Smoking and Diabetes

DEBRA HAIRE-JOSHU, PHD
RUSSELL E. GLASGOW, PHD
TIFFANY L. TIBBS, MA

The objective of this review is to summarize the literature on diabetes and smoking related to epidemiological risks, efficacy and cost-effectiveness of different cessation approaches, and implications for clinical practice. Over 200 studies were reviewed, with special emphasis placed on publications within the past 10 years. Intervention studies that included patients with diabetes but did not report results separately by disease are included. Diabetes-specific studies are highlighted. There are consistent results from both cross-sectional and prospective studies showing enhanced risk for micro- and macrovascular disease, as well as premature mortality from the combination of smoking and diabetes. The general cessation literature is extensive, generally well-designed, and encouraging regarding the impact of cost-effective practical office-based interventions. In particular, system-based approaches that make smoking a routine part of office contacts and provide multiple prompts, advice, assistance, and follow-up support are effective. Although there is minimal information on the effectiveness of cessation interventions specifically for people with diabetes, there is no reason to assume that cessation intervention would be more or less effective in this population. There is a clear need to increase the frequency of smoking cessation advice and counseling for patients with diabetes given the strong and consistent data on smoking prevalence; combined risks of smoking and diabetes for morbidity, mortality, and several complications; and the proven efficacy and cost-effectiveness of cessation strategies.

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The purpose of this review is to summarize tobacco control issues across multiple levels: the patient, the health care provider, the health care setting, and finally, policy implications. We first establish the health threat associated with tobacco use in general and then summarize its heightened impact on morbidity and mortality among people with diabetes. This includes a review of the patient perspectives associated with diabetes care and management, which often enhance the continuation of smoking (e.g., absence of advice to quit, priority given to other treatment objectives, weight concerns). We next consider the types of interventions that have proven most effective, focusing especially on the role of the health care provider and medical office in promoting smoking cessation and on the cost-effectiveness of smoking cessation. We then review data that suggest the importance of care settings in promoting optimal diabetes care as it relates to smoking cessation. Finally, implications for health care policy and future research are discussed.

LITERATURE REVIEW AND ANALYSIS — A review of the literature on smoking in general and smoking relative to type 1 and type 2 diabetes was conducted. The literature was reviewed by establishing criteria for relevant studies, conducting computer searches, reviewing the bibliographies of key articles, compiling and reviewing full articles, constructing tables and summarizing study content and criteria, and summarizing these studies and review articles. Articles included were published in peer-reviewed journals within the last 10 years in English. In a few instances, articles of particular merit within the past 15 years are presented. These procedures revealed a relatively small number of studies specific to diabetes and smoking, especially on intervention research. Therefore, in each section we present articles relevant to smoking in general, focusing on studies of medical patients (many of which include diabetic patients, but do not separate results for them vs. other patients), and then present the more limited literature specifically related to diabetes and smoking. Together, these studies allow for the extrapolation of findings from the general literature that are pertinent to people with diabetes.

PREVALENCE OF SMOKING — This section presents factors associated with smoking prevalence in the general population and its impact on health. The sociodemographic characteristics associated with prevalence are discussed. This is followed by the more limited research on smoking prevalence among individuals with diabetes.

Cigarette smoking is the leading avoidable cause of mortality in the U.S., accounting for 434,000 deaths each year (1). Among cigarette smokers, 52% of deaths for men and 43% of deaths for women were attributable to cigarette smoking (2). In general, smoking prevalence has decreased over the past 10 years because of extensive public health efforts (3,3a), including policy changes and making the population aware of the health hazards of active and passive smoking (environmental tobacco exposure). Despite these figures, 26–28% of American adults continue to smoke (4), with variations reported by ethnic group. For example, Royce et al. (5) reported that African-Americans typically smoke <25 cigarettes per day, but are more likely to be nicotine dependent. Demographic factors associated with higher smoking prevalence include lower socioeconomic status and lower educational level. Those with less than a high school education are more likely to be current, ever, and heavy smokers and the least likely to quit. In contrast, years of education are associ-

From the Department of Community Health (D.H.-J.), Saint Louis University School of Public Health; the Department of Psychology (T.L.T.), Washington University, St. Louis, Missouri; and the AMC Cancer Research Center (R.E.G.), Denver, Colorado.

Address correspondence and reprint requests to Debra Haire-Joshu, PhD, Department of Community Health, Saint Louis University School of Public Health, 3663 Lindell Blvd., St. Louis, MO 63108. E-mail: joshud@slu.edu.

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Abbreviations: AHCPR, Agency for Health Care Policy and Research; MRFIT, Multiple Risk Factor Intervention Trial.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

ated with never smoking and increased cessation rates (6).

The prevalence of smoking among people with diabetes appears to mirror that of the general population, at least at younger ages. In 1988, using results of the Behavioral Risk Factor Surveillance System, a cross-sectional telephone interview that assessed chronic disease risk factors in individuals across 37 states, over 3,000 people reporting diabetes were compared with >52,000 without diabetes (7). Similar percentages of smokers (26%), ex-smokers (25.9%), and those who never smoked (48.1%) were found in both populations. When stratified by age, race, and education, there were trends toward a higher prevalence of smoking among 18- to 34-year-olds, African-Americans, and those with lower educational levels. These findings are consistent with those of the National Health Interview Survey, which found self-reported smoking prevalence to be approximately equal between people with (27.4%) and without (25.9%) diabetes (8). Among people with diabetes, the prevalence of smoking decreased as the duration of disease increased (8). As reviewed later, this may in part be due to the increased mortality associated with the combination of smoking and diabetes.

There are some specific limitations of these studies that bear noting. Several of the studies do not distinguish between type 1 and type 2 diabetes. In addition, many studies also rely on self-reported versus biochemical validation of smoking status. This is not necessarily a critical flaw, but underreporting of smoking must be considered, especially in settings where there is pressure not to report smoking (9,10). However, in general, these data suggest diabetic individuals smoke at rates equivalent to the general population.

OVERVIEW OF EFFECTS OF SMOKING ON DIABETES — Next, the characteristics of nicotine and its effects on the general population are addressed. The biologic impact of nicotine and other metabolites, and the resulting addictive qualities are described. This is followed by studies suggesting the role of smoking on the development of diabetes and its related complications.

Nicotine is an addictive substance related to a highly controlled or compulsive pattern of drug use. The mood-altering effects function as a reinforcement to strengthen behavior and lead to further drug use (11). Various pharmacological, biochemical, and psychological processes interact in nicotine addiction (12,13). Cigarettes are an ideal vehicle for nicotine delivery, taking only 7 s for nicotine to reach the brain via inhalation. Nicotine then triggers euphoric effects as well as sedative or anxiolytic effects associated with neurohormonal processes. The biological power of nicotine makes smoking patterns resistant to change. At the same time, the daily circumstances, activities, and emotions to which smoking is conditioned tie this behavior to rituals of daily life, contributing to the difficulty of breaking the addiction (13,14). In addition, Parrott (15) conducted a series of studies that demonstrated the importance of mood control as a reason for smoking. Evidence for genetic influences on smoking and the impact of amount smoked on ability to quit have also been reported (12). Twin studies with 4,960 twin pairs obtained unadjusted heritability indices of 53% for smoking, with other work suggesting that genetic contributions are associated with the number of cigarettes smoked and ability to quit smoking (16).

Several prospective cohort studies suggest that smoking is associated with the development of diabetes. In the Nurses' Health Study, 114,247 women were followed for 8 years and 2,333 cases of type 2 diabetes were confirmed. After controlling for multiple risk factors, the relative risk of type 2 diabetes among women smoking ≥25 cigarettes per day compared with individuals who never smoked was 1.42 (95% CI 1.18–1.72), suggesting a moderate association between smoking and the subsequent development of diabetes (17). Rimm et al. (18) reported similar findings from a study of 41,810 men who were followed prospectively for 6 years. After controlling for known risk factors, men who smoked ≥25 cigarettes daily had a relative risk of diabetes of 1.94 (95% CI 1.25–3.03) compared with nonsmokers. After examining the effects of smoking on the 8-year incidence of type 2 diabetes on 2,312 Japanese men, Kawakami et al. (19) also concluded that age of smoking initiation and number of cigarettes smoked were major risk factors for developing diabetes. To evaluate the effects of cigarette smoking on insulin sensitivity, Targher et al. (20) studied 40 patients with type 2 diabetes and found insulin resistance was markedly aggravated among those who smoked. Smoking also appears to be associated with larger upper body fat distribution—a marker of insulin resistance, raised plasma glucose concentrations, and overt diabetes (21).

The relationship of smoking to metabolic control has also been postulated (22). Chiodera et al. (23) reported that hormonal responses, specifically growth hormone, arginine vasopressin, and cortisol responses, were significantly higher in type 1 diabetic versus nondiabetic smokers and concluded that smoking might interfere with the timing and optimization of insulin therapy. Bott et al. (24), as part of a large prospective multicenter study with 697 type 1 diabetic subjects, concluded smoking was one of the strongest predictors of poor metabolic control in addition to age of onset, blood glucose monitoring, socioeconomic status, and knowledge. However, Meigs et al. (25) measured the glycated hemoglobin levels in people without diabetes from the original cohort of the Framingham Heart Study and found that age and BMI were associated with increases in HbA_{1c} over the course of 4–6 years, while smoking was associated with a decrease, even after controlling for age and BMI. Although this effect was small, the results suggested that smoking blunts the rise of HbA_{1c}, which usually occurs in nonsmokers. Smoking was the strongest independent factor related to change in glycated hemoglobin.

