Reducing Levels of Toxic Chemicals in Cigarette Smoke: A New Healthy People 2010 Objective

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SYNOPSIS

We developed and implemented a national surveillance system to monitor and reduce the levels of toxic chemicals in tobacco smoke. A developmental Healthy People 2010 (HP 2010) objective was revised to report on levels of three categories of chemicals—tobacco-specific nitrosamines, polycyclic aromatic hydrocarbons, and volatile organic compounds—in the smoke of leading U.S. cigarette brands. Unit-based sales-weighted average levels were calculated for each chemical category. The target for the new HP 2010 objective is a 10% reduction in unit-based sales-weighted average levels of each chemical category. The Centers for Disease Control and Prevention provided the baseline, target data, and laboratory analyses.

A national data source, national baseline data, and target were presented to the Healthy People Steering Committee during 2005 Midcourse Review. Approval of the revised objective initiated the surveillance of three major classes of toxic chemicals in cigarette smoke. The approved objective provides a feasible, innovative approach for monitoring and supporting measurable population-based reductions in levels of toxic and carcinogenic chemicals in tobacco smoke.

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The adverse health effects from cigarette smoking account for 440,000 deaths in the U.S. each year. Smoking harms nearly every organ in the body, causing many diseases and reducing the health of smokers in general.¹ For every tobacco-related death, approximately 20 people are living with a tobacco-related illness.² Smoking causes cancer of the lung, larynx, pharynx, oral cavity, esophagus, pancreas, urinary bladder, cervix, kidney, and stomach as well as acute myeloid leukemia. In addition, smoking causes coronary heart disease, stroke, abdominal aortic aneurysm, subclinical atherosclerosis, major respiratory symptoms, chronic obstructive pulmonary disease, and poor control of asthma.¹

However, it is not only smokers who experience adverse health effects from exposure to tobacco smoke as there is no safe level of exposure to secondhand smoke (SHS).³ In adults, SHS exposure causes lung cancer and cardiovascular disease. Infants and young children seem especially vulnerable to SHS exposure and have increased risk for sudden infant death syndrome (SIDS), infections of the lower respiratory tract, decreased lung function, and other adverse health outcomes.³ Data from the 1999–2002 National Health and Nutrition Examination Survey (NHANES) show that almost 60% of U.S. children aged 3 to 11 years—or almost 22 million children—were exposed to SHS.³

Cigarette smoke contains more than 4,000 chemicals, including more than 60 carcinogens.⁴ The harm that smokers experience is determined by their cumulative exposure to these chemicals. To better understand population-level exposure, it is necessary to monitor the levels of these chemicals in the smoke of the types of cigarettes used by the majority of smokers. This information will assist with efforts to better understand the complicated relationship between levels of the chemicals delivered in cigarette smoke and human smoking behavior. To this end, the Office on Smoking and Health (OSH) of the Centers for Disease Control and Prevention (CDC) developed a system to monitor the levels of select toxicants in the smoke of commercial U.S. cigarette brands. The goal of the surveillance is to monitor reductions in levels of known toxic and carcinogenic chemicals in cigarette smoke.

The OSH is responsible for leading and coordinating strategic efforts aimed at preventing tobacco use among youth, promoting smoking cessation among youth and adults, protecting nonsmokers from secondhand tobacco smoke, and eliminating tobacco-related health disparities. In this capacity, CDC is also the lead agency for the Tobacco Use chapter (Chapter 27) in *Healthy People 2010*.⁵ Chapter 27 contains 21 objectives in four programmatic areas: tobacco use in population groups (objectives 27-1 through 27-4), cessation and

treatment (objectives 27-5 through 27-8), exposure to SHS (objectives 27-9 through 27-13), and social and environmental changes (objectives 27-14 through 27-21). Many objectives are divided into subobjectives.⁵ Developmental Healthy People objectives lack baseline data and targets.

In this article, we describe the new measurable objective 27-20, which is to “Reduce the sales-weighted average level of toxic chemicals in tobacco products sold in the United States.” The revision of developmental Healthy People 2010 objective 27-20 provided a mechanism to monitor and report on levels of toxic smoke constituents in the context of other tobacco-related national health objectives.

