on 2,205 children up to five years of age. In this age group the proportion of children smoking would, of course, be virtually zero, and the study was well controlled for relevant variables such as social class and family size. The incidence of pneumonia and bronchitis in the first year of life was associated with parents' smoking habits—being lowest when both were nonsmokers and highest when both smoked. Fergusson et al and Liard et al have reported similar findings. Colley and others reported a carefully conducted eight-year prospective study, in which many confounding variables (eg, number of siblings, later smoking habits, parental smoking habits, and respiratory disease) were taken into account. Respiratory symptoms or illness (or both) in later childhood and adult life were found to be related to early childhood respiratory illness. Wheezing and frank asthma in young children also appear to be more common if the parents smoke. A number of other studies over the past ten years support the suggestion that the respiratory health of infants and young children in the home is affected by parental smoking habits. Vogt found that children in smoking households used more inpatient services than those in nonsmoking households, a finding which may reflect more serious illness in these children. In a prospective study, increased risks of hospitalization for respiratory and other conditions were found for the children of mothers who smoked, and mortality was three times greater, a finding that was independent of birth weight, social class, and parity. An association between parental smoking at home and the height of children has been reported; the more people who smoke at home, the smaller the children. An association of maternal smoking with sudden infant death has been reported, but it is not known whether prenatal or postnatal exposure is more important.

Adults

Acute Effects. Most of the public consciousness regarding passive smoking is related to the acute irritating effects of indoor environmental cigarette smoke upon the eyes and respiratory mucous membranes. Speer interviewed 250 normal individuals and found that 69 percent reported eye irritation, 32 percent headache, 29 percent nasal symptoms, and 25...
percent cough, when exposed to smoky atmospheres. A study involving several federal US agencies, in which questionnaires distributed to passengers on military and commercial aircraft were analyzed, indicated that over 60 percent of the nonsmoking passengers and 20 percent of the smokers were annoyed by smoke in the air. Other studies involving large numbers of passive smokers have corroborated these complaints with approximately the same percentages of eye, nose, and lower respiratory tract irritation.

The Christmas Seal League of Southwestern Pennsylvania conducted a survey of 9,415 residents in shopping malls, offices, schools, restaurants, and other areas. In this large, but not carefully controlled study, 73 percent of nonsmokers, 66 percent of ex-smokers, and 41 percent of smokers indicated that tobacco smoke in indoor air bothered them. The places where smoke was most bothersome were similar to those found in other studies, ie, cars, 75 percent; restaurants, 64 percent; planes and buses, 53 percent; elevators, 52 percent; friends’ homes, 51 percent; waiting rooms, 51 percent; meetings, 43 percent; and hospitals, 41 percent.

**Chronic Effects. Airways:** In the first reported study of possible damage to small airways by passive smoking, White and Froeb provided data on 2,100 subjects enrolled in a physical fitness course. Mean forced expiratory flow during the middle half of the forced vital capacity (FEF25-75%) was lower in the nonsmoking involuntary smokers than in the nonsmokers not exposed to tobacco smoke at home or at work (p<0.005). These investigators concluded that chronic exposure to tobacco smoke in the work environment is deleterious to the nonsmoker and significantly reduces the function of small airways. Kauffmann and Perdrizet have confirmed these findings. There were significant differences for FEF25-75% for both sexes, with nonsmokers having larger measurements than passive smokers.

**Lung Cancer:** Hirayama reported the results of a prospective study involving 265,118 adults. Of particular interest were those data for lung cancer in the 91,540 married women. Among the nonsmokers, age-adjusted lung cancer mortality rates were lowest for wives of nonsmokers, intermediate for wives of light or ex-smokers, and highest for wives of heavy smokers (20+ cigarettes per day) (p<0.01). In a case-control study of lung cancer in women, Trichopoulos et al found a risk of lung cancer 2.4 times higher for wives of men who smoked less than a pack per day and 3.4 times higher for wives of heavy smokers, compared with the wives of nonsmokers. Garfinkel reported on the 12-year follow-up of 176,730 nonsmoking women. While the risk of lung cancer among the nonsmoking wives of smoking husbands was increased over that of the wives of nonsmokers, the difference was not statistically significant.

The limitations of each of these studies have been thoroughly discussed. Although the currently available evidence is not sufficient to conclude that passive smoking causes lung cancer in nonsmokers, the evidence does raise concern about a possible serious public health problem.

