POLICY

Employer-sponsored Insurance Coverage of Smoking Cessation Treatments

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Objective: To investigate the costs and benefits of covering smoking cessation interventions from insurers' and employers' perspectives.

Study Design: A Monte Carlo model was used to simulate smoking status and health expenditures in a hypothetical population of employees over a period of 20 years.

Methods: Population characteristics were drawn from the 1997-2002 National Health Interview surveys. Multivariate regressions using a number of publicly available datasets from 1996-2002 generated transition probabilities for the simulation. The costs and benefits of scenarios where smoking cessation treatments were covered were compared with a scenario where none were covered. Sensitivity to parameter estimates was evaluated.

Results: By the final simulation year, insurers had benefit-cost ratios of 0.56 to 1.67 with per member per month costs of −$0.22 to $0.43. The earliest year at which savings were achieved for insurers was year 8. Employers saw benefit-cost ratios of 1.88 to 5.58 by the final simulation year with per member per month costs of −$1.23 to −$0.15. Employers achieved savings as early as year 3 and as late as year 8. Models were sensitive to the rate at which population members were assumed to exit the insurer or employer.

Conclusion: Both insurers and employers may add smoking cessation benefits at minimal burden to their members and with potential savings, particularly where the population of interest is relatively stable.

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Universal insurance coverage for proven smoking cessation interventions is a goal of Healthy People 2010.[1] A number of interventions are known to improve smokers' ability to quit, including counseling,[2-4] nicotine replacement therapies,[5] and bupropion.[6] Evidence indicates insurance coverage for smoking cessation interventions both encourages their use and increases quit rates.[7-9] Viewed from a societal perspective, smoking cessation interventions are among the most cost-effective interventions in healthcare, with recent estimates of costs per life-year saved typically less than $4000.[10-13] (Note: All dollar figures are adjusted for inflation to year 2000 dollars using the All Items Urban Household Consumer Price Index.[14]) In contrast, colon cancer screening, which is widely covered by insurers and deemed cost-effective, costs at minimum $9572 per life-year saved.[15] However, employers and insurers do not take society's perspective, raising the concern that coverage for smoking cessation treatments may be underprovided.

The availability of smoking cessation benefits has not been well quantified. A 2002 survey reported by McPhillips-Tangum et al suggests that as many as 98% of plans offer "full coverage" for some form of smoking cessation intervention.[16] However, this survey focuses on HMO-type insurance products and had a 62% response rate. It is plausible that HMO-type plans would be more likely to cover smoking cessation treatments than other plan types. Furthermore, there is the possibility of selection bias if plans that did not offer coverage for smoking cessation treatments were less likely to respond to the survey. A 2004 survey by the Society for Human Resource Management reports that as few as a third of employers and insurers offer "comprehensive smoking cessation benefits."[17] Unfortunately, the methods and definitions used in these studies are such that the true prevalence of smoking cessation benefits is unknown, leaving open the possibility that many privately insured individuals do not have access to smoking cessation treatments as recommended.

If smoking cessation benefits are indeed underprovided, developing a business case for smoking cessation interventions may be an important tool for garnering support among employer purchasers of insurance. According to Barbara Lardy, the vice president of medical affairs for the America's Health Insurance Plans, an industry group representing many of the nation's health insurers, "many [plans] claim that since member turnover is so high, they won't realize the savings three or four years down the road for money they're spending today."[18] The central question is whether the reduction in smoking-related health expenditures that accompanies increased quit rates will outweigh the additional costs of covering smoking cessation interventions. Smoking-related illnesses can take decades to develop.[19] Meanwhile, many enrollees will change jobs and/or health plans or become eligible for Medicare. In the frag-

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mented system of the United States, private payers will save money offering a smoking cessation benefit only if the associated reductions in health expenditures occur within the time enrollees are tied to their jobs or health plans.