In summary, nicotine is an addictive drug with use supported by individual, personal, and social-environmental circumstances. There is evidence of genetic susceptibility to smoking that may affect initiation and cessation outcomes. Initial studies suggest a role for nicotine in diabetes development and interference with insulin activity. Research further delineating the metabolic effects of nicotine on diabetes is needed. Longitudinal studies with large sample sizes would allow for further determination of the role of smoking and cessation on diabetes development and management.

COMPLICATIONS OF DIABETES AND SMOKING — This section provides an overview of the relationship between diabetes, smoking, and the development of complications of diabetes. Core information is summarized on the relationship between complication development and diabetes. Length considerations dictated limiting the number and details associated with the noted studies. The reader is referred to specific articles for additional details related to adjustments for potentially confounding sociodemographic or psychosocial variables.

Macrovascular complications and mortality

Cigarette smoking is associated with morbidity and premature death among nondiabetic individuals primarily due to cardiovascular illness (2). People with either type 1 or type 2 diabetes exhibit excess morbidity and mortality due to circulatory and cardiovascular disease when compared with people without diabetes (26–28). The evidence from studies of individuals with diabetes shows the strong influence of smoking on mortality (29–33). Cigarette smoking was shown to be a significant risk factor for death by coronary heart disease in type 2 diabetes in the Multiple Risk Factor Intervention Trial (MRFIT), the Finnish Prospective Study, and the Paris Prospective Study (34). Specifically, systolic blood pressure, total cholesterol, and smoking were significantly associated with increased mortality in diabetic patients as reported by MRFIT and the Prospective Finnish Study; smoking, blood pressure, and obesity were most important in the Paris Prospective Study.

In addition, the combination of smoking and diabetes appear to heighten the development of macrovascular complications (35,36). Meigs et al. (37) reported on 1,539 patients with type 2 diabetes and found, in addition to other factors such as sex and hypertension, former cigarette smokers were 1.54 times (95% CI 1.49–1.58) more likely to be diagnosed with coronary artery disease. Similar findings are reported by Dean et al. (38) and Hanefield et al. (39). Tuomilehto et al. (40) conducted a prospective cohort study of 372 men and 430 women with diabetes who were followed over 16 years. Cigarette smoking was found to be an independent predictor for stroke in these subjects. Finally, Chaturvedi et al. (41), as part of an international cohort study of 4,427 people with diabetes, reported mortality risks were associated with history and duration of smoking and quitting. When compared with nonsmokers, mortality risk among individuals who had quit ≥10 years ago was increased by 25%, which was nevertheless markedly lower than among those who had quit ≤9 years ago. This large-scale study suggests the importance of quitting as early as possible in the course of diabetes (41). In conclusion, smoking increases the risk of death and the burden of morbidity from macrovascular complications in individuals with diabetes.

Microvascular complications of smoking and diabetes

Smoking is related to the premature development of multiple complications of diabetes (42,43). Nephropathy has been reported as common in type 1 diabetic patients who smoke, and smoking increases the risk for microalbuminuria in type 2 diabetes (43,44). Several studies have documented the relationship of smoking to the development of nephropathy in type 1 and 2 diabetes. Chase et al. (45) conducted a longitudinal study of 359 type 1 diabetic patients. When compared with nonsmokers and after controlling for glycated hemoglobin, smokers were at 2.2 times greater risk (95% CI 1.2–3.8) for albuminuria. Sawicki et al. (46) also found that progression of nephropathy was significantly less common ($P < 0.001$) among nonsmokers (11%) than smokers (53%) or those who had quit smoking (33%). Ikeda et al. (47) conducted a cross-sectional study of 148 men with type 2 diabetes, concluding that the incidence of micro- and macroalbuminuria were significantly higher in current smokers (53%) compared with ex-smokers (33%) and nonsmokers (20%). Similar findings have been reported by Couper et al. (48), Corradi et al. (49), and Klein et al. (50).

Smoking is also a documented risk factor for both the development and progression of various types of neuropathy (51,52). Mitchell et al. (53) conducted a retrospective case-control study of type 1 ($n = 163$) and type 2 ($n = 166$) diabetic patients, using symptoms and physical examination to diagnose peripheral neuropathy. Type 1 diabetic patients who were current or ex-smokers were significantly more likely to have neuropathy than individuals who never smoked (64.8 vs. 42.8%, $P < 0.02$). After adjusting for effects of other covariates, patients smoking ≥30 pack-years had more neuropathy than patients smoking less than this amount with an adjusted odds ratio of 3.32 (95% CI 1.15–9.58) (53). A more recent prospective study by Sands et al. (54) using a population-based cohort followed 231 subjects who were free of distal symmetric neuropathy at baseline for an average of 4.7 years. The adjusted incidence rate of smokers was 2.2 times higher (95% CI 0.99–4.7) than for nonsmokers. Among those diagnosed with definitive distal symmetric neuropathy, cigarette smoking was associated with a 12-fold increase (95% CI 2.0–71.5) (54).

The relationship of cigarette smoking to retinopathy is less well defined than that with other microvascular complications of diabetes. As reported by Klein et al. (50), most epidemiological research has not found a positive relationship between smoking and retinopathy, although there have been studies that have suggested such a relationship. In the Wisconsin Epidemiological Study of Diabetic Retinopathy, cigarette smoking was not found to be related to the incidence or prevalence of proliferative retinopathy, but was related to mortality. Other data suggest that smoking reduces retinal blood flow and potentiates the hypoxic environment of the diabetic retina (55). Reichard (56) found significant relationships between smoking and the progression of microvascular complications in 96 type 1 diabetic patients, followed over 5 years after being randomized to conventional or intensive therapy. Progression of retinopathy was independently related to level of HbA_{1c} and smoking habits. As part of a prospective multicenter study, Muhlhauser et al. (43) also concluded that there were significant relationships between smoking, retinopathy, and nephropathy.

In summary, several longitudinal and cross-sectional studies show consistently that smoking has an impact on the development and progression of microalbuminuria and the impairment of renal function in both type 1 and type 2 diabetes. Other studies are also strongly suggestive of an association with the development of neuropathy in both type 1 and type 2 diabetes and, less consistently, retinopathy development. Additional work is needed to clarify these relationships, and the effect of type and duration of diabetes and cessation on complications development. In particular, research is needed to further establish the effect of potentially confounding psychological or social factors on the relationship between diabetes, smoking, and development of complications.

SMOKING CESSATION INTERVENTIONS

— There is overwhelming evidence that smoking cessation decreases the risk of cardiovascular disease, cancer, stroke, and lung disease (57). Smoking rates in the U.S. population have declined from 40% in 1965 to the current level of 26%. This reduction is attributable to 30 years of smoking cessation research as well as various public health and policy actions (3,3a,58). Most cessation research has not focused on smoking in diabetic patients, but rather on smoking in the general population or in other disease groups

such as cardiovascular or lung disease patients (many of whom have diabetes). The following section first reviews the general evidence identifying treatment characteristics associated with successful cessation, with emphasis on intervention in medical office settings. We then evaluate the limited evidence on smoking cessation interventions in diabetes care and apply the general literature to this special population. The cessation rates reported here should be interpreted in light of two points. First, the data generally come from effectiveness studies in which all patients in a practice are included (using intent-to-treat analyses), not only highly motivated patients (who are typically recruited for clinical trials research). Second, many studies report on the success rates engendered by a single episode of smoking cessation advice or counseling, despite evidence that consistent and repeated messages reinforced over time yield the most successful outcomes.

Treatment characteristics

The importance of identifying successful smoking cessation interventions resulted in the convening of an expert panel by the Agency for Health Care Policy and Research (AHCPR) to develop smoking cessation clinical practice guidelines (59). These influential guidelines were based on a review of studies that *1*) were randomized controlled trials of interventions, *2*) provided a minimum of 5 months of follow-up, *3*) were peer-reviewed, and *4*) were published between 1974 and 1995. As presented in these clinical practice guidelines (59), there are core treatment characteristics, or dimensions, that influence successful smoking cessation. The evidence from health care settings and interventions in the general population, which includes but is not limited to diabetic patients, was evaluated and reported in the AHCPR Smoking Cessation Guidelines, with key intervention findings summarized in Table 1. Treatment characteristics associated with smoking cessation and supported by this evidence are summarized below. Some of the 55 key studies evaluating these characteristics are also highlighted in different sections. It is important to note that both the number of randomized trials and the methodological quality of these studies are exemplary and permitted the development of evidence-based guidelines derived from comprehensive meta-analyses (59).

