Second-hand Tobacco Smoke in Oklahoma: A Preventable Cause of Morbidity and Mortality and Means of Reducing Exposure

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Evidence has mounted in recent years establishing second-hand tobacco smoke exposure as a cause of morbidity and mortality in nonsmokers. The ratio of deaths is approximately one nonsmoker dying from illness caused by second-hand smoke exposure for every eight smokers who die from diseases caused by tobacco use. This is equivalent to about 750 nonsmoker deaths each year in Oklahoma caused by exposure to second-hand smoke.

This article reviews the components of second-hand smoke, its health effects, its prevalence in Oklahoma, and the means of protecting children and nonsmoking adults from exposure.

Oklahoma physicians are encouraged to advise their patients about the harmful effects of second-hand smoke and to actively support public policies that decrease exposure to second-hand smoke in public places and workplaces.

Introduction

Tobacco smoke is known to cause serious adverse health effects in smokers. Tobacco use is recognized as America's leading preventable cause of death.[1] Though nonsmokers do not directly puff on the burning tobacco products or on the devices containing them, they can be exposed to tobacco smoke second-hand. This smoke can be in different concentrations and of different composition than the mainstream smoke directly inhaled by smokers. It is now recognized that exposure to second-hand smoke causes morbidity and mortality in nonsmokers.[2] Children are particularly susceptible to its effects.[3]

Definition.

Second-hand smoke is a term commonly used to describe the gaseous and particulate aerosol that can be inhaled by nonsmokers from burning tobacco products. It consists primarily of sidestream smoke from the burning tobacco product, plus a smaller volume of mainstream smoke exhaled by the smoker. Second-hand smoke is sometimes referred to as environmental tobacco smoke (ETS); and exposure to it as passive smoking or involuntary smoking.

Ingredients

Smoke from a lighted tobacco product is a mixture of approximately 4,000 gases and particulate substances.[2] Some of these are additives or products of combustion and are not found in tobacco. The composition of the smoke varies as a result of factors, including the temperature of combustion. Sidestream smoke is created at lower temperatures than mainstream smoke and can include greater concentrations of some toxic substances that are reduced at the higher temperatures reached in active puffing. Consequently, second-hand smoke typically is even more toxic than the smoke inhaled by a smoker directly from a cigarette.[3]

Among the ingredients of second-hand smoke are at least 250 harmful substances,[4] including mutagens, carcinogens, eye and respiratory irritants, systemic toxicants, and reproductive and developmental toxicants.[5] The irritants and systemic poisons include ammonia, acrolein, carbon monoxide, formaldehyde, hydrogen cyanide, nicotine, nitrogen oxides, phenol, and sulfur dioxide. More than 40 compounds in second-hand smoke are classified as known or suspected human carcinogens, including benzene, hydrazine, vinyl chloride, aromatic amines, arsenic, cadmium, chromium, and nickel.[6] Second-hand smoke itself also is classified by the

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U. S. Government as a known human carcinogen.[4]

The following is a partial list of constituents of tobacco smoke which are harmful to health and which may be particularly concentrated in second-hand smoke. They are listed with the ranges of ratios found in sidestream smoke compared to mainstream smoke: carbon monoxide (2.5-4.7); benzene (5-10); formaldehyde (0.1-~50); acrolein (8-15); hydrazine (3); ammonia (3.7-5.1); and nickel (13-30).[7] The condensate of sidestream smoke is more carcinogenic in animal tests than the condensate of mainstream smoke.[8]

There is no safe level of exposure to class A (known human) carcinogens.[3,9] The estimated number of cancer deaths attributable to second-hand smoke in this country exceeds the combined cancer deaths caused by most federally regulated environmental pollutants, including outdoor air pollutants such as asbestos, radiation, pesticides on food, active hazardous waste sites, inactive hazardous waste sites, chemicals in drinking water, workplace chemicals, contaminated sludge and mining wastes, making second-hand smoke by far this nation's leading environmental cause of cancer.[10,11,12]