Several studies have attempted to quantify this tradeoff. Warner and colleagues simulated the introduction of an unspecified smoking cessation benefit in a self-insured, blue-collar firm using a dynamic population model.[20] They found that the benefits of reducing smoking outweighed the cost of subsidizing smoking cessation interventions in fewer than 5 years and that the benefit-cost ratio rose to more than 8 over the course of 25 years. Halpern et al, reporting simulations that took the perspectives of both employers and insurers, analyzed the costs and benefits of covering bupropion in conjunction with intense counseling.[21] Their estimates indicated that for insurers, benefits would outweigh costs in 4.5 to 5 years, and over the lifetimes of the enrollees, the benefit-cost ratio would be between 4.1 and 4.7. The break-even point estimated from an employer's perspective ranged from 3 to 3.5 years; over employees' lifetimes, the benefit-cost ratio ranged from 5 to 6.5. Both Warner et al and Halpern et al adjusted their simulation inputs for age and sex. Nielsen and Fiore used a decision-analytic model to estimate the net savings to employers of coverage for minimal counseling paired with one of several pharmacotherapy regimens.[22] With a time horizon of 1 year, they found net savings for each intervention. However, the authors' findings were sensitive to assumptions about health savings after smoking cessation that were far more generous than what is found elsewhere in the literature. Taking the perspective of employers, Javitz et al conducted a return-on-investment analysis of insurance coverage for smoking cessation as part of a randomized trial comparing different dosage combinations of bupropion and counseling.[23] They estimated 5-year benefit-cost ratios between 2.7 and 4.0. These results may be overly optimistic because smokers in clinical trials are likely more motivated to quit than smokers in general, and because the authors do not account for member turnover in the health plan. Finally, Warner et al simulated the introduction of an unspecified smoking cessation benefit to a managed care plan, again using a dynamic population model.[24] They found no net savings within a 30-year time horizon. It is not clear based on the reported differences between the 2 studies that took the insurer's perspective[21,24] why they arrived at such starkly different conclusions.

In the present study, I used a Monte Carlo simulation model to revisit the cost-benefit tradeoff insurers and employers face when considering whether to cover smoking cessation interventions. Here, transition probabilities were adjusted for many covariates beyond just age and sex, including race/ethnicity, marital status, education and income, geographic factors, health and health behaviors, and smoking status, to more realistically mimic population dynamics. Including smoking status in the transition probability estimates is a particularly important addition as insurers' and employers' expenditures in any given year will depend on the mix of current, former, and nonsmokers in their populations. Additional analyses using subpopulations defined by occupation took advantage of the range of covariates included in the model. The findings illustrate key factors affecting payers' monetary returns on investments in smoking cessation.

METHODS

Overview

A hypothetical population was followed for 20 years. In a given year, there was a chance that current smokers would quit smoking and former smokers would relapse. In simulations where a smoking cessation benefit was offered, quit probabilities were augmented relative to those when no benefit was offered. Both employer and insurer perspectives were taken. In either case, population members could leave or die, and new employees/enrollees were added to replace them. After each annual cycle, the payer's medical expenditures and smoking cessation costs were tallied. With the employer's perspective, financial losses due to increased absenteeism and reduced productivity were included. Finally, the marginal cost of adding a smoking cessation benefit was estimated.

Simulation Population

The characteristics of the initial simulation population were based on the 1997-2002 National Health Interview Surveys (NHIS). Respondents aged 18 to 64 years indicating they were privately insured were included; and their self-reported demographics, socioeconomic status, health status, and health behaviors were used to calculate the covariate-adjusted transition probabilities in the simulation. The mean age in the population was 40 years, 51% were female, 84% were white, 10% were black, 4% were Asian, 2% were of other race, 4% were of Hispanic ethnicity, the majority had more than a high school education, and the median income was approximately $50 000. Twenty-two percent were current smokers and 21% were former smokers.

To explore how costs and benefits varied for populations with alternative demographic profiles, additional simulations were conducted for subgroups defined by occupation. Using occupation data from NHIS and standard "class" criteria,[25] individuals were defined as "white collar workers," "blue collar workers," "service workers," and "farm workers." In addition to a variety of demographic differences, blue collar and service workers are much more likely to be current smokers than white collar or farm workers.

Model Parameters

Transition probabilities for quitting smoking, leaving the insurer, leaving the employer, and retiring, as well as the annual number of absentee days, were calculated using several publicly available datasets. For each parameter, **Table 1** lists the data source, regression model type, covariates used for model adjustment, and mean values estimated in the starting population (by smoking status, where relevant). In the employer-perspective models, the distinction between "leaving" and retiring is the assumption that retirees under age 65 years still have access to the smoking cessation benefit and that retiree medical expenditures typically covered by private insurance are covered by the employer; neither is true for "leavers." It was assumed that those aged 65 years and older and those who left their employer or insurer were not offered the smoking cessation benefit.

The annual probability a former smoker relapsed to current smoking was assumed to be 20% for the first 2 years after quitting, 5% for years 3 to 5 after quitting, and 1% for subsequent years, consistent with published estimates.[30] Based on analysis of the 2004 NHIS, nearly three quarters of all regular smokers began smoking by age 18 years, so smoking initiation is not included in this model.

The probability that a person died in a given year was based on age-, sex-, and race-specific estimates from the US's life tables.[31] These, together with estimates of the additional hazard of death due to smoking[32] and group-specific smoking prevalence (from the NHIS), were used to estimate death rates specific to age, sex, race, and current/former smoking status.