Type of health care provider. As noted in Table 1, interventions delivered by any type of health care provider significantly increase smoking cessation rates relative to no intervention. There does not appear to be any advantage to counseling (or intervention) delivered by a single type of professional. Rather, the data confirm the importance of the smoking cessation message being consistently and repeatedly delivered by *multiple* health care providers (57,60–64).

Format of contact. There are generally three formats for smoking cessation interventions: self-help, individual, or group counseling. Curry (65) concluded that self-help materials, defined as videotapes or audiotapes, manuals or booklets, community programs, and telephone hotlines, may increase cessation rates relative to no intervention. However, self-help formats were not as effective as interventions with providers (59). As noted in Table 1, the cessation rates for individual and group counseling were significantly higher than those for no intervention or self-help. Thus, smoking cessation interventions should include either individual or group counseling.

Intensity levels of intervention. This is defined as the amount of time a health care provider spends with a smoker during a clinical contact (e.g., session length). Minimal interventions are defined as consisting of strong and personalized advice to quit smoking, taking <3 min to conduct. Brief interventions involve counseling for at least 3–10 min; however, some intensive interventions may last ≥1 h and involve multiple contacts. As noted in Table 1, even minimal contact increases cessation. Conclusions from these data support a strong dose-response relationship between intensity of person-to-person contact and cessation (59,66).

Types of counseling. The content of smoking cessation refers to the type of information conveyed in clinical contacts and the specific behavior-change procedures used. As noted in Table 1, content found to be most effective in increasing cessation rates included aversive smoking techniques (e.g., rapid smoking), intratreatment social support (direct contact with health care provider), and general problem-solving (e.g., coping skills training, stress management, relapse prevention). Aversive techniques have generally been replaced by nicotine replacement therapies (59).

Duration and number of treatment sessions. Duration of an intervention is defined by length of treatment in weeks, while number of treatment sessions is defined by number of contacts. In general, these findings revealed that the longer the duration of treatment, the higher the cessation rates. Specifically, counseling beyond 8 weeks achieved cessation rates of 23.8% (95% CI 20.6–27.1). When compared with single sessions, four to seven sessions were the most effective in achieving cessation with an estimated cessation rate of 22.6% (95% CI 19.9–25.3), followed by two to three sessions with an estimated cessation rate of 18.8% (95% CI 15.8–21.9). In summary, the efficacy of a smoking cessation intervention increases the longer the duration of treatment over a period of multiple sessions or person-to-person contacts (59).

Pharmacotherapy and cessation. Various forms of pharmacotherapy, via gum, patch, and sprays, have been examined for effectiveness in promoting smoking cessation. Several meta-analyses concerning the use of nicotine gum and patches have been published (67–70), concluding that nicotine gum significantly improves abstinence. The AHCPR report concluded that nicotine gum improves smoking cessation rates by 40–60% at 1-year follow-up, is more efficacious than control interventions regardless of the intensity, and is more efficacious when used in 4-mg versus 2-mg dosages (59).

Transdermal nicotine, or the nicotine patch, is also effective and may be more acceptable because of greater ease of use. Fiore et al. (69) conducted a meta-analysis of studies and concluded that the patch doubles the likelihood of abstinence at 6 months, especially when used in conjunction with more intensive behavioral formats—findings supported by the work of Silagy et al. (70). Information regarding the use of the newer nasal nicotine sprays is more limited. Sutherland et al. (71) conducted a study with 227 cigarette smokers, comparing nasal nicotine spray to placebo spray. Biochemical verification of status showed people using nasal sprays were significantly more likely to achieve 12-month abstinence (26%) compared with a placebo group (10%)—findings supported by Tonnesen et al. (72) and Hjalmarson et al. (73).

Finally, the data regarding the use of antidepressants (74,75), clonidine, and anxiolytics is not conclusive (59). However, Hurt et al. (76) found in a double-blind placebo-controlled trial of sustained release form, bupropion yielded 1-year cessation rates of 12.4% (placebo), 19.6% (100 mg group), 22.9% (150 mg group), and 23.1% (300 mg group). In addition, bupropion subjects had reduced weight gain, making

Table 1—*Meta-analytic results examining smoking outcomes: estimated odds ratios and cessation rates by treatment characteristics*

Characteristics	Number of arms	Estimated odds ratio (95% CI)	Estimated cessation rate (95% CI)
Type of health care provider (n = 41 studies)			
No provider (reference group)	38	1.0	8.2
Multiple providers	14	3.8 (2.6–5.6)	25.5 (18.1–32.7)
Nonmedical health care provider (psychologist, social worker, counselor)	23	1.8 (1.5–2.2)	14.1 (12.0–16.3)
Physician provider	36	1.5 (1.2–1.9)	12.0 (9.6–14.3)
Nonphysician medical health care provider (dentist, nurse, health counselor)	20	1.4 (1.1–1.8)	11.5 (9.0–14.0)
Format of contact (n = 25 studies)			
No intervention (reference group)	23	1.0	7.6
Self-help	8	1.2 (1.0–1.6)*	9.3 (7.3–11.4)
Individual counseling	26	2.2 (1.9–2.4)	15.1 (13.6–16.5)
Group counseling	15	2.2 (1.6–3.0)	15.3 (11.4–19.2)
Intensity levels of person-to-person contact (n = 56 studies)			
No contact (reference group)	49	1.0	8.8
Minimal contact (≤3 min)	14	1.2 (1.0–1.5)†	10.7 (8.9–12.5)
Brief counseling (>3 to ≤10 min)	26	1.4 (1.2–1.7)	12.1 (10.0–14.3)
Counseling (>10 min)	60	2.4 (2.1–2.7)	18.7 (16.8–20.6)
Types of content (n = 39 studies)			
No contact (reference group)	25	1.0	8.8
Aversive smoking‡	9	2.1 (1.0–4.2)§	17.5 (7.6–27.2)
Intratreatment social support‖	21	1.8 (1.4–2.5)	15.2 (11.3–19.1)
General problem solving¶	57	1.6 (1.2–2.2)	13.7 (10.3–17.1)
Quit day (specific quit date)	30	1.3 (0.9–2.0)	11.5 (7.4–15.7)
Extratreatment social support#	16	1.3 (0.8–2.0)	11.2 (7.0–15.5)
Motivation**	40	1.1 (0.9–1.5)	9.8 (7.5–12.2)
Weight, diet, or nutrition management	17	1.1 (0.8–1.6)	9.8 (6.6–13.0)
Exercise or fitness information or program	8	1.1 (0.6–1.0)	9.6 (4.8–14.3)
Contingency contract††	13	1.0 (0.7–1.6)	9.1 (5.6–12.7)
Relaxation or breathing techniques	15	0.8 (0.5–1.3)	7.5 (4.3–10.7)
Cigarette fading‡‡	18	0.7 (0.4–1.1)	6.4 (3.6–13.3)
Duration of treatment sessions (n = 55 studies)			
<2 Weeks (reference group)	101	1.0	10.4
2 Weeks to <4 weeks	14	1.6 (1.3–2.0)	15.6 (12.9–18.3)
4 Weeks to 8 weeks	12	1.6 (1.2–2.1)	16.1 (12.4–19.7)
>8 Weeks	15	2.7 (2.2–3.2)	23.8 (20.6–27.1)
Number of treatment sessions (n = 55 studies)			
≤1 Session (reference group)	96	1.0	10.4
2–3 Sessions	15	2.0 (1.6–2.4)	18.8 (15.8–21.9)
4–7 Sessions	25	2.5 (2.2–2.9)	22.6 (19.9–25.3)
>7 Sessions	12	1.7 (1.2–2.5)	16.7 (11.4–22.0)

Number of arms refers to the number of treatment groups included in the category. *Actual 95% lower confidence estimate equals 0.97; †actual 95% lower confidence estimate equals 1.03; ‡techniques that involve smoking in an unpleasant or concentrated manner; §actual 95% lower confidence estimate equals 1.04; ‖providing support, help, or encouragement as part of the treatment; ¶training to identify and cope with events or problems that increase the likelihood of smoking, including coping skill training, relapse prevention, and stress management; #techniques to help smokers increase social support outside of treatment; **interventions designed to bolster patients' resolve to quit; ††providing rewards for cigarette abstinence and incurring costs or unpleasant consequences for smoking; ‡‡reducing the number of cigarettes smoked. Modified from Wetter et al. (144).

this a particularly promising tool to assist smokers in cessation (76a,76b). Based on the low risk for side effects, the use of pharmacotherapy to promote smoking cessation is recommended when used in conjunction with behavioral counseling. Use in special populations, such as those who are pregnant, is also recommended if the benefits of quitting outweigh the limited risks (77,78).

Smoking cessation delivery systems

One of the most important and consistent findings from the comprehensive literature review establishing AHCPR Smoking Cessation Guidelines is that repeated interventions, provided by multiple health care professionals and reinforced over time, are much more effective than single session recommendations or brief counseling (59). Such an approach denotes the importance

of an integrated system of care in systematically reducing smoking rates. All patients should be screened for use of tobacco and have their status documented on a regular basis. Screening systems in clinical settings increase the probability of consistent assessment and documentation of tobacco use (79,80). Follow-up assessment of smoking status and abstinence should also be conducted on a routine basis at regular intervals (59). Additional assessments within the first 2 weeks of quitting have proven to be effective in aiding patients to maintain abstinence (81). Reinforcement of the decision to quit and strategies encouraging relapse prevention promote long-term abstinence.