METHODS

Healthy People 2010 is intended as a road map to better health for all.⁵ Reducing levels of harmful chemicals in tobacco smoke is an important step toward understanding and assessing the impact of decreased levels of these toxic chemicals on population-level exposure and adverse health effects from tobacco use. Thus, in consultation with researchers in tobacco control at the National Cancer Institute, CDC determined that objective 27-20 provided an opportunity to report on population-based levels of toxic chemicals in cigarette smoke and pursue reductions in their levels.

The Emergency Response and Air Toxicants (ERAT) Branch Laboratory, Division of Laboratory Science, National Center for Environmental Health, CDC has a growing capacity to analyze tobacco and tobacco smoke.⁶ The ERAT tobacco product research is intended to further our scientific understanding of factors that influence the health consequences of tobacco use and to aid public health officials in evaluating the effectiveness of tobacco-control measures.⁶ The ERAT laboratory agreed to provide the smoke chemistry data for the new objective 27-20.

Tobacco smoke is an aerosol containing approximately 17 chemical classes (amides, imides, lactams, carboxylic acids, lactones, esters, aldehydes, ketones, alcohols, phenols, amines, *N*-heterocycles, hydrocarbons, nitriles, anhydrides, carbohydrates, and ethers). Three chemical classes were selected to provide baseline data for objective 27-20: tobacco-specific nitrosamines (TSNAs), polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). TSNAs are a class of known carcinogens (substances that cause cancer) that are formed during the curing, processing, fermentation, and combustion of tobacco.^{7,8} Of the seven known TSNAs, *N*-nitrosotobaccoamine (NTA) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone

(NNK) generally occur in greater quantities in tobacco products and are clearly the most carcinogenic.⁹

While TSNAs are specific to tobacco, PAHs are ubiquitous environmental pollutants that are formed from the incomplete combustion of organic material. The simplest PAH is naphthalene with two benzene rings. More complex PAHs can have nine, 10, or even 11 benzene rings. PAHs are found in the particulate fraction of tobacco smoke. Hundreds to thousands of PAHs and their derivatives are reported to occur in cigarette smoke.^{10,11} PAHs have been found to be toxic and carcinogenic in laboratory animals and are suspected to be carcinogenic in humans.¹² Even PAHs that are inactive or weakly carcinogenic alone can act as cocarcinogens (strengthen the carcinogenicity of other carcinogens) when administered with a low dose of another carcinogen.¹³ Benzo[*e*]pyrene is an example of a cocarcinogenic PAH in tobacco smoke.¹⁴ TSNAs (notably NNK) and PAHs have been identified as probable causes of lung cancer in smokers.¹⁵

In addition to the TSNAs and PAHs, tobacco smoke contains several thousand other chemicals including numerous irritants, inflammatory agents, and reactive species.¹⁶ These chemicals likely work in concert with cancer-causing chemicals such as the TSNAs and PAHs through such mechanisms as enhanced growth of initiated cells and genetic mutations.

Consequently, another important class of chemicals, the VOCs, which includes irritants, inflammatory agents, and reactive species, was included in objective 27-20. VOCs are a group of chemicals largely defined as organic chemicals that evaporate quickly at room temperature. Like PAHs, VOCs are not found exclusively in tobacco products. There are many sources of VOCs, including paints, solvents, pesticides, cleaning supplies, and tobacco smoke. VOCs can have short- and long-term harmful health effects. The long- or short-term health effects of VOCs vary depending on the compound: some, like benzene, cause cancer, while others (e.g., 2-butanone) are associated with irritation of the eyes and respiratory tract and other toxic effects.^{17,18} The 13 VOCs included in this study are associated with a variety of short- and long-term health effects.

To provide baseline data for these three chemical classes, ERAT scientists measured levels of NNN and NNK (collectively TSNAs), naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[*a*]anthracene, chrysene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*e*]pyrene, and benzo[*a*]pyrene (collectively PAHs), and benzene, toluene, styrene, *o*-xylene, *m/p*-xylene, 3-ethylbenzene, 3-ethyltoluene, acetone,

3-buten-2-one, 2,3-butanedione, 2-butanone, 2-pentanone, and 3-pentanone (collectively VOCs) in the mainstream smoke of leading U.S. cigarette brands. Mean levels of individual chemicals in each cigarette brand were totaled for each chemical class (TSNAs, PAHs, VOCs) (Table 1).