Medical expenditures paid for by employer-sponsored health insurance were predicted based on age- and sex-adjusted models estimated from the 1998-2001 Medical Expenditures Panel Survey (MEPS). The models' functional form followed that of Warner et al.[20] Expenditures for smokers were assumed to be 25% higher than expenditures in the general population. Among former smokers, excess expenditures due to smoking were assumed to decrease by 20% per year after quit-

Table 1. Regression Models for Simulation Parameters

	Parameter				
Outcome (Annual)	Quit	Leave Insurer	Leave Employer	Retire	No. Days Absent
Model type	Logit	Logit	Logit	Logit	Poisson
Data source	1997-2002 NHIS[26]	1996-1997 CTSHS[27]	1998-2002 MEPS[28]	1998, 2000 HRS[29]	1997-2002 NHIS[26]
Covariate adjustment					
Age & sex	✓	✓	✓	✓	✓
Race/ethnicity	✓	✓	✓	✓	
Marital status	✓		✓	✓	
Education & income	✓	✓	✓	✓	
Census region	✓	✓	✓		
Metropolitan statistical area	✓				
Health behaviors (eg, alcohol consumption, exercise)	✓				
Self-reported health	✓		✓	✓	
History of smoking-related illness	✓		✓		
Smoking status		✓	✓	✓	✓
Number of years postquitting					✓
	Mean Outcome at Baseline				
Never smokers	NA	21.5%	15.6%	9.7%	3.8
Former smokers	NA	18.6%	12.4%	11.9%	5.4
Current smokers	4.3%*	23.1%	19.6%	11.4%	6.3

*Absent any smoking cessation benefit.
NHIS indicates National Health Interview Survey; CTSHS, Community Tracking Study Household Survey; MEPS, Medical Expenditures Panel Survey; HRS, Health and Retirement Survey; NA, not applicable.

ting. Mean annual medical expenditures in the first simulation year were estimated to be $543 per person.

The cost of absenteeism was taken to be the income (a proxy for salary from the NHIS) of the absent worker for the days missed. Following previous studies,[20,22] it was assumed that current smokers' reduced productivity was worth 1% of the smoker's salary. Income was updated annually to reflect the mean for a given education, age, and sex group.

Simulation Scenarios

Four coverage scenarios were compared with the case where smoking cessation treatments were not covered. Each scenario was loosely based on those proposed by Levy and Friend, who reported cost and effectiveness estimates for insurance coverage of various combinations of approved smoking cessation treatments.[33] As discussed previously, there are 3 general types of approved smoking cessation treatments. Behavioral therapy includes group or individual therapy conducted in person or over the phone. A course of individual therapy improves quit rates by approximately 56%[3] with direct costs estimated at $120 per quit attempt,[10] but indirect costs in terms of the smoker's time may limit the effectiveness despite the proven efficacy.[33] Nicotine replacement therapies are available over-the-counter (OTC) in the form of a patch, gum, or lozenge (about $300 per successful quit) or by prescription as an inhaler or nasal spray (cost per quit estimates are unavailable for these 2 treatments), improving quit rates by 66% (nicotine gum) to 135% (nicotine nasal spray).[5] Nicotine nasal spray, while more effective than the OTC nicotine replacement therapies, has unpleasant side effects.[34] Lastly, bupropion improves quit rates by 106%[6] and costs approximately $250 per successful quit[21,33] with generally mild side effects.[35]

Levy and Friend estimated that offering coverage for individual counseling improved baseline quit rates by 5.9% and cost $2501 per additional successful quit, whereas offering coverage for a flexible choice of counseling, nicotine replacement therapy, and/or bupropion therapy improved baseline quit rates by 28.6% and cost $7394 per additional successful quit. In the present simulation, these estimates were used to create 4 coverage scenarios, low or high effectiveness (5.9% or 28.6% improvement in quit rates, respectively) paired with low or high cost ($2501 per successful quit or $7394 per successful quit, respectively), to assess a reasonable range of input values. The present simulation does not attach the Levy and Friend estimates to specific treatments, so readers may view the results generally in terms of the cost and effectiveness values.

To illustrate explicitly how these values were used, consider a comparison between the high-effectiveness, high-cost scenario and the scenario with no coverage for smoking cessation treatments. If, absent coverage for smoking cessation treatments, a smoker had a 10% annual probability of quitting, under a high-effectiveness scenario the person would have a 12.86% annual chance of quitting. The simulation did not attempt to model quit attempts and successful quits separately; the effectiveness and cost estimates take into account the rate at which treatments would be taken up, given their respective desirabilities to smokers. Therefore, higher numbers of successful quits reflect, in part, greater numbers of quit attempts; thus, costs rise as the number of successful quits rises. Hence, if in a given year 1000 population members quit smoking when there was no coverage and 1286 members quit when treatments were covered, under a high-cost scenario that would impose a marginal cost of (1286 − 1000) × $7394 = $2 114 684.