Only about half of smokers seeing a primary care physician in the past year reported being asked about their smoking (79), with a smaller number being advised to quit (82). Malarcher et al. (83) examined data from the National Health Interview Surveys from 1974, 1985, and 1990 and noted positive trends toward more physicians offering smoking cessation advice to diabetic patients, however 41% of diabetic patients did not receive any advice to quit smoking. Barriers commonly reported by providers in delivering cessation advice are lack of time and reimbursement for smoking cessation services, actual or perceived lack of knowledge and skill in cessation counseling, and low expectations regarding the efficacy of such counseling (58,84). Additional provider training is needed in the AHCPR Smoking Cessation Guidelines emphasizing the public health significance of achieving small changes by delivering preventive services to all patients (85), especially because performance-based quality of care indicators (e.g., Health Plan Employer Data Information Set [HEDIS], National Committee on Quality Assurance [86], AHCPR Smoking Cessation Guidelines [59], and American Diabetes Association Provider Recognition Program measures [87]) are based on populations rather than individual care guidelines.

More recently, technological advances via computer-based methodologies have provided innovative delivery methods that have reduced the intervention burden on clinical staff (88). For example, there is substantial evidence that tailoring or personalizing intervention content in a meaningful way results in changes of various lifestyle behaviors, enhances outcomes relative to usual care advice to quit, and has been shown to be more effective than standard nonpersonalized cognitive-behavioral interventions in both physician office settings (89,90) and mail-based interventions (91,92). The use of multimedia kiosks, Internet World Wide Web–based applications, and small handheld computers have shown promise (93) but have not been used to prevent smoking initiation or to enhance quitting success among smokers with diabetes specifically.

Cessation systems for smokers with diabetes

There is minimal literature evaluating treatment characteristics or delivery systems specific to diabetes and smoking. To date, only two intervention studies that address smoking cessation limited to people with diabetes are identified. Ardron et al. (94) conducted a randomized study with 60 diabetic smokers, contrasting brief advice with intensive advice to stop smoking. The study included a follow-up home visit. Half of the subjects cited an attempt to quit resulting from the intensive counseling. There was, however, only one verified quitter at the end of 6 months. Sawicki et al. (95) conducted a prospective randomized controlled intervention study with 89 diabetic smokers that contrasted intensive behavior therapy over 10 weeks with 15 min of unstructured outpatient physician advice. Mean number of cigarettes decreased in the behavior therapy group when compared with the control group. However at the 6-month follow-up, overall quit rates as confirmed by cotinine testing (a metabolite of nicotine) was 10% and did not differ significantly by group. There is also little evidence regarding the effectiveness of smoking cessation treatment characteristics or the impact of adjunctive pharmacotherapy specific to smokers with diabetes. The majority of articles about diabetes and smoking have focused on reviews of the current literature and have extrapolated from other studies, such as those previously cited, to include issues of particular pertinence to diabetes care (96–98). The limited number of studies focusing on the need for smoking cessation interventions with diabetic patients are primarily descriptive in design (99) and report results on small numbers of subjects (100).

In conclusion, the minimal information available specifically on diabetic smokers suggests that they may fare less well than nondiabetic smokers and that intensive strategies, including nicotine replacement therapy, should be considered to optimize successful cessation. In addition, studies are needed to identify and understand factors associated with diabetes management (e.g., stress posed by following the dietary regimen, medication management, etc.) and how these factors may influence the ability to achieve successful cessation. In addition, these data strongly suggest that systems of care, promoting routine smoking identification and counseling need to be a priority of routine diabetes management. Further research on delivery systems via system-wide clinic or technology-based interventions, has not been conducted specific to smokers with diabetes and is strongly recommended.

Cost-effectiveness of cessation counseling

Smoking cessation is one of the few interventions that can safely and cost-effectively be recommended for all patients. Cummings et al. (101) published an influential early analysis on the cost-effectiveness of counseling smokers to quit that demonstrated physician counseling to be as or more cost-effective than other routine health care practices, such as treating hypertension, screening for cholesterol, and other medical practices. Eddy (102) identified smoking cessation as the "gold standard" against which other preventive behaviors should be evaluated. Since these early articles, virtually all subsequent studies (103–107) and reviews (103,108) have confirmed and even strengthened these findings. Most recent studies have estimated that smoking cessation counseling costs between $1,000 and $3,000 per year of life saved. Even more encouraging is the fact that it often costs less than $2,000 per quality adjusted life year saved. Providing screening and counseling for high-risk groups (e.g., those with coronary heart disease, who have major risk factors, or who are hospitalized) are even more cost-effective and may even be cost saving: a very rare finding in the economic literature (107–109). Although we are not aware of current data on the cost-effectiveness of smoking cessation solely among diabetic patients, it is a logical extension from existing data on medical patients in general and high-risk groups to conclude that smoking cessation should be extremely cost-effective for diabetic patients.

It is more difficult to estimate the cost-effectiveness of public health measures such as no smoking policies and tax/price increases, but these actions may be even more cost-effective (108) and should be

included as part of a societal tobacco control program. One of the paradoxes of the cost-effectiveness literature on smoking cessation is that although intensive counseling has been shown to be one of the most cost-effective interventions ever studied (103,105,107), only 5% of patients are willing to participate in such multisession counseling. So, even if offered, patients often do not perceive cessation as a key treatment priority. For example, in a study of patients' "personal model" of the importance of various aspects of diabetes self-management, it was found that not smoking ranked 7th and was perceived as less important than "not eating many sweets" (2nd) or "drinking little or no alcohol" (5th) (110).

In summary, studies of implementation of diabetes guidelines and best practices document that assessment of smoking status and smoking cessation counseling occurs less often than many other aspects of care. Despite the demonstrated efficacy and cost-effectiveness and the extensive data summarized above, smoking cessation does not receive the priority it deserves from either patients with diabetes or health care providers.

SPECIAL AND EMERGING ISSUES

— Several factors of particular relevance to people with diabetes may be associated with difficulty in achieving long-term abstinence from smoking. These factors include weight gain concerns and depression. Issues associated with smoking and special populations with diabetes, including adolescent and hospitalized patients, will be summarized. Finally, factors associated with refractory smokers will be addressed.

Weight gain

Obesity is a risk factor for type 2 diabetes, while weight management is a critical focus of the diabetes care regimen (111–113). Cigarettes affect weight with smokers weighing less than nonsmokers. The mechanisms by which smoking decreases body weight include insulin homeostasis, lipoprotein lipase activity, and preferences for food consumption (59,114). Williamson et al. (115) addressed this relationship using data from the 1982–1984 National Health and Nutrition Examination Survey (NHANES) I Study. They found weight gain attributable to smoking cessation averaged 6–10 lb, with women gaining slightly more weight than men. Major weight gain (>25 lb) occurred in ~10% of men and ~13% of women. In general, weight gain after cessation may negatively affect the desire to quit (59), with attempts to prevent weight gain during cessation potentially enhancing the risk of relapse (116). However, a review by Perkins (117) cites little direct evidence to suggest that weight gain after cessation interferes with motivation of smokers to maintain abstinence. Instead, he suggests developing treatments to enable ex-smokers to accept what may be unavoidable weight gain.

Few studies have assessed the role of smoking and weight in individuals with diabetes, but it is of concern because of the association of both insulin treatment and cessation with weight gain. Haire-Joshu et al. (118) assessed beliefs of 64 smokers with type 1 diabetes about smoking and diabetes as part of a cross-sectional descriptive study. Results suggesting concerns about weight gain after quitting were prevalent among women, obese smokers, and those in poor metabolic control (36%). Cigarettes were cited by smokers as an appetite suppressant (46%), and many smokers were reluctant to quit because of fear of weight gain (49%). Diabetic smokers appear to view smoking as a strategy for weight control and expressed concern that weight gain would adversely affect diabetes management. However, much more evidence is needed to support these interpretations. Research is also needed on ways to help providers more effectively communicate the risks of smoking in light of information related to weight gain after cessation and the importance of not smoking for diabetic patients.

Depression and low mood

The relationship between smoking and depression or dysphoric mood has been reviewed in numerous population surveys and clinical studies (119). Major depressive disorder is more than twice as common among smokers as among nonsmokers (6.6 vs. 2.9%), and smokers with a lifetime history of clinical depression are half as likely to succeed in smoking cessation as smokers without such a history (14 vs. 28%). These findings have been replicated in numerous studies (120,121). Fant et al. (122) reviewed evidence and explanations for nicotine addiction and concluded that women have a higher prevalence of depression and thus may be more prone to smoking relapse. This is supported by other reviews that concluded that negative affect is related to smoking treatment failure (120,121,123).