Health Effects of Second-hand Smoke

Second-hand smoke was identified as a health risk in the 1972 report of the Surgeon General.[13] In 1986, the Surgeon General's Report, *The Health Consequences of Involuntary Smoking*, dealt exclusively with this problem and concluded that second-hand smoke causes lung cancer in some persons.[2] It called for further research into this relationship, and in 1992 the Environmental Protection Agency (EPA) published results of a systematic review, classifying second-hand smoke as a human carcinogen and estimating that it is responsible for approximately 3,000 lung cancer deaths, plus impairing the respiratory health of hundreds of thousands of children in this country every year.[3]

The tobacco industry challenged the EPA's findings in federal court, and in 1998 a judge in North Carolina vacated certain sections of the 1992 EPA report, largely on procedural grounds.[14] But the underlying scientific evidence was unchanged, and it has continued to accumulate. In 1999 the National Cancer Institute published a monograph, *Health Effects of Exposure to Environmental Tobacco Smoke,* reporting the findings of a scientific review panel in California that had studied the research published to 1997.[5] These findings backed up the conclusions of the earlier EPA report concerning lung cancer and children's health and added information from more recent research into the relationships of second-hand smoke to cardiovascular disease, reproductive disorders and other health problems.

In its *Ninth Report on Carcinogens* in 2000, the National Toxicology Program—a federal interagency group involving the EPA, the National Institutes of Health (NIH), the National Institute of Environmental Health Sciences (NIEHS), the National Cancer Institute (NCI), the National Center for Environmental Health (NCEH), the Food and Drug Administration (FDA), the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the Consumer Product Safety Commission (CPSC), and the Agency for Toxic Substances and Disease Registry (ATSDR)—officially classified second-hand smoke as a human carcinogen.[4] Also in 2000, *Reducing Tobacco Use: A Report of the Surgeon General* provided an updated summary of the recognized adverse health effects of second-hand smoke and the evidence-based means of preventing second-hand smoke exposure.[15]

Cancer

The EPA's panel in 1992 concluded from its review of 32 studies of second-hand smoke and lung cancer that second-hand smoke exposure causes 3,000 lung cancer deaths in the United States annually.[3] Similar conclusions regarding this causal relationship had been reached by the U.S. Surgeon General, the National Research Council, and the National Institute for Occupational Safety and Health.[2,16,17] More recently, the National Toxicology Program, the California EPA, and the American Academy of Occupational and Environmental Medicine have been among the groups reviewing additional studies and confirming the finding that second-hand smoke causes lung cancer.[4,5,18] The average increased risk ratio for lung cancer in nonsmokers exposed to second-hand smoke is 1.2, based on the review published by the National Cancer Institute in 1999.[5]

There also is evidence that second-hand smoke may cause nasal sinus cancer. Whether it causes other types of cancers is less clear, but a positive association has been observed between second-hand smoke exposure and cervical cancer,[5] and some researchers also suggest the possibility of a causal relationship with breast cancer.[19,20,21]

Heart Disease

Most nonsmoker deaths caused by second-hand smoke are from heart disease, calculated various-

ly at ten[22] to twenty[23] times the corresponding number of deaths from lung cancer. This represents up to 62,000 coronary heart disease (CHD) deaths of nonsmokers annually in the United States from exposure to second-hand smoke,[24] and up to 760 in Oklahoma.

Prior to 1997, studies had established that exposure of nonsmokers to spousal smoking at home caused CHD mortality, with an increased risk factor of 1.3.[22] More recent studies have confirmed that workplace exposure also can cause CHD, with similar increase in risk.[25,26] Findings of the European CARDIO2000 study included increases in risk for coronary heart disease from second-hand smoke exposure, with a significant dose-response relationship identified.[27] Second-hand smoke has been observed to adversely affect heart rate variability in adult nonsmokers.[28]

