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Impacts of a Smoking Cessation Benefit Among Employed Populations

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Learning Objectives

- Summarize the changes, if any, in numbers of cases of smoking-related diseases accompanying a smoking cessation benefit for a hypothetical cohort of 10,000 workers who reflect, geographically and by type of work, the U.S. population.
- Point out the economic effects of providing a smoking cessation benefit, taking into account both workplace and medical care cost savings and estimating the "return on investment."
- Infer the contributions made by prescription aids and counseling to the overall success of smoking cessation efforts.

Abstract

Objective: *The objective of this study was to project the health and economic impacts of providing a workplace smoking cessation benefit.* ***Methods:*** *The authors conducted an update of a previously published outcomes model using recently published data and clinical trial results.* ***Results:*** *In four example workplace types evaluated, coverage of a cessation benefit resulted in greater numbers of successful cessations and decreased rates of smoking-related diseases. Total savings from benefit coverage (decreased healthcare and workplace costs) exceeded costs of the benefit within 4 years. Total savings per smoker ranged from $350 to $582 at 10 years and $1152 to $1743 at 20 years. Internal rate of return ranged from 39% to 60% at 10 years.* ***Conclusion:*** *Providing a workplace smoking cessation benefit results in substantial health and economic benefits with economic savings exceeding the cost of the benefit within a relatively short period.* ***Clinical Significance:*** *Providing a workplace smoking cessation benefit is projected to increase the rate of smoking cessation as well as decrease the incidence of smoking-related conditions and healthcare costs. In addition, workplace cessation benefits can result in decreased absenteeism, increased productivity, and net cost savings within 4 years.* (J Occup Environ Med. *2007;49:11–21*)

Smoking results in 438,000 premature deaths, 5.5 million years of potential life lost, and over $75 billion in healthcare costs annually in the United States.[1] Beyond these effects on mortality and direct medical costs, smoking is also responsible for substantial workplace costs. Studies have demonstrated that smokers have considerably increased absenteeism, accidents, and injuries.[2–4] This leads to losses in workplace productivity, which may result in costs of 10s of billions of dollars.[1]

Employers can potentially reduce smoking-related costs by adopting smoking cessation programs. These programs include media campaigns, counseling sessions, support groups, and pharmacologic cessation aids.[5] A number of pharmaceuticals are currently available to help smokers stop smoking: transdermal nicotine, nicotine chewing gum, nicotine inhaler, and oral nonnicotinic agents. These alternatives may be used by themselves or with varying levels of counseling. Workplace smoking cessation programs offer many advantages to employees: increased convenience, reduced stigma, discounted or free pharmaceuticals and/or counseling (for companies that pay for all or part of the program), and a cohort of friends and coworkers for support.[6]

Halpern et al[7] evaluated the impact of smoking status on workplace costs using quantitative productivity data. In this study, data on the impact of smoking status (never, current, or former smoker) were prospectively collected among a population of airline reservation agents. Smokers had

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significantly higher absenteeism rates than former or never smokers. Among former smokers, productivity decreased shortly after cessation but increased to levels greater than those of smokers within 2 years.

A previous model evaluated direct and indirect costs associated with smoking cessation programs within a cohort of employees or health plan members.[8] The model was designed to be flexible and to accept user-specific values; for example, the user can specify the types of cessation interventions, their costs, and their success rates. Recently, varenicline, an alpha 4 beta 2 nicotinic receptor partial agonist,[9] has been approved to assist with smoking cessation. Because data on varenicline were not available during the development of the previous model, it is important to consider this new option in evaluating the health and economic impacts of workplace-based smoking cessation programs.

Study Objective

The objective of this study was to revise and update the previously developed economic model to evaluate the health and economic impacts of a smoking cessation benefit including varenicline compared with lack of such coverage for an employed population.