People with diabetes are at greater risk of depression compared with the general adult population, with a prevalence estimated at 14% in the diabetic population (range 8.5–27.3%) versus 3–4% in the general population (124,125). However, there is minimal data examining depression and smoking specific to people with diabetes. One cross-sectional survey examining these two factors was conducted with 183 diabetic smokers who completed measures of depression and smoking. Results indicated that the number of cigarettes smoked was a significant predictor of the level of depression among people with diabetes (126). Further studies examining the strength of the relationship of depression and smoking in diabetes, and the possible impact of depression on smoking initiation or cessation, are needed.

Adolescent smokers

Of current adult smokers, 70% were regular smokers before age 18. People who smoke at an early age are more likely to become nicotine addicted and develop serious comorbid health conditions at younger ages than their nonsmoking counterparts. The younger one begins to smoke, the more likely one is to be a current smoker as an adult (2). Overall, about one-third of high school–aged adolescents in the U.S. smoke or use smokeless (chew or spit) tobacco. About 16% of adolescents in the U.S. smoke (127). Currently, female and male adolescents appear equally likely to smoke (2), with the highest rate (28%) found among high school seniors (128). Key predictors of smoking initiation include age, living with a tobacco user, and alcohol use (129).

Few studies have addressed the prevalence of smoking among adolescents with diabetes. Often studies rely on cross-sectional self-reported information without biochemical verification of smoking status (130), raising the possibility of underreporting of status. Masson et al. (131) verified smoking status via urinary cotinine and found 31% of diabetic adolescents admitted smoking, while 48% were verified as smokers. In addition, the majority of smokers initiated the habit after their diagnosis of diabetes, a finding also reported by Shaw et al. (132). In addition, Frey et al. (133) also found that certain types of risky behaviors, including smoking, were prevalent among adolescents with diabetes. In summary, it appears that a diagnosis of diabetes may not be a deterrent to initiation of smoking in

adolescents. Adolescents with diabetes appear to initiate smoking at a rate equivalent to nondiabetic adolescents. Prevalence of smoking may be higher than the data suggest because of underreporting by adolescents. Systematic methods of preventing smoking and promoting adolescent cessation through diabetes clinics or other venues need to be developed and evaluated.

Hospitalized smokers

In general, studies suggest that smoking cessation may be more likely during or subsequent to a patient's hospitalization, since there may be an increased sense of vulnerability associated with the health risks and consequences of smoking (134). Studies of patients with serious smoking-related disease reported estimates of cessation rates ranging from 20 to 51% among patients with pulmonary disease and from 22 to 62% among those with cardiac disease (135,136). Stevens et al. (136) conducted a randomized trial of 1,110 hospitalized smokers, comparing a usual care treatment to a bedside counseling intervention tailored to the patient's readiness to quit. Overall, the relatively low intensity bedside intervention increased quitting odds by 50% in the treatment group. We were able to find only one survey by Haire-Joshu et al. (137) reporting on cessation counseling among hospitalized diabetic patients. In a study of 59 smokers, only 5 agreed to participate in cessation counseling, with the remainder citing lack of interest or illness as reasons for not participating. This study suggests that diabetic smokers, at the time of hospitalization, may be less motivated to participate in smoking cessation counseling than some other medical populations. Future research is needed to replicate this study and to determine reasons for its findings.

Refractory smokers

Pomerleau (119) suggests that those who continue to smoke in the present day U.S. are highly nicotine dependent, overrepresent people of lower socioeconomic status, often have other drug dependencies, and have behavioral or affective deficits amenable to nicotine management. The nicotine dependence scores of American smokers substantially exceed those of smokers in other countries (138). Thus, it is probable that the success of many smoking cessation interventions has resulted in a present day pool of refractory smokers (119) whose nicotine dependence is associated with repeated relapse (139). For the sizeable percentage of smokers currently not ready to undertake another attempt to quit, it is important to develop alternative strategies designed to decrease smoking. For example, there is empirical evidence to suggest reduced smoking, also referred to as controlled smoking (140–142) or harm reduction, as a therapeutic option for those smokers unable or unwilling to quit (143). Glasgow et al. (142) and Hughes (143) found smokers randomized to such an intervention were no less likely, and possibly even more likely, to quit smoking in the long-term than comparable smokers randomly assigned to more traditional cognitive-behavioral interventions. While not the first treatment of choice, such therapies might be considered for recalcitrant smokers unwilling to repeat or try other more established cessation methods.

It is unclear whether smokers with diabetes are more likely to present as recalcitrant smokers. However, given the data to suggest lower cessation rates and the additional demands of diabetes management, smokers may be more dependent and benefit from additional strategies to promote cessation. Additional research is needed on effective ways (including harm reduction and other strategies) to reach and work with the high percentage of patients who may not presently be ready to quit and also people who have comorbid medical or psychological conditions and/or a history of unsuccessful attempts to quit.

CONCLUSIONS

— The following statements are drawn from the evidence presented above and apply to individuals with either type 1 or type 2 diabetes.

Epidemiology and health consequences of smoking

- The prevalence of smoking among individuals with diabetes may be equivalent to those without diabetes. Only about half of people with diabetes are advised to quit smoking by their health care providers.
- Smoking influences several factors that may increase insulin resistance and interfere with insulin action. Smoking may also be associated with development of type 2 diabetes, although the evidence is preliminary.
- Smoking significantly enhances the risk for cardiovascular disease, contributing to premature morbidity and mortality. Smoking substantially heightens the risk for neuropathy and nephropathy. Data suggest that smoking is related to the development of retinopathy, although the evidence is less conclusive.

Smoking cessation

- Smoking is a complex change-resistant behavior. Several treatment characteristics have been identified by AHCPR meta-analyses and guidelines as critical to achieve cessation. These include cessation counseling by multiple health care providers, using individual or group counseling, over time, and including problem-solving or skills training components with social support. Every effort should be made to assure that diabetic smokers receive cessation advice reflecting these treatment characteristics to optimize cessation rates.
- Nicotine replacement therapy enhances cessation rates when used as an adjunct to smoking cessation counseling in nondiabetic individuals. Pharmacotherapy appears to limit withdrawal symptoms and increase abstinence. To date, there is no evidence of the impact of pharmacotherapy specific to diabetic smokers. The data suggesting the extensive benefits of quitting versus the heightened risks of continuing to smoke should guide the decision regarding use of nicotine replacement therapy and other pharmacological aides for cessation.
- Smoking cessation delivery *systems* should be a routine component of diabetes care, in accordance with recommendations of the AHCPR Smoking Cessation Guidelines (59) for all patients. Smoking status should be assessed for all diabetic individuals as a part of routine care, a strategy that encourages providers to deliver smoking cessation advice in a systematic way. Documentation of counseling and follow-up further assures successful cessation and is critical to long-term success.
- Computer-based technologies and other methods of personalizing information and counseling strategies are promising methods and should be further explored.
- Training of health care providers in the AHCPR guidelines should assist in overcoming perceived barriers to cessation counseling and help both patients and providers give smoking cessation the emphasis it deserves.
- Smoking cessation is cost-effective. Stopping smoking is likely one of the

most effective medical actions that can be taken with diabetic patients. Policies supporting reimbursement for delivery of smoking cessation services should be enacted.

Special issues and current concerns

- Nicotine dependence is associated with relapse. Nicotine dependence should be evaluated in all smokers with diabetes, and pharmacological supplements to counseling interventions should be planned accordingly.
- Postcessation weight gain may be an issue for smokers with diabetes who are focused on weight management. The weight gain is generally minimal in contrast to the risks associated with continued smoking. Based on the current evidence from the general population, health care providers should inform the patient as to the potential for weight gain but increase the emphasis on smoking cessation as the priority for all diabetic smokers.
- Depression is prevalent among individuals with diabetes. Negative affect is associated with increased smoking and decreased cessation rates. Diabetic smokers should be assessed for history of depression or negative affect. Pharmacotherapy and/or psychotherapy for depression should be considered as adjunctive therapy on an as needed basis.
- Adolescents with type 1 diabetes may initiate smoking after diagnosis. Screening for tobacco use and counseling regarding smoking prevention and cessation need to be standard diabetes care for adolescents with diabetes.
- Alternative strategies for caring for refractory smokers should be considered to enhance patient cessation.

Recommendations for future research

Extensive research has been completed in the general population that examines factors associated with smoking initiation, cessation, and relapse. However, much more research is needed on populations with diabetes.

- Studies further evaluating the impact of smoking on diabetes development are needed. The designs of these studies should have adequate sample sizes and representative samples and should allow for longitudinal cohorts.
- More intervention research tailored to diabetic smokers is needed. Systematic introduction of interventions using controlled within-subject designs are recommended given the small sample sizes in many clinics.
- Additional research designed to help those with diabetes to understand the importance of smoking cessation as part of diabetes management is needed.
- Clinical trials evaluating the use of pharmacotherapy adjuncts to cessation among diabetic smokers are needed.
- Further evaluations of the role of weight, weight gain concerns, and their influence on cessation among diabetic patients are needed. The impact of smoking cessation on metabolic control should be addressed.
- Studies assessing the cost-effectiveness of interventions for diabetic smokers are needed.
- Studies denoting how effective change principles can be efficiently applied in diabetes care settings are needed.
- Evaluation of the impact of and ways to facilitate implementation of quality of care performance indicators, all of which include smoking identification, cessation counseling, and follow-up, are needed.
- Systems that inform providers of the smoking status of their patients and prompt appropriate personalized counseling and follow-up, including computer-based technologies, need to be developed and evaluated.