Simulation Execution

For each simulation year, population members' transitions in smoking, enrollment/employment, and vital status were determined based on random draws from the probability models described above, and health and absenteeism costs were predicted. Because costs are incurred in the year the benefit is introduced but savings do not appear until the following year, the results were presented in terms of years subsequent to the benefit introduction. All monetary outcomes were discounted annually by 3% based on the standard suggested for cost-effectiveness analyses.[36] Each scenario was simulated 500 times to account for variation across random draws.

Outcomes

The cost of implementing the smoking cessation benefit itself (the "program cost"), based on the costs per additional successful quit, and the marginal savings from changes in medical expenditures estimated from the MEPS models ("savings in medical expenditures") were calculated. In the employer-perspective models, the marginal savings from reducing productivity losses and absenteeism also were calculated. An overall, absolute change in spending was calculated as the savings net of smoking cessation treatment costs. Per member per month (PMPM) costs were calculated based on the absolute change in spending. All outcomes were reported on a cumulative basis. A benefit-cost ratio was calculated as the savings divided by the costs. Lastly, the simulation year at which the savings from reduced medical expenditures exceeded the costs of adding the smoking cessation benefit was determined (the "conversion year").

Sensitivity Analyses

To see how different parameter assumptions affected the model conclusions, individual inputs were changed and the model was rerun. For both the insurer-perspective and employer-perspective models, simulations were run where the effect of the smoking cessation benefit, the relapse rate, or the death rate was halved or doubled. Models were run assuming that smokers' expenditures were 12.5% or 37.5% higher than average, and that the excess expenditures for smokers were reduced by 10% or 40% per year after smoking cessation. For models taking the insurer perspective, the rate at which population members switched out of the plan was halved or doubled, either overall or specifically for current smokers. For models taking the employer's perspective, the retirement rate or the rate at which employees left the firm was halved or doubled, either overall or specifically for current smokers. To examine the model at its extremes, simulations were run where all the parameters were biased either in favor of or against adding smoking cessation benefits. Each alternative scenario was simulated 50 times. The 4 occupational class groups also were simulated 50 times each. Outcomes for all simulations were alternatively evaluated using 0%, 5%, and 10% annual discount rates.

RESULTS

Costs From Insurers' Perspective

Cost results for the model taking the insurer's perspective are presented in **Table 2** as dollar amounts per 1000 enrollees starting in a plan. Program cost rather than pro-

Table 2. Insurers' Cumulative Costs and Savings per 1000 Enrollees (in Year 2000 Dollars)*

		Year				
Scenario	**Outcome**	**2**	**5**	**10**	**15**	**19**
	Program cost, $	3583	6674	10 953	14 487	16 932
Low cost, low effectiveness	Savings in medical expenditures, $	1256	4988	13 167	21 598	28 189
Conversion year 8	Change in spending, $	2327	1686	*−2214*	*−7111*	*−11 257*
	B/C ratio	0.35	0.75	*1.20*	*1.49*	*1.66*
	PMPM cost, $	0.06	0.02	*−0.02*	*−0.04*	*−0.05*
	Program cost, $	10 594	19 732	32 384	42 831	50 059
High cost, low effectiveness	Savings in medical expenditures, $	1256	4988	13 167	21 598	28 189
Conversion year ≥ 20	Change in spending, $	9337	14 744	19 217	21 233	21 870
	B/C ratio	0.12	0.25	0.41	0.50	0.56
	PMPM cost, $	0.26	0.20	0.15	0.11	0.09
	Program cost, $	17 064	31 545	51 609	68 146	79 583
Low cost, high effectiveness	Savings in medical expenditures, $	6061	23 822	62 311	101 817	132 649
Conversion year 8	Change in spending, $	11 003	*7723*	*−10 701*	*−33 671*	*−53 066*
	B/C ratio	0.36	0.76	*1.21*	*1.49*	*1.67*
	PMPM cost, $	0.31	0.11	*−0.08*	*−0.18*	*−0.22*
	Program cost, $	50 451	93 264	152 586	201 478	235 291
High cost, high effectiveness	Savings in medical expenditures, $	6061	23 822	62 311	101 817	132 649
Conversion year ≥ 20	Change in spending, $	44 390	69 442	90 275	99 661	102 642
	B/C ratio	0.12	0.26	0.41	0.51	0.56
	PMPM cost, $	1.23	0.96	0.68	0.52	0.43

*Cost-beneficial outcomes are indicated in italics.
B/C indicates ratio of benefit to cost; PMPM, per member per month.

gram effectiveness drove the benefit-cost ratios. Only the least expensive scenarios had benefit-cost ratios above 1 within the simulation time period in year 8. By the last time period, the simulation predicted a benefit-cost ratio of 1.66 for the 2 low-cost scenarios. PMPM costs by the final year were lowest for the low-cost, high-effectiveness scenario at −$0.22 (ie, a savings), and highest for the high-cost, high-effectiveness scenario at $0.43.