Materials and Methods

Model Structure

The structure of the smoking cessation model is illustrated in Figure 1. The model compares the clinical and economic outcomes for a hypothetical cohort of 10,000 workers. The model is designed to follow this cohort from the start of the model to retirement and to death, each treated separately. Retirement and death are assumed to occur at age 65 and 85 years, respectively. There is turnover within the model to reflect patterns of changing employment or healthcare program/insurance coverage; a 10% turnover is assumed each year. Individuals who are younger than 65 years at the time of leaving the model are replaced by new individuals of the same age and sex, whereas individuals who leave the model at retirement age or older are not replaced. Individuals who choose to quit smoking (whether or not they have a covered cessation benefit) can do so with varenicline, bupropion, nicotine patches, or without aids.

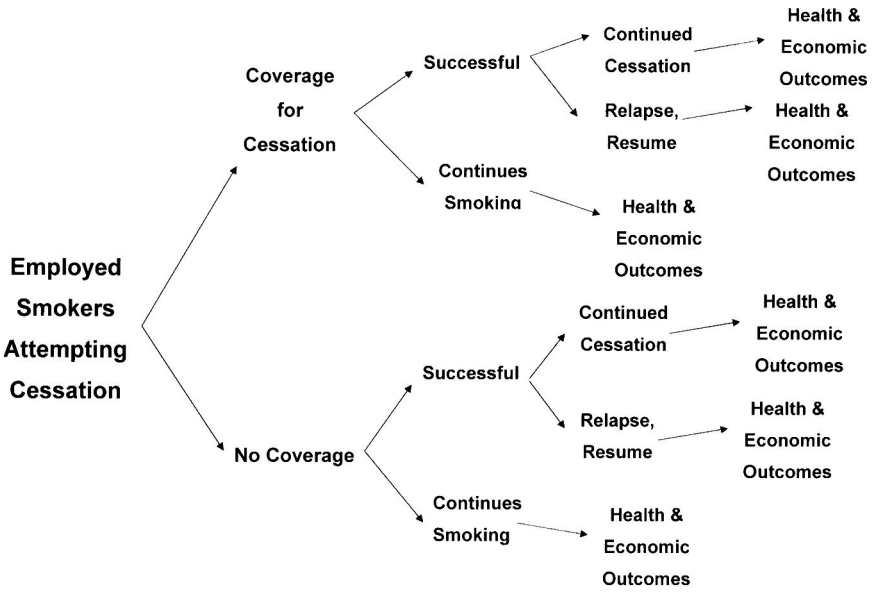

Fig. 1. Structure of the smoking cessation model.

Population Characteristics

The default population characteristics reflect the U.S. population. The distribution of individuals by age and gender, industry classification, and geographic region was derived from the 2005 U.S. Current Population Survey.[10] Age is presented as six cohorts: 18–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years, and 65 years and older. Thirteen industry classifications are included, also from the Current Population Survey: agriculture, forestry, and fishing; mining; construction; manufacturing; transportation and utilities; wholesale and retail trade; information; financial activities; business and professional services; education and health services; leisure and hospitality; public administration; and other services. The four geographic regions are those defined by the U.S. Census Bureau: Northeast, South, Midwest, and West.[11] For the results presented in this article, we chose four representative combinations of industries and geographic regions: business and professional services in the Northeast; education and health services in the West; manufacturing in the Midwest; and wholesale and retail trade in the South. Table 1 provides details of the characteristics of each of these cohorts.

The proportion of the workforce in each of the job classifications is determined based on the specified industry type and geographic region using data from the Current Population Survey.[10] The distribution of job classifications is used to determine an average hourly salary, which is then used in assessments of absenteeism and productivity (discussed subsequently).

Data on smoking status by age, gender, and geographic region (Northeast, Midwest, South, or West Census regions) were derived from the National Health Interview Survey (NHIS) 2003.[12] Smoking status in the NHIS is based on having ever smoked 100 cigarettes. Current smokers continue to smoke everyday or some days, whereas former smokers have smoked 100 cigarettes but no longer smoke. Logistic regression