The effects of second-hand smoke on the cardiovascular system include reduced exercise capability, enhanced platelet aggregation, acceleration of atherosclerotic lesions, carotid wall thickening, altered lipoprotein profiles, and increases in tissue damage following ischemia or myocardial infarction.[5,29] One recent study showed evidence of endothelial dysfunction of the coronary circulation in nonsmokers following a single 30-minute exposure to second-hand smoke; the adverse effects were experienced only by nonsmokers, not by smokers who were similarly exposed.[30] An editorial in the issue of *JAMA* containing this report was entitled "Even a little second-hand smoke is dangerous."[31]

Other vascular disease

The American Heart Association scientific statement on "Primary prevention of ischemic stroke" attributes 12% of stroke risk to second-hand smoke exposure among nonsmokers, compared to 18% as a result of current smoking and 6% as a result of former smoking.[32] The increased risk ratio from second-hand smoke for stroke was calculated as 1.8 and 2.03 in 1999 studies in New Zealand and Australia, respectively.[33,34]

Respiratory effects in adults

Exposure to second-hand smoke decreases respiratory system performance in nonsmoking adult men and women.[7] Exposure also elevates the risk of pneumococcal pneumonia.[18,35,36] Control of adult asthma is more difficult and morbidity is greater with exposure to second-hand smoke.[37] Eye and nasal irritation are commonly reported symptoms of nonsmokers exposed to second-hand smoke.

Adverse health effects in children

Second-hand smoke exposure causes lower respiratory tract infections such as bronchitis and pneumonia in children.[3] The EPA estimates 150,000-300,000 of these cases are attributable to second-hand smoke annually in the United States, with 7,500 to 15,000 of them requiring hospitalization. Children exposed to second-hand smoke also experience upper respiratory tract irritation. Chronic respiratory symptoms such as cough, phlegm, and wheezing are associated with parental smoking.

It is now recognized that second-hand smoke is a risk factor for new cases of asthma in children.[5] It also increases the frequency and severity of episodes of asthma, adversely impacting up to 12,000 Oklahoma children yearly, based on the EPA national estimate.[3]

Children have an increased risk of acute and chronic middle ear infections if they have been exposed to second-hand smoke. Exposure also may exacerbate cystic fibrosis, and children with this condition are likely to be more sensitive to second-hand smoke than healthy persons.[5]

Nonsmoking mothers exposed to second-hand smoke during pregnancy have an increased risk for delivering a low birthweight baby. Exposure of the infant to second-hand smoke increases the risk of sudden infant death syndrome (SIDS). If the mother is a smoker, exposure of the infant to second-hand smoke increases the risk of SIDS independent of the elevated risk resulting from in utero exposure.[5]

Mortality attributable to second-hand smoke in Oklahoma

Estimated annual mortality in this country is more than 400,000 from smoking[38] and 53,000 nonsmokers from second-hand smoke exposure,[29] a ratio of approximately eight to one. In Oklahoma about 6,000 persons die from smoking each year[39] and an estimated 750 from second-hand smoke exposure.

Exposure of Oklahomans to second-hand smoke.

Information on exposure to second-hand smoke in Oklahoma includes data from two different surveys asking questions about smoke-free policies at the worksite, one of which also provides information about smoking in the home.

The Behavioral Risk Factor Surveillance System (BRFSS) is an annual telephone survey of a random sample of adults in each state. Some years, Oklahoma has been among several states asking an additional module of tobacco-related

questions, some regarding second-hand smoke. The 1996 survey ranked Oklahoma 37th, with 25.6% of its children under age eighteen living in households with at least one adult smoker.[40] This represented 216,335 children.

The latest BRFSS data shows that 72.9% of employed Oklahoma adults work indoors most of the time,[41] and that 73.3% of these reported the official policies at their workplaces do not allow smoking in work areas.[42] Regarding their homes, 69.6% indicated they knew of no smoking by anyone in their home in the past 30 days, while 23.3% identified themselves as current smokers.