Table 1 contains the mean sums of the TSNAs, PAHs, and VOCs organized by manufacturer in alphabetical order. The brands are not ordered by levels of the three chemical classes because not all classes of chemicals were measured for all brands. Also, the sums are not weighted by the potency, toxicity, or relative amounts of the individual chemicals making up the chemical class (e.g., amount of benzene relative to all 13 VOCs) and, thus, are not used to make a comparative toxicity ranking of brands. The smoking machine conditions require all cigarettes to be smoked under standard conditions and to a standard butt length (23 mm, or to the length of the filter and overwrap plus 3 mm if in excess of 23 mm).

The sums of TSNAs, PAHs, and VOCs and the number of cigarettes sold (*q*) were transformed mathematically into unit-based sales-weighted averages for each chemical class using the sum of all analytes for each chemical class for each cigarette brand (array1 in formula 1.1) and *q* for each cigarette brand (array2 in formula 1.1). The unit-based sales-weighted averages for each chemical class are presented as subobjectives in Table 2. The number of cigarettes sold (*q*) for each cigarette brand is derived from proprietary ACNielsen sales data (Scan-Trac data, Grocery Channel, 50 Retail Markets, 1994–2004; ACNielsen; Schaumburg, IL) for the year the cigarettes were purchased.

$$\text{Unit-based sales-weighted average} = \frac{\text{SUMPRODUCT}(\text{array1}, \text{array2})}{\text{SUM}(\text{array2})} \quad (\text{Formula 1.1})$$

RESULTS

The proposed objective 27-20 with three subobjectives (27-20a TSNAs, 27-20b PAHs, and 27-20c VOCs) was presented to the Healthy People Steering Committee and offered for public comment during the 2005 Healthy People 2010 Midcourse Review. The proposed data source, baseline data, and target were all approved by the Steering Committee in January 2005. The public comment period ran from August 15 through September 15, 2005. Public comments received for this objective suggest that regulation of tobacco products is viewed as a critical means of reducing tobacco-related morbidity and mortality and that additional chemical classes should be monitored.

Table 1. Tobacco-specific nitrosamine, polyaromatic hydrocarbon, and volatile organic compound levels in the smoke of leading U.S. commercial brands of filtered cigarettes

Manufacturer/ brands	Tobacco-specific nitrosamines				Polyaromatic hydrocarbons			Volatile organic compounds		
	Mean NNK (ng/cig.) ± SD	Mean NNN (ng/cig.) ± SD	Mean NNN + mean NNK (ng/cig.)	CV (percent)	Mean (ng/cig.) ± SD	Median (ng/cig.)	CV (percent)	Mean (µg/cig.) ± SD	Median (µg/cig.)	CV (percent)
Brown & Williamson Tobacco Corporation										
Carlton full flavor, non-mentholated	2.5 ± 0.9	10.4 ± 3.1	12.9	NNK 34 NNN 30	87 ± 46	51	53	108 ± 9	106	9
Carlton full flavor, mentholated	NA	NA	NA	NA	NA	NA	NA	85 ± 18	78	21
GPC full flavor, non-mentholated	40.3 ± 8.8	96.5 ± 18.4	136.8	NNK 22 NNN 19	1232 ± 231	1,290	19	976 ± 42	973	4
GPC medium, non-mentholated	NA	NA	NA	NA	NA	NA	NA	704 ± 20	715	3
GPC light, non-mentholated	21.6 ± 4.6	38.1 ± 7.6	59.7	NNK 21 NNN 20	751 ± 102	754	14	618 ± 46	642	7
GPC ultra light, non-mentholated	16.2 ± 2.5	32.5 ± 5.7	48.7	NNK 15 NNN 17	561 ± 105	609	19	433 ± 54	425	12
Kool full flavor, mentholated	23.9 ± 5.5	73.3 ± 20.6	97.2	NNK 23 NNN 28	1274 ± 280	1,170	22	981 ± 167	1,015	17
Lorillard Tobacco Company										
Kent full flavor, non-mentholated	35.5 ± 6.2	89.3 ± 16.3	124.9	NNK 18 NNN 18	832 ± 46	836	6	737 ± 44	737	6
Newport full flavor, mentholated	34.2 ± 5.3	124.1 ± 20.8	158.3	NNK 15 NNN 17	1146 ± 264	1,168	23	974 ± 22	969	2
Newport medium, mentholated	29.8 ± 5.6	97.2 ± 19.2	127.0	NNK 19 NNN 20	921 ± 73	923	8	757 ± 73	723	10
Newport light, mentholated	14.5 ± 3.2	49.0 ± 14.6	63.6	NNK 22 NNN 30	660 ± 138	645	21	591 ± 43	603	7
True full flavor, non-mentholated	13.1 ± 3.4	56.2 ± 13.9	69.3	NNK 26 NNN 25	401 ± 43	393	11	242 ± 17	247	7
Misty full flavor, non-mentholated	28.4 ± 4.7	80.1 ± 12.1	108.5	NNK 16 NNN 15	1165 ± 86	1,156	7	NA	NA	NA
Misty light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	519 ± 30	534	6
Misty light, mentholated	NA	NA	NA	NA	NA	NA	NA	475 ± 74	448	16