TABLE 1
Characteristics of the Model Cohorts

Characteristic	Business and Professional Services, Northeast	Education and Health, West	Manufacturing, South	Wholesale and Retail Trade, Midwest
Percent male	59.5%	32.8%	69.6%	62.4%
Age distribution				
18–24	6.7%	7.0%	7.9%	13.0%
25–34	24.7%	21.7%	22.4%	24.3%
35–44	28.3%	24.8%	29.7%	25.6%
45–54	25.1%	28.3%	25.3%	23.7%
55–64	12.6%	16.5%	13.0%	10.8%
65+	2.6%	1.7%	1.7%	2.6%
Percent current smokers	32.0%	11.7%	32.0%	40.3%
Percent former smokers	28.9%	24.5%	26.1%	23.8%
Mean hourly salary	$20.80	$20.10	$15.48	$14.69

equations were then used to predict smoking status (current/former/never) based on age group, gender, geographic region, and industry; results from the regression analyses were used as default values in the model. Mortality data for men and women are from the National Center for Health Statistics' Life Tables.[13]

Smoking Cessation Intervention Effectiveness and Costs

Each year, whether or not a smoking cessation benefit is provided, 43% of current smokers will attempt to quit based on analysis of data from the 2003 NHIS.[12] If a smoking cessation benefit is provided, the model assumes that 14% of individuals attempting to quit smoking will use a prescription aid; with no covered benefit, 7% will use a prescription aid.[8] Sensitivity analyses were performed both on the proportion of smokers attempting cessation and the proportion of individuals attempting cessation who use a prescription aid. In either case, we assumed that the use of prescription aids was divided equally between the two available medications approved for smoking cessation, varenicline and bupropion, because varenicline has been recently approved for use in the United States and the eventual relative rates of use for these products is unknown. Sensitivity analyses were also performed on the relative rates of use of varenicline versus bupropion. Among individuals not using a prescription aid, 30% will use nonprescription nicotine replacement therapy (NRT) and 70% will attempt smoking cessation with no pharmacologic aid.[8] Whether or not a smoking cessation benefit is covered, individuals attempting cessation using a pharmacologic aid will also receive at least a minimal counseling session as recommended in current guidelines.[14] The model makes the conservative assumption (ie, involving the least initial cost to the employer) that the employer will not specifically promote the smoking cessation benefit or the covered prescription aids; promotion of the benefit or aids would be expected to increase participation in the program and use of the prescription aids, resulting in greater benefits association with cessation coverage.

Rates of cessation with varenicline and bupropion are based on clinical trial data provided by Pfizer Inc. (data on file). Effectiveness for NRT is based on a study by Jorenby et al[15] and cessation with no aids is based on Cromwell et al.[16] The cessation rates for varenicline, bupropion, and NRT are based on clinical trials involving low to moderate counseling (a single session of approximately 10 minutes). For coverage of a workplace cessation benefit, we therefore assumed that patients quitting without pharmacologic aids would also receive a single 10-minute counseling session. We also assumed that smokers attempting cessation without a covered cessation benefit would receive only the minimal level of counseling if using a pharmacologic aid and no counseling if attempting cessation without aids.[8] Based on the Cromwell et al study, cessation rates for individuals receiving NRT and minimal counseling were 1.7% lower than the rates for individuals receiving NRT and low to moderate counseling.[16] Therefore, the rates of successful cessation using pharmacologic aids for smokers without a cessation benefit (who receive only minimal counseling) are 1.7% lower than the rates for smokers with a benefit, and their cost per cessation attempt is also lower (reflecting the cost for the lower level of associated counseling). This reduction in cessation rate with minimal versus low to moderate counseling is explored in sensitivity analyses.

There are no adverse event costs associated with pharmacologic aids (prescription or nonprescription) included in the model, because it is assumed that adverse events would be self-limiting and would not require additional medical attention. This assumption is applied equally to all pharmacologic aids in the model.