Costs From Employers' Perspective

Results were more favorable for employers than for insurers (**Table 3**). The 2 low-cost scenarios still had the earliest conversion year (year 3) and the highest benefit-cost ratio (5.58) by the end of the simulation. The 2 high-cost scenarios had a later conversion year (year 8) and a benefit-cost ratio by the end of the simulation of 1.88. Both program cost and effectiveness drove PMPM costs, though program effectiveness had the greater impact. Although initial PMPM costs were highest for the high-cost, high-effectiveness scenario, over time this scenario led to a savings (−$0.70 PMPM).

Sensitivity Analyses

Table 4 presents selected results from the sensitivity analyses. To summarize each simulation in a single number, conversion years for each parameter/scenario combination are presented. For the sake of brevity, only the parameter changes that altered the conversion year for at least 1 scenario by more than 1 year compared with the base case are included.

From the insurer's perspective, results were sensitive to 3 parameters. When the dropout rate was doubled overall, the conversion years for the low-cost scenarios were shifted out by 1 or 2 years. When the dropout rate for current smokers only was doubled, the conversion years for the low-cost scenarios were shifted beyond the time horizon of the simulation. Halving the plan dropout rate for current smokers only shifted the conversion year for the low-cost scenarios from 8 to 6. Assuming smokers' excess expenditures relative to the general population were 12.5% rather than 25% extended the conversion year for the low-cost scenarios to 10. Biasing all parameters against the smoking cessation benefits resulted in conversion years beyond the simulation time horizon for all scenarios. Biasing all parameters in favor of the smoking cessation benefits reduced the conversion year to 6 for the low-cost scenarios, but did not bring the conversion years for the high-cost scenarios below 20.

Simulations run from the employer's perspective were only sensitive to parameter adjustments in the extreme scenarios. Biasing all the parameters in favor of the smoking cessation benefits shifted conversion years for the low-cost scenarios earlier by 1 year. When all parameters were biased against the benefits, conversion years for the low-cost scenarios were unchanged while conversion years for the high-cost scenarios were shifted out by 2 to 3 years.

Varying the discount rate did not substantially alter the simulation results for either insurers or employers. Models with higher discount rates had lower present discounted absolute savings but higher benefit-cost ratios over time than models with lower discount rates.

Alternative Populations

Conversion years for simulations using each of the 4 occupational classes are presented in **Table 5** along with smoking prevalence data and average predicted probabilities for switching insurers and leaving employers. The probabilities were based on differences in the covariate distributions across the populations and were not based on any occupation-specific probability models.

From the insurer's perspective, only the results for farm workers were slightly different from those for the overall population, with the conversion year for the low-cost, low-effectiveness scenario increased by 2 years. No other scenario or occupation group had conversion years shifted by more than 1 year, whether the model took the insurers' or employers' perspective.

DISCUSSION

Establishing an economic rationale for the provision of smoking cessation benefits by insurers and employers may be one way to increase the benefits' availability to smokers. The simulations presented in this study suggest that adding smoking cessation benefits to employer-sponsored insurance plans would cost very little, and under certain circumstances, employers and insurers could achieve savings.

From the insurer's perspective, the model predicts that the costs of providing a smoking cessation benefit either do not outweigh the reductions in medical expenditures or take too long to support a business case argument, as it is put forth here. Although slightly more optimistic than what Warner et al reported in a managed care setting,[24] the current findings essentially agree that insurers will have difficulty saving money (or at least reducing premiums, as theoretically insurers make no profits in a competitive market) by adding smoking cessation benefits.

For employers, the model predicts that adding smoking cessation benefits can achieve reductions in total expenditures relative to not covering smoking cessation treatments within 3 to 8 years. Even the high-cost, high-effectiveness scenario, with a first year PMPM cost of $1.55, seems unlikely to pose a major burden on

Table 3. Employers' Cumulative Costs and Savings per 1000 Employees (Year 2000 Dollars)*