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Table 1 (continued). Tobacco-specific nitrosamine, polyaromatic hydrocarbon, and volatile organic compound levels in the smoke of leading U.S. commercial brands of filtered cigarettes

Manufacturer/ brands	Tobacco-specific nitrosamines				Polyaromatic hydrocarbons			Volatile organic compounds		
	Mean NNK (ng/cig.) ± SD	Mean NNN (ng/cig.) ± SD	Mean NNN + mean NNK (ng/cig.)	CV (percent)	Mean (ng/cig.) ± SD	Median (ng/cig.)	CV (percent)	Mean (µg/cig.) ± SD	Median (µg/cig.)	CV (percent)
Misty ultra light, mentholated	NA	NA	NA	NA	NA	NA	NA	275 ± 18	277	7
Philip Morris USA										
Basic full flavor, non-mentholated	81.7 ± 26.3	180.4 ± 58.0	262.2	NNK 32 NNN 32	1,114 ± 233	1,071	21	832 ± 67	808	8
Basic light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	687 ± 8	690	1
Basic ultra light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	389 ± 55	385	14
Benson & Hedges full flavor, non-mentholated	34.6 ± 6.2	91.9 ± 23.1	126.5	NNK 18 NNN 25	1,598 ± 116	1,639	7	884 ± 62	882	7
Marlboro full flavor, non-mentholated	48.0 ± 9.3	101.3 ± 15.5	149.3	NNK 19 NNN 15	1,149 ± 243	1,108	21	825 ± 45	814	5
Marlboro light, non-mentholated	30.4 ± 6.6	72.8 ± 12.2	103.3	NNK 22 NNN 17	1,070 ± 183	1,123	17	657 ± 36	672	6
Marlboro ultra light, non-mentholated	13.3 ± 2.6	37.4 ± 6.9	50.7	NNK 20 NNN 18	594 ± 203	519	34	440 ± 70	445	16
Marlboro full flavor, mentholated	NA	NA	NA	NA	NA	NA	NA	774 ± 54	751	7
Marlboro mild, mentholated	NA	NA	NA	NA	NA	NA	NA	723 ± 64	694	9
Marlboro medium, non-mentholated	NA	NA	NA	NA	NA	NA	NA	683 ± 58	713	8
Marlboro light, mentholated	NA	NA	NA	NA	NA	NA	NA	620 ± 51	619	8
Marlboro ultra light, mentholated	NA	NA	NA	NA	NA	NA	NA	392 ± 32	402	8
Virginia Slims full flavor, non-mentholated	50.3 ± 9.7	118.2 ± 18.9	168.5	NNK 19 NNN 16	1,185 ± 397	1,366	34	NA	NA	NA

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Table 1 (continued). Tobacco-specific nitrosamine, polyaromatic hydrocarbon, and volatile organic compound levels in the smoke of leading U.S. commercial brands of filtered cigarettes