Costs for counseling were based on Medicare national allowable average reimbursements for moderate counseling sessions (CPT 99402)[17] and were updated to 2005 values. Costs for bupropion and NRT (nicotine patches) were based on wholesale acquisition cost (WAC), which

was assumed to be 80% of the average wholesale prices from the 2005 *Red Book*.[18] The WAC for varenicline is $3.20 per day (Pfizer Inc., personal communication). Durations of therapy for varenicline and bupropion were 12 weeks based on the clinical trials from which the effectiveness data were obtained. Duration of therapy for NRT was obtained from the Jorenby et al study,[15] which included use of nicotine patches for 9 weeks. It was assumed that employers offering a smoking cessation benefit would cover the cost for a counseling session and the cost of varenicline or bupropion minus standard prescription copayments ($8.00 per copayment, three copayments for each) but would not cover the cost of over-the-counter nicotine patches. We also conservatively assumed that employers not offering a smoking cessation benefit would not cover the costs of any prescription aids or counseling, although these may be covered if associated with different diagnosis codes. Details of the costs and effectiveness for the four smoking cessation methods as well as overall for coverage or no coverage of a smoking cessation benefit are presented in Table 2. Overall, coverage of the cessation benefit increased the effectiveness (rate of quitting success) at 1 year by approximately 2.9% and increased the cost per cessation attempt by approximately $109.

Recidivism

Many smokers need more than one quit attempt to successfully quit smoking. Rates of recidivism (relapse into smoking) are the same as in the previous cessation model; they are based on the number of years since quitting and use the 1989 Surgeon General's Report on Smoking and Health.[19] These rates apply to smokers who successfully quit smoking in the model; that is, they achieved sustained cessation at 1 year after the cessation attempt. The default values for recidivism by years since cessation, with or without coverage, are 14% at 2 years since cessation, 10.5% at 3 years, 3.4% at 4 years, 3.0% at 5 years, 1.5% at 6 to 11 years, and 0.0% after 11 years.

Smoking-Related Condition Rates

The model reflects the higher rates of various smoking-related conditions, in particular ischemic heart disease, cerebrovascular disease, chronic airway obstruction, and lung cancer. Disease incidence by age group for each condition for the overall U.S. adult population was determined using the 2003 NHIS[12] except for lung cancer incidence, which was determined based on estimates from the Centers for Disease Control and Prevention (CDC).[20] The relative risk values for each condition by smoking status were derived from the Smoking-Attributable Morbidity, Mortality, and Economic Consequences application developed by the CDC.[21] The relative risk for ischemic heart disease (International Classification of Diseases, 9th Revision [ICD-9] 410–414, 429.2) and cerebrovascular disease (ICD-9 430–438) are provided separately for individuals aged 35 to 64 and those 65 and older, whereas a single relative risk is provided for cancers of the trachea, lung, and bronchus (ICD-9 162) and chronic airway obstruction (ICD-9 496).[22]

The model also incorporates pregnancy complications related to smoking. Rates of complications of pregnancy are derived from DiFranza and Lew (rate of spontaneous abortion by smoking status)[23] and Marks and colleagues (rate of low birth weight).[24] The model assumes that nonsmokers and former smokers have the same rate of pregnancy complications. In addition, it assumes that 46% of pregnant smokers temporarily quit during pregnancy[25] and have the same rate of pregnancy complications as nonsmokers. Age-specific rates of pregnancy and induced abortion are derived from the National Vital Statistics Report.[26]

Medical Care Costs

The costs of medical care for current smokers and nonsmokers are derived from recent publications detailing these costs. All costs have been inflated to 2005 U.S. dollars. Baseline healthcare costs for individuals by age, gender, and smoking status

TABLE 2
Effectiveness and Costs of Smoking Cessation Interventions

	With Cessation Benefit			Without Cessation Benefit		
	One-Year Effectiveness	Covered Cost per Quit Attempt*	Total Cost per Quit Attempt*	One-Year Effectiveness	Covered Cost per Quit Attempt*	Total Cost per Quit Attempt*
Varenicline	22.5%	$317.84	$341.84	20.8%	$0.00	$311.58
Bupropion	15.5%	$341.74	$365.74	13.8%	$0.00	$335.48
Nicotine replacement therapy	9.8%	$73.04	$243.90	8.1%	$0.00	$213.64
No aids	3.2%	$73.04	$73.04	1.3%	$0.00	$0.00
Overall average	7.1%	$108.99	$156.43	4.3%	$0.00	$82.25

*Including prescription medication and counseling.

were based on Hodgson et al.[27] The Hodgson study provides healthcare costs for smokers versus never smokers. The cost for former smokers is incorporated into the Hodgson estimate of smokers. Current smokers likely have higher costs than former smokers; thus, the model may overestimate the costs of former smokers and underestimate those of current smokers. In accordance with standard economic analysis methods, costs are discounted annually at 3% and no cost inflation factor is included.