References

1. US Department of Health and Human Services: *Healthy People 2000: Midcourse Review and 1995 Revisions.* Washington, DC, U.S. Department of Health and Human Services, Public Health Service, 1995
2. US Department of Health and Human Services: *Preventing Tobacco Use Among Young People: A Report of the Surgeon General*. Atlanta, GA, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1994

3a. Lichtenstein E, Glasgow RE: Smoking cessation: what have we learned over the past decade? *J Consult Clin Psychol* 60:518–527, 1992

3. Brownson R, Jackson-Thompson J, Wilkerson J, Davis J, Owens N, Fisher E Jr: Demographic and socioeconomic differences in beliefs about the health effects of smoking. *Am J Public Health* 82:99–103, 1992
4. Centers for Disease Control: Cigarette smoking among adults: United States 1994. *MMWR* 45: 588–590, 1996
5. Royce J, Hymowitz N, Corbett K, Hartwell T, Orlandi M: Smoking cessation factors among African Americans and Whites. *Am J Public Health* 83:220–226, 1993
6. Zhu B, Giovino G, Mowery P, Eriksen M: The relationship between cigarette smoking and education revisited: implications for categorizing persons' educational status. *Am J Public Health* 86:1582–1589, 1996
7. Ford E, Newman J: Smoking and diabetes mellitus: findings from 1988 Behavioral Risk Factor Surveillance System. *Diabetes Care* 14:871–874, 1991
8. Ford E, Malarcher A, Herman W, Aubert R: Diabetes mellitus and cigarette smoking: findings from the 1989 National Health Interview Survey. *Diabetes Care* 17:688–692, 1994
9. Velicer W, Prochaska J, Rossi J, Snow M: Assessing outcome in smoking cessation studies. *Psychol Bull* 111:23–41, 1992
10. Glasgow R, Mullooly J, Vogt T: Biochemical validation of smoking status in public health settings: pros, cons, and data from four low-intensity intervention trials. *Addict Behav* 18:511–527, 1993
11. US Deptartment of Health and Human Services: *The Health Consequences of Smoking: Nicotine Addiction: A Report of the Surgeon General.* Atlanta, GA, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1988
12. Pomerleau O, Collins A, Shiffman S, Pomerleau C: Why some people smoke and others do not: new perspectives. *J Consult Clin Psychol* 61:723–731, 1993
13. Fisher E Jr, Lichtenstein E, Haire-Joshu D: Multiple determinants of tobacco use and cessation. In *Nicotine Addiction: Principles and Management*. Orleans C, Slade J, Eds. New York, Oxford University Press, 1993, p. 59–87
14. Haire-Joshu D, Morgan G, Fisher EB Jr: Determinants of cigarette smoking. *Clin Chest Med* 12:711–725, 1991
15. Parrott A: Stress modulation over the day in cigarette smokers. *Addiction* 90:233–244, 1995
16. Carmelli D, Swan G, Robinette D, Fabitz R: Genetic influence on smoking: a study of male twins. *N Engl J Med* 327:829–833, 1992
17. Rimm E, Manson J, Stampfer M: Cigarette smoking and the risk of diabetes in women. *Am J Public Health* 83:211–214, 1993
18. Rimm E, Chan J, Stampfer M, Colditz G, Willett W: Prospective study of cigarette smoking, alcohol use, and the risk of dia-

betes in men. *BMJ* 310:555–559, 1995
19. Kawakami N, Takatsuka N, Shimizu H, Ishibashi H: Effects of smoking on incidence of non-insulin-dependent diabetes mellitus. *Diabetes Care* 16:103–109, 1997
20. Targher G, Alberiche M, Zenere M, Bonadonna R, Muggeo M, Bonora E: Cigarette smoking and insulin resistance in patients with non-insulin-dependent diabetes mellitus. *J Clin Endocrinol Metab* 82: 3619–3624, 1997
21. Chan J, Rimm E, Colditz G, Stampfer M, Willett W: Obesity, fat distribution, and weight gain as risk factors for clinical diabetes in men. *Diabetes Care* 17:1–10, 1994
22. Lundman B, Asplund K, Norberg A: Smoking and metabolic control in patients with insulin-dependent diabetes mellitus. *J Intern Med* 227:101–106, 1990
23. Chiodera P, Volpi R, Capretti L: Abnormal effect of cigarette smoking on pituitary hormone secretions in insulin-dependent diabetes mellitus. *Clin Endocrinol* 46:351–357, 1997
24. Bott U, Jorgens V, Grusser M, Bender R, Muhlhauser I, Berger M: Predictors of glycaemic control in type I diabetic patients after participation in an intensified treatment and teaching programme. *Diabet Med* 14:362–371, 1994
25. Meigs J, Nathan D, Cupples L, Wilson P, Singer D: Tracking of glycated hemoglobin in the original cohort of the Framingham Heart Study. *J Clin Epidemiol* 49:411–417, 1996
26. Sowers J: Diabetes mellitus and cardiovascular disease in women. *Arch Intern Med* 158:617–621, 1998
27. Wei M, Mitchell B, Haffner S, Stern M: Effects of cigarette smoking, diabetes, high cholesterol, and hypertension on all-cause mortality and cardiovascular disease mortality in Mexican Americans: the San Antonio Heart Study. *Am J Epidemiol* 144: 1058–1065, 1996
28. Walters D, Gatling W, Houston A, Mulle M, Julious S, Hill R: Mortality in diabetic subjects: an eleven-year follow-up of a community-based population. *Diabet Med* 11:968–973, 1994
29. Moy C, Laporte R, Dorman J: Insulin-dependent diabetes mellitus mortality: the risk of cigarette smoking. *Circulation* 82: 37–43, 1990
30. Klein R, Moss S, Klein B, Mets DD: Relation of ocular and systemic factors to survival in diabetes. *Arch Intern Med* 149:266–272, 1989
31. Uusitupa M, Nikanen L, Siitonen O, Voutilainen E, Pyorala K: Ten year cardiovascular mortality in relation to risk factors and abnormalities in lipoprotein composition in type II diabetic and non-diabetic subjects. *Diabetologia* 36:1175–1184, 1993
32. Manson J, Colditz G, Stampfer M: A prospective study of maturity onset diabetes mellitus and risk of coronary heart disease and stroke in women. *Arch Intern Med* 151:1141–1147, 1991
33. Stamler J, Vaccaro O, Neaton J, Wentworth D: Diabetes, other risk factors, and 12-year cardiovascular mortality for men screened in the Multiple Risk Factor Intervention Trial. *Diabetes Care* 16:434–444, 1993
34. Schernthaner G: Cardiovascular mortality and morbidity in type-2 diabetes mellitus. *Diabetes Res Clin Pract* 31 (Suppl. 31):S3–S13, 1996
35. Group UKPDS: UK Prospective Diabetes Study (UKPDS) VIII: study design, progress, and performance. *Diabetologia* 34:877–890, 1991
36. Yudkin J: How can we best prolong life? Benefits of coronary risk factor reduction in non-diabetic and diabetic subjects. *BMJ* 306:1313–1318, 1993
37. Meigs J, Singer D, Sullivan L, Dukes K, D'Agostino R, Nathan D, Wagner E, Kaplan S, Greenfield S: Metabolic control and prevalent cardiovascular disease in non-insulin diabetes mellitus (NIDDM): the NIDDM patient outcomes research team. *Am J Med* 102:38–47, 1997
38. Dean J, Matthews S, Dolben J, Carolan G, Luzio S, Owens D: Cholesterol rich apo B containing lipoproteins and smoking are independently associated with macrovascular disease in normotensive NIDDM patients. *Diabet Med* 11:740–747, 1994
39. Hanefield M, Fisher S, Julius U, Schulze J, Schwaneback U, Schmechel H, Ziegelasch H, Lindner J: Risk factors for myocardial infarction and death in newly detected NIDDM: the Diabetes Intervention Study, 11-year follow-up. *Diabetologia* 39:1577–1583, 1996
40. Tuomilehto J, Rastenyte D, Jousilahti P, Sarti C, Vartiainen E: Diabetes mellitus as a risk factor for death from stroke: prospective study of the middle-aged Finnish population. *Stroke* 27:210–215, 1996
41. Chaturvedi N, Stevens L, Fuller J: Which features of smoking determine mortality risk in former cigarette smokers with diabetes? The World Health Organization Multinational Study Group. *Diabetes Care* 20:1266–1272, 1997
42. Muhlhauser I: Cigarette smoking and diabetes: an update. *Diabet Med* 11:336–343, 1994
43. Muhlhauser I, Bender R, Bott U, Jorgens V, Grusser M, Wagener W, Overmann H, Berger M: Cigarette smoking and progression of retinopathy and nephropathy in type 1 diabetes. *Diabet Med* 13:536–543, 1996
44. Ritz E, Keller C, Bergis K: Nephropathy of type II diabetes mellitus. *Nephrol Dial Transplant* 11 (Suppl. 9):38–44, 1996
45. Chase H, Garg S, Marshall G: Cigarette smoking increases the risk of albuminuria among subjects with type I diabetes. *JAMA* 265:614–617, 1991
46. Sawicki P, Didjurgeit U, Muhlhauser I, Bender R, Heinemann L, Berger M: Smoking is associated with progression of diabetic nephropathy. *Diabetes Care* 17:126–131, 1994
47. Ikeda Y, Suehiro T, Takamatsu K, Yamashita H, Tamura T, Hashimoto K: Effect of smoking on the prevalence of albuminuria in Japanese men with non-insulin-dependent diabetes mellitus. *Diabetes Res Clin Pract* 36:57–61, 1997
48. Couper J, Staples A, Cocciolone R, Nairn J, Badcock N, Henning P: Relationship of smoking and albuminuria in children with insulin-dependent diabetes. *Diabet Med* 11:666–669, 1994
49. Corradi L, Zoppi A, Tettamanti F, Malamina G, Lazzari P, Fogari R: Association between smoking and micro-albuminuria in hypertensive patients with type 2 diabetes mellitus. *J Hypertens* 11 (Suppl. 5):S190–S191, 1993
50. Klein R, Klein B, Moss S: Epidemiology of proliferative diabetes retinopathy. *Diabetes Care* 15:1875–1891, 1992
51. Tesfaye S, Stevens L, Stephenson J: Prevalence of diabetic peripheral neuropathy and its relation to glycaemic control and potential risk factors: the EURODIAB IDDM Complications Study. *Diabetologia* 39:1377–1384, 1996
52. Maser R, Steenkiste A, Dorman J: Epidemiological correlates of diabetic neuropathy: report from the Pittsburgh Epidemiology of Diabetes Complications Study. *Diabetes* 38:1456–1461, 1989
53. Mitchell B, Hawthorne V, Vinik A: Cigarette smoking and neuropathy in diabetic patients. *Diabetes Care* 13:434–447, 1990
54. Sands M, Shetterly S, Franklin G, Hamman R: Incidence of distal symmetric (sensory) neuropathy in NIDDM: the San Luis Diabetes Study. *Diabetes Care* 20: 322–329, 1997
55. Morgando P, Chen H, Patel V, Herbert L, Kohner E: The acute effect of smoking on retinal blood flow in subjects with and without diabetes. *Ophthalmology* 101: 1220–1224, 1994
56. Reichard P: Risk factors for progression of microvascular complications in the Stockholm Diabetes Intervention Study (SDIS). *Diabetes Res Clin Pract* 16:151–156, 1992
57. US Department of Health and Human Services: *The Health Benefits of Smoking Cessation: A Report of the Surgeon General.* Atlanta, GA, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1990
58. Orleans C: Treating nicotine dependence in medical settings: a stepped-care model.