		Year				
Scenario	**Outcome**	**2**	**5**	**10**	**15**	**19**
	Program cost, $	3438	5724	9069	11 758	13 773
Low cost, low effectiveness	Savings in medical expenditures, $	1380	5733	16 496	29 193	39 885
	Savings for reduced absenteeism/increased productivity, $	1846	6980	17 634	28 508	36 988
Conversion year 3	Change in spending, $	211	*−6989*	*−25 061*	*−45 943*	*−63 101*
	B/C ratio	0.94	*2.22*	*3.76*	*4.91*	*5.58*
	PMPM cost, $	0.01	*−0.10*	*−0.19*	*−0.24*	*−0.26*
	Program cost, $	10 165	16 924	26 812	34 764	40 720
High cost, low effectiveness	Savings in medical expenditures, $	1380	5733	16 496	29 193	39 885
	Savings for reduced absenteeism/increased productivity, $	1846	6980	17 634	28 508	36 988
Conversion year 8	Change in spending, $	6938	4211	*−7318*	*−22 938*	*−36 153*
	B/C ratio	0.32	0.75	*1.27*	*1.66*	*1.89*
	PMPM cost, $	0.19	0.06	*−0.06*	*−0.12*	*−0.15*
	Program cost, $	16 352	27 014	42 576	55 102	64 518
Low cost, high effectiveness	Savings in medical expenditures, $	6551	27 003	77 251	136 267	185 889
	Savings for reduced absenteeism/increased productivity, $	8822	32 979	82 881	133 551	173 014
Conversion year 3	Change in spending, $	979	*−32 968*	*−177 556*	*−214 717*	*−294 384*
	B/C ratio	0.94	*2.22*	*3.76*	*−4.91*	*5.58*
	PMPM cost, $	0.03	*−0.46*	*−0.89*	*−1.12*	*−1.23*
	Program cost, $	48 345	79 867	125 879	162 912	190 753
High cost, high effectiveness	Savings in medical expenditures, $	6551	27 003	77 251	136 267	185 889
	Savings for reduced absenteeism/increased productivity, $	8822	32 979	82 881	133 551	173 014
Conversion year 8	Change in spending, $	32 972	19 886	*−34 253*	*−106 907*	*−168 150*
	B/C ratio	0.32	0.75	*1.27*	*1.66*	*1.88*
	PMPM cost, $	0.92	0.28	*−0.26*	*−0.56*	*−0.70*

*Cost-beneficial outcomes are indicated by italics.
B/C indicates ratio of benefit to cost; PMPM, per member per month.

employers or employees and cumulative PMPM costs would decline rapidly each year.

The most important factor driving the difference in findings between employers and insurers is the additional costs borne by employers. In this analysis, the cost-beneficial results for employers were driven by the costs of reduced productivity and increased absenteeism for smokers. There is, however, variability in the extent to which these factors will influence an employer's analysis. The more a firm's productivity is affected

Table 4. Sensitivity Analyses: The Effect of Parameter Variation on Conversion Year

Parameter Adjustment	Low Cost, Low Effectiveness	High Cost, Low Effectiveness	Low Cost, High Effectiveness	High Cost, High Effectiveness
Conversion Year: Insurer Perspective				
None (base case)	8	≥20	8	≥20
Annual probability of plan dropout				
½ ×	8	≥20	8	≥20
2×	9	≥20	10	≥20
Current smokers' annual probability of plan dropout				
½ ×	6	≥20	6	≥20
2×	≥20	≥20	≥20	≥20
Excess expenditures for smokers				
37.5%	8	≥20	7	≥20
12.5%	10	≥20	10	≥20
All biased *in favor of* smoking cessation benefit	6	≥20	6	≥20
All biased *against* smoking cessation benefit	>20	≥20	≥20	≥20
Conversion Year: Employer Perspective				
None (base case)	3	8	3	8
All biased *in favor of* smoking cessation benefit	2	8	2	8
All biased *against* smoking cessation benefit	3	10	3	11

Table 5. Sensitivity Analyses: Parameters and Conversion Years by Occupational Class

Characteristic	Overall Population	White Collar Worker	Blue Collar Worker	Farm Worker	Service Worker
Smoking status, %					
Current	22	19	32	20	27
Former	21	21	21	22	18
Never	57	60	47	58	55
Insurer perspective					
Probability of switching insurers, %	21	22	22	20	22
Conversion year					
Low cost, low effectiveness	8	8	8	10	9
High cost, low effectiveness	>20	>20	>20	>20	>20
Low cost, high effectiveness	8	7	8	8	9
High cost, high effectiveness	>20	>20	>20	>20	>20
Employer perspective					
Probability of leaving employer, %	16	15	15	16	18
Conversion year					
Low cost, low effectiveness	3	3	3	3	3
High cost, low effectiveness	8	8	8	7	9
Low cost, high effectiveness	3	3	3	3	3
High cost, high effectiveness	8	7	8	8	8

by smoking (eg, when productivity depends on employee physical fitness), the greater the incentive it has to cover smoking cessation benefits. Employer costs attributable to smoking will therefore partially depend on the employer's industry.