Manufacturer/ brands	Tobacco-specific nitrosamines				Polyaromatic hydrocarbons			Volatile organic compounds		
	Mean NNK (ng/cig.) ± SD	Mean NNN (ng/cig.) ± SD	Mean NNN + mean NNK (ng/cig.)	CV (percent)	Mean (ng/cig.) ± SD	Median (ng/cig.)	CV (percent)	Mean (µg/cig.) ± SD	Median (µg/cig.)	CV (percent)
R.J. Reynolds Tobacco Company										
Camel full flavor, non-mentholated	35.9 ± 7.2	121.4 ± 35.6	157.3	NNK 20 NNN 29	1,292 ± 266	1,181	21	973 ± 26	968	3
Camel full flavor, mentholated	NA	NA	NA	NA	NA	NA	NA	1,032 ± 70	1,033	7
Camel light, mentholated	NA	NA	NA	NA	NA	NA	NA	686 ± 89	651	13
Camel light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	698 ± 45	586	7
Camel ultra light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	465 ± 17	475	4
Camel Jade full flavor, mentholated	NA	NA	NA	NA	NA	NA	NA	1,085 ± 83	1,089	8
Camel Jade light, mentholated	NA	NA	NA	NA	NA	NA	NA	721 ± 47	707	7
Doral full flavor, non-mentholated	36.0 ± 6.3	108.3 ± 21.8	144.3	NNK 18 NNN 20	1,248 ± 109	1,231	9	1,021 ± 253	939	25
Doral light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	605 ± 68	568	11
Doral ultra light, non-mentholated	NA	NA	NA	NA	NA	NA	NA	312 ± 21	323	7
Salem full flavor, mentholated	37.6 ± 8.1	146.3 ± 13.4	183.9	NNK 21 NNN 9	1,432 ± 208	1,391	15	1,075 ± 101	1,071	9
Winston full flavor, non-mentholated	53.6 ± 10.6	127.3 ± 29.0	180.9	NNK 20 NNN 23	1,124 ± 255	1,228	23	898 ± 72	935	8
Winston light, non-mentholated	39.6 ± 8.3	115.6 ± 23.2	155.2	NNK 21 NNN 20	942 ± 114	875	12	713 ± 38	711	5
Winston ultra light, non-mentholated	10.7 ± 2.6	41.2 ± 7.6	51.9	NNK 24 NNN 19	745 ± 158	742	21	393 ± 10	389	3

SD = standard deviation

CV = coefficient of variation

NA = not available

ng/cig. = nanograms/cigarette

µg/cig. = micrograms/cigarette

NNN = N'-nitrosanornicotine

NNK = 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone

Table 2. Healthy People 2010 objective 27-20: baseline data, targets, target-setting method, and data source

<i>Subobjective</i>	<i>Baseline data year</i>	<i>Baseline</i>	<i>2010 target</i>
27-20a Unit-based sales-weighted average tobacco-specific nitrosamines in cigarette smoke (nanograms/cigarette)	2003/2004	121.5	109.4
27-20b Unit-based sales-weighted average polycyclic aromatic hydrocarbon compounds in cigarette smoke (nanograms/cigarette)	2003/2004	993.7	894.3
27-20c Unit-based sales-weighted average volatile organic compounds in cigarette smoke (micrograms per cigarette)	2002	707.0	636.3

Target-setting method: 10% reduction from the baseline rate

Data source: Centers for Disease Control and Prevention

DISCUSSION

In a report published in 2000, the Surgeon General concluded that tobacco products should be no more harmful than necessary given available technology.¹⁹ The dose of toxic chemicals received by a smoker plays a key role in determining how harmful cigarettes are for that person. The dose of toxic chemicals received by a smoker is influenced by several factors including levels of chemicals in the smoke and smoking behavior (e.g., how many puffs are taken and how long the smoke is held in the lungs before exhalation). Therefore, the revised, approved objective is relevant to assessments of the harmfulness of tobacco products as it provides information for one major factor: levels of chemicals in the smoke as measured under machine smoking conditions. The objective is also a feasible, innovative approach for monitoring and supporting measurable reductions of toxic chemicals in tobacco products.