In *Nicotine Addiction: Principles and Management*. Orleans C, Slade J, Eds. New York, Oxford University Press, p. 145–161, 1993
59. Fiore M, Bailey W, Cohen S: *Smoking Cessation.* Clinical Practice Guideline Number 18. Rockville, MD, U.S. Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research, 1996
60. Kottke T, Solberg L, Brekke M, Conn S, Maxwell P, Brekke M: A controlled trial to integrate smoking cessation advice into primary care practice: doctors helping smokers, round III. *J Fam Pract* 34:701–708, 1992
61. Fiore M, Epps R, Manley M: Missed opportunity: teaching medical students about tobacco cessation and prevention. *JAMA* 271:624–626, 1994
62. Hollis J, Lichtenstein E, Vogt T, Stevens V, Biglan A: Nurse-assisted counseling for smokers in primary care. *Ann Intern Med* 118:521–525, 1993
63. Tomar S, Husten G, Manley M: Do dentists and physicians advise tobacco users to quit? *J Am Dent Assoc* 127:259–265, 1996
64. Cohen S, Stookey G, Katz B: Helping smokers quit: a randomized controlled trial with private practice dentists. *J Am Dent Assoc* 118:41–45, 1989
65. Curry S: Self-help interventions for smoking cessation. *J Consult Clin Psychol* 61: 790–803, 1993
66. Fiore M, Novotny T, Pierce J: Methods used to quit smoking in the United States: do cessation programs help? *JAMA* 263: 2760–2765, 1990
67. Cepeda-Benito A: A meta-analytic review of the efficacy of nicotine chewing gum in smoking treatment program. *J Consult Clin Psychol* 61:822–830, 1993
68. Tang J, Law M, Wald N: How effective is nicotine replacement therapy in helping people to stop smoking? *BMJ* 308:21–26, 1994
69. Fiore M, Smith S, Jorenby D, Baker T: The effectiveness of the nicotine patch for smoking cessation: a meta-analysis. *JAMA* 271:1940–1947, 1994
70. Silagy C, Mant D, Fowler G, Lodge M: Meta-analysis on efficacy of nicotine replacement therapies in smoking cessation. *Lancet* 343:139–142, 1994
71. Sutherland G, Stapleton J, Russell M: Randomised controlled trial of nasal nicotine spray in smoking cessation. *Lancet* 340:324–329, 1992
72. Tonnesen P, Norregaard J, Mikkelsen K, Jorgensen S, Nilsson F: A double-blind trial of a nicotine inhaler for smoking cessation. *JAMA* 269:1268–1271, 1993
73. Hjalmarson A, Franzon M, Westin A, Wiklund O: Effect of nicotine nasal spray on smoking cessation: a randomized, placebo-controlled, double-blind study. *Arch Intern Med* 154:2567–2572, 1994
74. Anda R, Williamson D, Escobedo L, Mast E, Giovino G, Remington P: Depression and the dynamics of smoking: a national perspective. *JAMA* 264:1541–1545, 1990
75. Glassman A, Helzer J, Covey L: Smoking, smoking cessation, and major depression. *JAMA* 264:1546–1549, 1990
76. Hurt R, Sachs D, Glover E: A comparison of sustained-release bupropion and placebo for smoking cessation. *N Engl J Med* 337:1195–1202, 1997
76a. Jorenby DE, Leischow SJ, Nides MA, Rennard SI, Johnston JA, Hughes AR, Smith SS, Muramoto ML, Daughton DM, Doan K, Fiore MC, Baker TB: A controlled trial of sustained-release bupropion, a nicotine patch, or both for smoking cessation. *N Engl J Med* 340:685–691, 1999
76b. Hughes JR, Goldstein MG, Hurt RD, Shiffman S: Recent advances in the pharmacotherapy of smoking. *JAMA* 281:72–76, 1999
77. Benowitz N: Nicotine replacement therapy during pregnancy. *JAMA* 22:3174–3177, 1991
78. Mullen P, Ramirez G, Groff J: A meta-analysis of randomized trials of prenatal smoking cessation interventions. *Am J Obstet Gynecol* 171:1328–1334, 1994
79. Robinson M, Laurent S, Little JJ: Including smoking status as a new vital sign: it works. *J Fam Pract* 40:556–563, 1995
80. Fiore M, Jorenby D, Schensky A, Smith S, Bauer R, Baker T: Smoking status as the new vital sign: effect on assessment and intervention in patients who smoke. *Mayo Clin Proc* 70:209–213, 1995
81. Kenford S, Fiore M, Joernby D, Smith S, Wetter D, Baker T: Predicting smoking cessation: who will quit with and without the patch. *JAMA* 271:589–594, 1994
82. Centers for Disease Control: Physician and other health care professional counseling of smokers to quit. *MMWR* 42:854–857, 1993
83. Malarcher A, Ford E, Nelson D: Trends in cigarette smoking and physicians' advice to quit smoking among people with diabetes living in the U.S. *Diabetes Care* 18:694–697, 1995
84. Orlandi M: Promoting health and preventing disease in health care settings: an analysis of barriers. *Prev Med* 16:119–130, 1987
85. Solberg L, Kotte T, Brekke M, Calomeni C, Conn S, Davidson G: Using continuous quality improvement to increase preventive services in clinical practice: going beyond guidelines. *Prev Med* 25:259–266, 1996
86. Assurance NCQ: Health Plan Employer Data and Information Set 3.0. Washington, DC, National Committee for Quality Assurance, 1996
87. Joyner L, McNeeley S, Kahn R: ADA's (American Diabetes Association) provider recognition program. *HMO Pract* 11:168–170, 1997
88. Strecher V, Kreuter M, Boer DD, Kobrin S, Hospers H, Skinner C: The effects of computer tailored smoking cessation in family practice settings. *J Fam Pract* 39:262–268, 1994
90. Skinner C, Siegfried J, Kegler M, Strecher V: The potential of computers in patient education. *Patient Educ Couns* 22:27–34, 1993
91. Prochaska J, DiClemente C, Velicer W, Rossi J: Standardized, individualized, interactive, and personalized self-help programs for smoking cessation. *Health Psychol* 12:399–405, 1993
92. Rimer B, Orleans C, Fleisher L: Does tailoring matter? The impact of a tailored guide on ratings and short-term smoking-related outcomes for older smokers. *Health Educ Res* 9:69–84, 1994
93. Schneider S, Schwartz M, Fast J: Computerized, telephone-based health promotion. I. Smoking cessation program. *Comput Hum Behav* 11:135–148, 1995
94. Ardron M, MacFarlane I, Robinson C, Heyningen C, Calverley P: Anti-smoking advice for young diabetic smokers: is it a waste of breath? *Diabet Med* 5:667–670, 1988
95. Sawicki P, Didjurgeit U, Muhlhauser I, Berger M: Behaviour therapy versus doctor's anti-smoking advice in diabetic patients. *J Intern Med* 234:407–409, 1993
96. Haire-Joshu D: Smoking, cessation, and the diabetes health care team. *Diabetes Educ* 17:54–67, 1993
97. Haire-Joshu D: Smoking and diabetes care: enhancing patient capacity for cessation. *Diabetes Spectrum* 10:99–104, 1997
98. MacFarlane I: The smoker with diabetes: a difficult challenge. *Postgrad Med J* 67: 928–930, 1991
99. Stacy R, Lloyd B: An investigation of beliefs about smoking among diabetes patients: information for improving cessation efforts. *Patient Educ Couns* 15:181–189, 1990
100. Fowler PM, Hoskins PL, McGill M, Dutton SP, Yue DK, Turtle JR: Anti-smoking programme for diabetic patients: the agony and the ecstasy. *Diabet Med* 6:698–702, 1989
101. Cummings S, Rubin S, Oster G: The cost-effectivenss of counseling smokers to quit. *JAMA* 261:75–79, 1989
102. Eddy D: David Eddy ranks the tests. *Harvard Health Lett* (Suppl. 10–11), 1992
103. Cromwell J, Bartosch W, Fiore M, Hasselblad V, Baker T: Cost-effectiveness of the clinical practice recommendations in the AHCPR Guidelines for Smoking Cessation. *JAMA* 278:1759–1766, 1997
104. Croghan I, Offord K, Evans R: Cost-effectiveness of treating nicotine dependence: the Mayo Clinic experience. *Mayo Clin Proc* 72:917–924, 1997