Another factor distinguishing the employers' calculus from the insurers' is greater population stability among employees than among insurance enrollees (by a factor of 35% in this analysis). Though the sensitivity analyses indicate that population stability does not drive costs and benefits nearly as much as productivity and absenteeism, as a rule the more stable a payer's population, the better it is able to recoup investments in prevention. Thus, employers are somewhat better able to capitalize over time on savings due to smoking cessation. A corollary to this result is that payers in markets with universal provision of smoking cessation benefits will all be able to reap the benefits of reduced smoking, as such markets are functionally similar to individual payers with no employee/enrollee turnover.

In an analysis taking society's perspective, each of these distinctions would be taken to its extreme—all costs and benefits would be considered, and there would be no cycling out of the population. It is therefore easy to see why smoking cessation benefits or other interventions aimed at preventing illnesses that take years to develop, when paid for by private payers with narrow interests and dynamic populations, might be underprovided from society's perspective. Reduced medical expenditures not captured by the payer covering smoking cessation would still benefit other payers in the market, particularly Medicare. Finally, beyond medical expenditure reductions, the most obvious benefit of smoking cessation—improved health—is not fully or explicitly captured in the insurer's or the employer's economic analyses.

Despite variation in demographic characteristics across the occupation groups and significant relationships between those characteristics and transition probabilities in the simulation model, there were no major differences in simulation results across the occupation groups. Taken together, the variations in demographic characteristics across the occupation groups did not significantly alter the distributions of the transition probabilities and thus did not affect the model outcomes.

The simulation results are largely robust to changes in assumptions about the model parameters. One parameter in particular, the relationship between smoking and medical expenditures, is estimated plausibly, but it is not based on an empirically derived model. Ideally, one would measure how smoking affects medical expenditures for the smokers who will quit only if a smoking cessation benefit is provided. Unfortunately, no data are available to properly estimate this effect.

Some model simplifications may have affected estimates of potential savings. The models do not include savings in health expenditures for newborns, a group adversely affected by smoking in the short and long terms.[37] Nor do the models capture savings for other nonsmoking beneficiaries resulting from reductions in secondhand smoke within the home. Potential savings from reduced numbers of cigarettes smoked per day also were excluded. Lastly, it is assumed that those leaving the population do not reenter at a later date. Each of these factors is likely to cause an underestimate of savings.

CONCLUSIONS

Although provision of coverage for smoking cessation interventions is unlikely to result in cost savings for insurers in the average population modeled here, it does not impose large costs. When the analytical perspective widens to include the additional costs smoking imposes on employers, covering smoking cessation interventions looks more economically desirable, which may help convince employers to offer these benefits.

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REFERENCES

1. US Department of Health and Human Services. *Healthy People 2010.* 2nd ed. Washington, DC: US Government Printing Office; November 2000.

2. Lancaster T, Stead L. Physician advice for smoking cessation. *Cochrane Database Syst Rev.* 2004(4):CD000165.

3. Lancaster T, Stead LF. Individual behavioural counselling for smoking cessation. *Cochrane Database Syst Rev.* 2005(2):CD001292.

4. Stead LF, Lancaster T. Group behaviour therapy programmes for smoking cessation. *Cochrane Database Syst Rev.* 2005(2):CD001007.

5. Silagy C, Lancaster T, Stead L, Mant D, Fowler G. Nicotine replacement therapy for smoking cessation. *Cochrane Database Syst Rev.* 2004(3):CD000146.

6. Hughes J, Stead L, Lancaster T. Antidepressants for smoking cessation. *Cochrane Database Syst Rev.* 2004(4):CD000031.

7. Curry SJ, Grothaus LC, McAfee T, Pabiniak C. Use and cost effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. *N Engl J Med.* 1998;339:673-679.

8. Schauffler HH, McMenamin S, Olson K, Boyce-Smith G, Rideout JA, Kamil J. Variations in treatment benefits influence smoking cessation: results of a randomised controlled trial. *Tob Control.* 2001;10:175-180.

9. Kaper J, Wagena EJ, Severens JL, Van Schayck CP. Healthcare financing systems for increasing the use of tobacco dependence treatment. *Cochrane Database Syst Rev.* 2005(1):CD004305.

10. Cromwell J, Bartosch WJ, Fiore MC, Hasselblad V, Baker T. Cost-effectiveness of the clinical practice recommendations in the AHCPR guideline for smoking cessation. Agency for Health Care Policy and Research [see comments]. *JAMA.* 1997;278:1759-1766.

11. Javitz HS, Swan GE, Zbikowski SM, et al. Cost-effectiveness of different combinations of bupropion SR dose and behavioral treatment for smoking cessation: a societal perspective. *Am J Manag Care.* 2004;10:217-226.

12. Song F, Raftery J, Aveyard P, Hyde C, Barton P, Woolacott N. Cost-effectiveness of pharmacological interventions for smoking cessation: a literature review and a decision analytic analysis. *Med Decis Making.* 2002;22(5 suppl):S26-S37.