This revised objective reflects the evolving expertise and capacity of the federal government to scientifically evaluate levels of toxic constituents in tobacco and tobacco smoke. The Institute of Medicine in its report *Clearing the Smoke* recommends that information on the characteristics of tobacco products be part of a comprehensive surveillance system to assess how these products affect the health of the public.²⁰ Previously, there was no systematic, published source of brand-specific levels of toxic chemicals in cigarette smoke. As indicated in Table 1, there are clear differences among cigarette brands in their summary levels of the chemical classes. We did not draw direct conclusions from our comparisons, however, because the chemicals that were measured vary in their toxicity profile (e.g., subobjective 27-20c includes both carcinogenic and noncarcinogenic VOCs) and because several brand variations (e.g., soft pack and hard pack) may have been tested for the overall brand data. While additional studies are required to assess individual- or population-level reductions in exposure or in adverse health effects that

occur as a result of meeting the goals of this objective, the fact that these data will be routinely collected and analyzed will likely accelerate advancement in both research and practice in tobacco control.

Data on smoke chemistry is a key component of any determination of risk. If comparable data on smoke chemistry had been available to researchers studying tobacco-related diseases over the last few decades, it would have been a valuable tool in the investigation of factors underlying the observed changes in the histology of lung cancer among cigarette smokers. Despite dramatic reductions in the sales-weighted tar and nicotine values of American cigarettes since the late 1950s, the risk of lung cancer has increased.²⁰ Not until the late 1990s did data on smoke chemistry reveal that changes in the design and construction of cigarettes that achieved reductions in the level of benzo[*a*]pyrene (monitored as a representative of PAHs as a class of chemicals) came at the expense of increases in levels of tobacco-specific nitrosamines (as NNK).^{21,22} These changes in smoke chemistry, accompanied by compensatory smoking behavior (inhaling the smoke more deeply and smoking more intensely) by smokers adopting cigarettes with lower tar and nicotine, are viewed as major contributors to the large increase in adenocarcinoma incidence observed over the past several decades.^{21–23} Once weakly associated with cigarette smoking, adenocarcinoma has now replaced squamous cell carcinoma as the most common type of lung cancer in the United States.²³

Limitations

There are at least two important limitations that should be considered when interpreting the baseline and target data for the revised objective. First, data reported here are determined from cigarette smoke generated by automated smoking machines. People do not smoke cigarettes like machines. Random and systematic variations in how people smoke cigarettes may cause their intake of TSNAs, PAHs, and other constituents

of smoke to differ substantially from levels produced by machine smoking of cigarettes.²⁴ Still, because the monitoring will be conducted in a systematic manner, the overall level and changes in the toxic composition of cigarette smoke will be objectively assessed.

Second, while including brands with a substantial market share, these data are not equivalent to a comprehensive surveillance of all varieties of cigarettes sold in the U.S. Furthermore, new cigarette technologies such as novel filters or cigarettes that heat, rather than burn, tobacco may bring products to market that differ from the traditional, tobacco-burning cigarettes measured in objective 27-20. If a significant number of U.S. smokers adopt new-technology tobacco products, the relevance of the data to U.S. smokers will likely be reduced.

Future revisions to objective 27-20 may expand upon the current subobjectives by adding additional chemical analytes linked with adverse health outcomes from tobacco use, such as nicotine addiction and cardiovascular disease.¹ Scientific research to identify validated tobacco-derived biomarkers may also provide subobjectives for 27-20. Although it is unknown whether reductions in any of the chemical classes will reduce the risk for disease represented by cigarettes, manufacturers of tobacco products are urged to voluntarily achieve the maximum reductions in the levels of chemicals in cigarette smoke that are technologically feasible.

CONCLUSION

The first goal of Healthy People 2010 is to help people of all ages increase their life expectancy and improve their quality of life.⁵ Tobacco is the leading preventable cause of death in the U.S.,²⁵ and measurement of toxic chemicals in tobacco smoke, assessment of smokers' exposure to these chemicals, evaluation of the impact of any changes in exposure on the spectrum of disease risks, and assessment of the population impact of changes in the product are all important information for understanding the harms caused by tobacco. The chemicals that will be monitored as part of the revised Healthy People 2010 objective are carcinogens and toxicants of public health concern.^{15,16} The surveillance of smoke chemistry initiated with approval of the objective will provide important information on the science of tobacco products and assist researchers in their efforts to identify tobacco-derived biomarkers of effect and exposure. Reducing the risks from tobacco use, however, will require more than a modest reduction in levels of several chemical classes.

Department of Health and Human Services, or the Centers for Disease Control and Prevention (CDC).

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of CDC.

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