**Effects on Persons with Certain Diseases and Conditions**

**Cardiovascular Disease**

Aronow demonstrated the effect of passive smoking on shortening time to angina in exercising patients. Patients exposed to passive smoking had increases in resting heart rate, systolic and diastolic blood pressure, and venous COHb. The duration of exercise until angina occurred was decreased 22 percent after passive smoking in a well-ventilated room (p<0.001) and 38 percent after passive smoking in a nonventilated room (p<0.001).

**Allergies**

Pipes observed that 15 percent of patients with respiratory allergies gave a history of their respiratory allergy being precipitated or aggravated by exposure to tobacco smoke. Speer compared 250 nonallergic nonsmokers to 191 allergic nonsmokers. Eye irritation was experienced about equally; however, nasal symptoms were experienced on passive exposure to tobacco smoke by 61 percent of the allergic patients and by 29 percent of the nonallergic patients. The frequencies of other symptoms among these two groups, respectively, were as follows: headache (46 percent, 32 percent); cough (46 percent, 25 percent); wheezing (23 percent, 4 percent); sore throat (23 percent, 6 percent); and hoarseness (16 percent, 4 percent).

**Pulmonary Disease**

There is a paucity of studies on the effect of passive smoking on chronic pulmonary disease. Shephard et al showed little effect on the ventilatory function of asthmatic subjects upon passive exposure to cigarette smoke. O’Connell and Logan assessed the effects upon asthmatic children if parents stopped smoking and reported improvements in 18 of 20 children. In contrast, only four of 15 asthmatic children improved when parents continued to smoke. Dahms et al reported that their asthmatic subjects placed in an environmental chamber for 60 minutes with exposure to side-stream cigarette smoke showed a highly significant and substantial decline in pulmonary function. None of the normal control subjects demonstrated a change in pulmonary function.
THE CASE FOR CONTROL MEASURES

New work continues to be reported on the long-term chronic effects of passive smoking. Controversies, such as the one concerning the validity of the reports of Hirayama, Trichopoulos et al., and Garfinkel, with regard to lung cancer in nonsmoking wives passively exposed to tobacco smoke because of their husbands' smoking, no doubt will continue; however, the weight of evidence in the area of adverse chronic effects has increased rapidly. The reports of acute irritation of the respiratory and eye membranes support opinion surveys which indicate quite clearly the demand for "clean air" in public places, including offices, other work places, bars, restaurants, public transportation, and hospitals. In these surveys the respondents, smokers as well as nonsmokers, favored actions of various kinds, including legislation to control cigarette smoke in enclosed spaces.

Technologic Measures

As a continuing practical solution to the separation of smokers from nonsmokers, attempts have been made to change ventilation patterns in rooms and buildings, to filter cigarette smoke, or to exhaust occupied premises at a rate which guarantees a very low level of residual cigarette smoke; however, no reports of the overall effectiveness or the cost of these attempts are available.

The segregation of smokers to one side of a restaurant or meeting room, or to one end of an aircraft, is not satisfactory. Within an hour the mixing of room air is such that smoke is carried to all parts of the enclosed space, with little difference between the "smoking" and "nonsmoking" sections. Repace and Lowrey have shown both theoretically and experimentally that under the practical range of standard ventilation practices and building occupancy, the "respirable suspended particle (RSP) levels generated by smokers overwhelm the effects of ventilation and inflict significant air pollution burdens on the occupants. Attempts to reduce RSP levels from smoking by increasing the rate of mechanical ventilation or the efficiency of filtration yield exponentially diminishing returns for linear increases in ventilation energy (and cost)." Similarly, Olshansky showed that nonsmokers seated in adjacent smoking/nonsmoking areas in a natural environment (a weekly bingo game in Milwaukee Knights of Columbus Hall) not only were exposed to similar ambient levels of carbon monoxide, but also showed similar physical and physiologic reactions to their exposure as measured by coordination test scores, expired carbon monoxide, and blood COHb.

Many institutions have purchased high-volume electrostatic filters. Repace and Lowrey have indicated that these are completely outpaced by continual smok-
“no-smoking” signs does elicit compliance by most smokers, even when no penalties have been specified.4 In the state of Minnesota, a high level of compliance has been reported with the Clean Indoor Air Act of 1975.43

CONCLUSION

There is still much research to be done into the health effects of passive smoking, however, the need for such research should not be used as an excuse for inaction. The accumulated body of evidence concerning the health risks of passive smoking, together with changing public perceptions and attitudes, provides a reasonable and rational basis for control measures in enclosed environments. The time has come for governments to respond by assuring that appropriate measures to deal with this health hazard are implemented.44

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