105. Wasley M, McNagny S, Phillips V, Phil D, Ahluwalia J: The cost-effectiveness of the nicotine transdermal patch for smoking cessation. *Prev Med* 26:264–270, 1997
106. Mudde A, Vries HD, Strecher V: Cost-effectiveness of smoking cessation modalities: comparing apples with oranges? *Prev Med* 25:708–716, 1996
107. Vogt T, Hollis J, Lichtenstein E, Stevens V, Glasgow R, Whitlock E: The medical care system and prevention: the need for a new paradigm. *HMO Pract* 12:5–13, 1998
108. Elixhauser A: The costs of smoking and the cost effectiveness of smoking-cessation programs. *J Public Health Policy* 11:218–237, 1990
109. Meenan R, Stevens V, Hornbrook M: Cost-effectiveness of a hospital-based smoking-cessation intervention. *Med Care* 36:670–678, 1998
110. Glasgow R, Hampson S, Strycker L, Ruggiero L: Personal-model beliefs and social-environmental barriers related to diabetes self-management. *Diabetes Care* 20:556–561, 1997
111. Wing R, Anglin K: Effectiveness of a behavioral weight control program for blacks and whites with NIDDM. *Diabetes Care* 19:409–413, 1996
112. Williams K, Mullen M, Kelley D, Wing R: The effect of short periods of caloric restriction on weight loss and glycemic control in type II diabetes. *Diabetes Care* 21:2–8, 1998
113. Bloomgarden Z: American Diabetes Association Annual Meeting 1996: the etiology of type II diabetes, obesity, and the treatment of type II diabetes. *Diabetes Care* 19:1311–1315, 1996
114. Gritz E, Klesges R, Meyers A: The smoking and body weight relationship: implications for intervention and postcessation weight control. *Ann Behav Med* 11:144–156, 1989
115. Williamson D, Madans J, Anda R, Kleinman J, Giovino G, Byers T: Smoking cessation and severity of weight gain in a national cohort. *N Engl J Med* 324:739–745, 1991
116. Pirie P, McBride C, Hellerstedt W: Smoking cessation in women concerned about weight. *Am J Public Health* 82:1238–1243, 1992
117. Perkins K: Issues in the prevention of weight gain after smoking cessation. *Ann Behav Med* 16:46–52, 1994
118. Haire-Joshu D, Heady S, Thomas L, Schechtman K, Fisher EB Jr: Beliefs about smoking and diabetes care. *Diabetes Educ* 20:410–415, 1994
119. Pomerleau C: Co-factors for smoking and evolutionary psychobiology. *Addiction* 92:397–408, 1997
120. Hall S, Munoz R, Reus V, Sees K: Nicotine, negative affect, and depression. *J Consult Clin Psychol* 61:761–767, 1993
121. Breslau N, Kilbey M, Andreski P: Nicotine withdrawal symptoms and psychiatric disorders: findings from an epidemiological study of young adults. *Am J Psychiatry* 149:464–469, 1992
122. Fant R, Everson D, Dayton G, Pickworth W, Henningfield J: Nicotine dependence in women. *J Am Med Wom Assoc* 51:19–24, 1996
123. Hall S, Munoz R, Reus V: Cognitive-behavioral intervention increases abstinence rates for depressive-history smokers. *J Consult Clin Psychol* 62:141–146, 1994
124. Lustman P, Griffith L, Gavard J, Clouse R: Depression in adults with diabetes. *Diabetes Care* 15:1631–1639, 1992
125. Gavard J, Lustman P, Clouse R: Prevalence of depression in adults with diabetes. *Diabetes Care* 16:1167–1178, 1993
126. Haire-Joshu D, Heady S, Thomas L, Schechtman K, Fisher EB Jr: Depressive symtomatology and smoking among persons with diabetes. *Res Nurs Health* 17: 273–282, 1994
127. Moss A, Allen K, Giovino G, Mills S: *Recent Trends in Adolescent Smoking, Smoking Uptake Correlates, and Expectations About the Future*. Hyattsville, MD, National Center for Health Statistics, 1992
128. French S, Perry C: Smoking among adolescent girls: prevalence and etiology. *J Am Med Wom Assoc* 51:25–28, 1996
129. Hovell M, Slymen D, Keating K: Tobacco use prevalence and correlates among adolescents in a clinician initiated tobacco prevention trial in California, USA. *J Epidemiol Comm Health* 50:340–346, 1996
130. Gold M, Gladstein J: Substance use among adolescents with diabetes mellitus: preliminary findings. *J Adolesc Health* 14:80–84, 1993
131. Masson E, MacFarlane I, Priestley C, Wallymahmed M, Flavell H: Failure to prevent nicotine addiction in young people with diabetes. *Arch Dis Child* 67:100–102, 1992
132. Shaw N, McClure R, Kerr S, Lawton K, Smith C: Smoking in diabetic tennagers. *Diabet Med* 10:275–277, 1993
133. Frey M, Buthrie B, Loveland-Cherry C, Park P, Foster C: Risky behavior and risk in adolescents with IDDM. *J Adolesc Health* 20:38–45, 1997
134. Taylor C, Miller NH, Killen J, DeBusk R: Smoking cessation after acute myocardial infarction: effects of a nurse-managed intervention. *Ann Intern Med* 113:118–123, 1990
135. Orleans C, Rotberg H, Quade D, Lees P: A hospital quit-smoking consult service: clinical report and intervention guidelines. *Prev Med* 19:198–212, 1990
136. Stevens V, Glasgow R, Hollis J, Lichtenstein E, Vogt T: A smoking-cessation intervention for hospital patients. *Med Care* 31:65–72, 1993
137. Haire-Joshu D, Ziff S, Houston C: The feasibility of recruiting hospitalized patients with diabetes for a smoking cessation program. *Diabetes Educ* 21:214–218, 1995
138. Fagerstrom K, Kunze M, Schoberberger R: Nicotine dependence vs. smoking prevalence: comparisons among countries and categories of smokers. *Tob Control* 5:52–56, 1996
139. Killen J, Fortmann S, Kraemer H, Varady A, Newman B: Who will relapse? Symptoms of nicotine dependence predict long-term relapse after smoking cessation. *J Consult Clin Psychol* 60:797–801, 1992
140. Fox R, Brown R: Nicotine fading and self-monitoring for cigarette abstinence or controlled smoking. *J Appl Behav Anal* 12:111–125, 1979
141. Glasgow R, Klesges R, Klesges L, Vasey M, Gunnarson D: Long-term effects of a controlled smoking program: a two and a half year follow-up. *Behav Ther* 16:303–307, 1985
142. Glasgow R, Morray K, Lichtenstein E: Controlled smoking vs. abstinence as a treatment goal: the hopes and fears may be unfounded. *Behav Ther* 20:77–91, 1989
143. Hughes J: Applying harm reduction to smoking. *Tob Control* 4 (Suppl. 2):S33–S38, 1995
144. Wetter DW, Fiore MC, Gritz ER, Lando HA, Stitzer ML, Hasselblad V, Baker TB: The Agency for Health Care Policy and Research Smoking Cessation Clinical Practice Guideline: findings and implications for psychologists. *Am Psychol* 53:657–669, 1998