13. Warner KE. Cost effectiveness of smoking-cessation therapies. Interpretation of the evidence and implications for coverage. *Pharmacoeconomics.* 1997;11:538-549.

14. US Department of Labor, Bureau of Labor Statistics. Consumer price index home page. Available at: http://www.bls.gov/cpi/home.htm#data. Accessed June 26, 2005.

15. Pignone M, Saha S, Hoerger T, Mandelblatt J. Cost-effectiveness analyses of colorectal cancer screening: a systematic review for the US Preventive Services Task Force. *Ann Intern Med.* 2002;137:96-104.

16. McPhillips-Tangum C, Bocchino C, Carreon R, Erceg C, Rehm B. Addressing tobacco in managed care: results of the 2002 Survey. *Prev Chronic Dis.* 2004;1(4): A04. Epub 2004 Sep 15.

17. Fuhrmans V. Case grows to cover quitting. *Wall St J.* April 26, 2005; D: 1.

18. Orleans CT, Alper J. Helping addicted smokers quit: the Foundation's tobacco-cessation programs. In: Isaacs SL, Knickman JR, eds. *To Improve Health and Health Care.* Vol VI, Section III. San Francisco, Calif: Jossey-Bass; 2003: chap 6. Available at: http://www.rwjf.org/files/publications/books/2003/chapter_06.html. Accessed August 11, 2006.

19. The health consequences of smoking: a report of the Surgeon General. Atlanta, Ga: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2004.

20. Warner KE, Smith RJ, Smith DG, Fries BE. Health and economic implications of a work-site smoking-cessation program: a simulation analysis. *J Occup Environ Med.* 1996;38:981-992.

21. Halpern MT, Khan ZM, Young TL, Battista C. Economic model of sustained-release bupropion hydrochloride in health plan and work site smoking-cessation programs. *Am J Health Syst Pharm.* 2000;57:1421-1429.

22. Nielsen K, Fiore MC. Cost-benefit analysis of sustained-release bupropion, nicotine patch, or both for smoking cessation. *Prev Med.* 2000;30:209-216.

23. Javitz HS, Swan GE, Zbikowski SM, et al. Return on investment of different combinations of bupropion SR dose and behavioral treatment for smoking cessation in a health care setting: an employer's perspective. *Value Health.* 2004;7:535-543.

24. Warner KE, Mendez D, Smith DG. The financial implications of coverage of smoking cessation treatment by managed care organizations. *Inquiry.* 2004;41:57-69.

25. Giovino G, Pederson L, Trosclair A. The prevalence of selected cigarette smoking behaviors by occupational class in the United States. In: *Work, Smoking, and Health: A National Institute of Occupational Safety and Health (NIOSH) Scientific Workshop.* Washington, DC: NIOSH; 2000.

26. National Center for Health Statistics. National Health Interview Survey. Hyattsville, Md: National Center for Health Statistics; 1997-2002.

27. Center for Studying Health System Change. Community Tracking Study Household Survey. Washington, DC: Center for Studying Health System Change; 1996-1997.

28. Agency for Healthcare Research and Quality. Medical Expenditures Panel Survey. Rockville, Md: Agency for Healthcare Research and Quality; 2000-2002.

29. University of Michigan Institute for Social Research. Health and Retirement Survey. Ann Arbor, Mich: University of Michigan Institute for Social Research; 1998, 2000.

30. Gilpin EA, Pierce JP, Farkas AJ. Duration of smoking abstinence and success in quitting. *J Natl Cancer Inst.* 1997;89:572-576.

31. Arias E. United States life tables, 2000. *Natl Vital Stat Rep.* December 19, 2002;51(3):1-38.

32. Russell LB, Carson JL, Taylor WC, Milan E, Dey A, Jagannathan R. Modeling all-cause mortality: projections of the impact of smoking cessation based on the NHEFS. NHANES I Epidemiologic Follow-up Study. *Am J Public Health.* 1998;88: 630-636.

33. Levy DT, Friend K. A simulation model of policies directed at treating tobacco use and dependence. *Med Decis Making.* 2002;22:6-17.

34. Cummings KM, Hyland A. Impact of nicotine replacement therapy on smoking behavior. *Annu Rev Public Health.* 2005;26:583-599.

35. Jorenby DE, Leischow SJ, Nides MA, et al. A controlled trial of sustained-release bupropion, a nicotine patch, or both for smoking cessation [see comments]. *N Engl J Med.* 1999;340:685-691.

36. Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. *Cost Effectiveness in Health and Medicine.* New York: Oxford University Press; 1996.

37. Women and smoking: a report of the Surgeon General. Atlanta, Ga: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; March 2001:297-301.