Another similar survey is the Current Population Survey (CPS) Tobacco Use Supplement conducted by the Census Bureau for the National Cancer Institute. In the 1999 CPS survey, Oklahoma ranked 30th with 67.7% of the persons over age 15 who reported working indoors stating their workplace policies restricted smoking in work areas and common areas.[43]

The similarity of these findings shows that approximately two-thirds of Oklahomans who work indoors believe their employers' policies officially restrict smoking in their work areas.

These surveys do not specify in detail the types of restrictions or the protections provided. The worksites identified by respondents as having smoking restrictions may have either smoking bans or designated smoking areas, and designated smoking areas may not be physically separated or may not have their exhaust air vented to the outside. In addition, enforcement may not be equally effective in all cases.

These surveys indicate that 25% to 33% of Oklahoma indoor workers work in areas where smoking is not restricted, meaning 300,000 to 400,000 or more workers in this state still are subject to worksite exposure to second-hand smoke.[41]

Variations in exposure risk by location and occupation

An analysis of several published studies of workers in different settings and persons in homes has shown that workers in restaurants and bars experienced the greatest risk.[44] Measures of second-hand smoke exposure in restaurants were twice those in the offices studied and one and a half times as great as the levels in homes with at least one smoker. In bars, the mean concentrations of second-hand smoke constituents measured were 3.9 to 6.1 times higher than in the offices and at least 4.4 to 4.5 times higher than in the residences with smokers.

Analyses of mortality data by occupation have shown food service workers to have an elevated risk for lung cancer, with an increased odds ratio of 1.88 for waitresses.[45,46] An evaluation conducted for NIOSH revealed that casino workers received greater exposure than average to second-hand smoke and that their serum cotinine levels, the marker of exposure in this study, increased an average of 38% during the work shift because of second-hand smoke in this work setting.[47]

The higher concentration of second-hand smoke prevalent in many hospitality industry settings is of concern, both from the standpoint of members of the public who choose to patronize these venues and from the standpoint of the employees who spend significant time in these environments.

Reducing Exposure to Second-hand Smoke

The Oklahoma State Board of Health has declared tobacco use as the state's number one health problem.[48] In its *2002 State of the State's Health Report,* the Board of Health issued a call--in conjunction with public agency and private organization community partners, including the Oklahoma State Medical Association—that aggressive steps be taken to combat this problem, including making all public places and workplaces smoke-free.

Both means of intervention to achieve this goal—mechanical and policy—are evaluated below, progressing from the least effective options to the most effective.

Mechanical interventions.

Separation. This is a means commonly encountered in Oklahoma to attempt to protect persons from exposure to second-hand smoke, but it is ineffective.[2] State law requires or authorizes designated smoking and nonsmoking areas in various situations, and it says they can be in the same room.[49] The law refers to the use of existing physical barriers and ventilation systems to minimize smoke in both smoking and nonsmoking areas, but this reference appears to be stated as much to protect restaurants and other public places from any new requirements as to offer protection to nonsmokers. Although its concentrations may vary from spot to spot, tobacco smoke circulates and diffuses throughout an enclosed space. Separation of smokers and nonsmokers within the same enclosure is inadequate as a means to reduce exposure.

Ventilation. This also is not an effective means of protection against second-hand smoke.[50] Smoke disperses in a room before the heating, ventila-

tion and air conditioning (HVAC) system removes a portion of it with the exhaust air. Most HVAC systems recirculate all or some of this exhausted air back into the same space and/or into other spaces in the building. Filtration cannot remove the multiple gases, semi-volatile compounds, and very fine (under 2.5 microns) respirable suspended particles that comprise second-hand smoke.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) develops standards, which include ASHRAE Standard 62-1999 "Ventilation for acceptable indoor air quality."[51] It has been calculated that the prevailing type of dilution ventilation HVAC system, with air turnover rates specified in the ASHRAE standard, at best could only reduce second-hand smoke concentrations to 2,500 times the level that would require intervention by federal agencies to protect the public health, if the pollutant were not second-hand smoke but another human carcinogen.[52] The recently approved "Addendum e" to Standard 62-1999 removed a reference to accommodating "a moderate amount of smoke," and ASHRAE's interpretations of this standard now state "the Ventilation Rate Procedure applies only to spaces with no smoking."[53] More proposed amendments were published late in 2001 with opportunity for public comment through early 2002, and the tobacco industry continues to lobby directly and through partners and surrogates to influence any types of regulations that could potentially encourage or interfere with the public's use of tobacco products. On the public health side, a representative of the American Medical Association staff has been approved by ASHRAE as a member of the panel reviewing this standard.[54]

Separately ventilated smoking lounges. These lounges possibly can protect other spaces in a building from exposure to tobacco smoke if several requirements are met, but they also have disadvantages. The requirements include intact structural separation of the space, negative air pressure relative to the surrounding spaces so that smoke does not escape to nonsmoking areas of the building when a door is opened, and no circulation of the air by the HVAC system to any other area of the building.[55] Preferably the smoke-contaminated air should be exhausted directly to the outside. Drawbacks of this arrangement include cost, the need for safeguards to prevent employee exposure, and liability considerations regarding the exposure of smokers to the atmosphere in the lounge.

Policy interventions that restrict or ban smoking. On the other hand, policies to restrict or ban smoking are effective and relatively simple. Bans are also inexpensive. Indoors bans also should exclude smoking outside near the entrances and air intake vents to buildings. Few other public health problems have such a ready and practical solution.

An independent panel of public health leaders and researchers supported by public and private agencies, the Task Force for Community Preventive Services, conducted a thorough review of the literature and published its recommendations in 2000 for effective, evidence-based interventions to reduce the serious health problems posed by tobacco use.[56] The Task Force concluded that policies to restrict or ban smoking effectively reduce exposure to second-hand smoke, and its *Community Guide* "strongly recommends" developing policies, laws and regulations to restrict or ban smoking in workplaces and general areas used by the public.[57,58,59]

Although more than one thousand cities and towns across the country have passed ordinances limiting smoking,[60] a preemption provision in Oklahoma's state Smoking in Public Places Act has severely limited public policy as a means of protecting workers and the public in this state from the health hazards of second-hand smoke.[61] Oklahoma's preemption provision is one of the three most restrictive in the nation, and all seven states bordering Oklahoma are among the majority of states that are free from any such preemptive restrictions in their state laws regarding tobacco use.[62] Cities in Oklahoma, organizations representing the political subdivisions, public health organizations and coalitions have urged the state to repeal this preemption provision, but without success to this date.[63]

Under Oklahoma law as of January 2002, no city or town could even make its own buildings smoke-free by ordinance, and the law generally provides very little protection for the public from second-hand smoke.

Smoke-free policies not only protect nonsmokers from known or unknown exposure to harmful components of second-hand smoke, they also provide significant incentives for smokers to quit.[64,65] Most adult smokers (74.6%)[66] and about half of middle school and high school smokers (49.9% and 47.9%, respectively)[67] in Oklahoma say they want to quit, so these policies would be a welcome incentive to many. In addition, those who do not quit nevertheless do reduce their consumption as a result of smoke-free policies.[64,68]

A tobacco industry study in 1992 estimated

these effects at an 84% increase in cessation and an 11-15% decrease in consumption by the remaining smokers.[69]

Conclusions

Second-hand smoke exposure poses serious health risks to otherwise healthy nonsmokers. Even brief exposures can be harmful, and nonsmokers are particularly susceptible to its harmful effects.

However, this significant preventable cause of mortality can be largely eliminated through policies banning smoking in public places and other worksites and by encouraging smoke-free homes.

Oklahoma physicians can play a significant role in decreasing the harmful impact of second-hand smoke in our state. Physicians are encouraged to (1) advise families to make their homes smoke-free, particularly where children reside in the household, and to avoid other exposure to second-hand smoke; (2) foster private policies for clean indoor air; (3) support repeal of preemption so that communities in Oklahoma can adopt local clean indoor air ordinances; and (4) work for passage of state and local laws to make all public buildings, other public places including restaurants, and all other worksites smoke-free. ▯

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