Worksite Effects

Absenteeism and productivity losses due to smoking were based on a prospective study conducted by Halpern et al.[7] In this study, the number of incremental days of absenteeism due to illness over a 12-month period reported by former smokers compared with never smokers was 1.07; the number of incremental days missed by current smokers compared with never smokers was 2.66. Data from this study were also used to estimate the decreased productivity among current smokers included in the model, which averaged 4.5%. Costs associated with changes in absenteeism and productivity were determined by average hourly salaries, obtained from the Current Population Survey,[10] based on the proportion of individuals in various job classifications for a specified industry type and geographic region. Like with medical care costs, workplace costs were discounted annually at 3% and no inflation factor was included.

Results

Table 3 presents the changes in model health outcomes for each of the four scenarios. With coverage of smoking cessation aids, the cumulative number of successful long-term smoking cessations increases; this increase is observed within the first 2 years of the model. Increases in successful smoking cessations and other health outcome changes are least for the education and health services cohort, reflecting the substantially lower rate of smoking in this group (12% vs 32% to 40% in the other cohorts). Over the 20-year model period, the numbers of coronary heart disease (CHD) cases, chronic obstructive pulmonary disease (COPD) cases, and lung cancer cases avoided with a smoking cessation benefit are approximately 27, 23, and 2, respectively, for the education and health cohort. For the other three cohorts, with greater proportions of smokers, the number of CHD cases avoided over the 20-year model period ranges from 78 to 94, the number of COPD cases avoided ranges from 51 to 61, and the number of lung cancer cases avoided ranges from 6.3 to 7.5.

Table 4a presents the change in economic outcomes associated with a smoking cessation benefit. Coverage of a smoking cessation benefit resulted in costs ranging from approximately $106,000 to $367,000 in the first 2 years with continuing but lower incremental costs over subsequent years. However, coverage of the benefit also resulted in increased successful cessation (as presented in Table 2) and medical care cost savings. After 10 years of providing a cessation benefit, healthcare cost savings range from approximately $403,000 to over $1.1 million. Over the 20-year model period, these healthcare savings range from approximately $1 million for the education and health services cohort to

TABLE 3
Changes in Health Outcomes With Coverage of Smoking Cessation

Health Outcome and Time Interval (yr)	Business and Professional Services, Northeast	Education and Health, West	Manufacturing, South	Wholesale and Retail Trade, Midwest
No. of additional smoking cessations				
2 yr	74.6	27.3	74.7	94.1
5 yr	176.2	64.9	176.1	221.5
10 yr	324.5	119.7	323.7	408.1
20 yr	565.2	205.8	563.8	716.8
No. of coronary heart disease cases avoided				
2 yr	0.5	0.2	0.5	0.6
5 yr	4.0	1.5	4.3	4.7
10 yr	22.1	8.1	24.0	26.4
20 yr	78.3	27.3	83.8	93.5
No. of chronic obstructive pulmonary disease cases avoided				
2 yr	0.3	0.1	0.3	0.3
5 yr	2.2	1.0	2.2	2.7
10 yr	13.8	6.2	13.7	16.2
20 yr	52.2	22.7	51.0	61.2
No. of lung cancer cases avoided				
2 yr	0.03	0.01	0.03	0.04
5 yr	0.25	0.09	0.26	0.30
10 yr	1.62	0.62	1.72	1.91
20 yr	6.30	2.35	6.62	7.47

TABLE 4
Incremental Costs and Cost Savings With Coverage of Smoking Cessation

Cost Category and Time Interval (yr)	Business and Professional Services, Northeast	Education and Health, West	Manufacturing, South	Wholesale and Retail Trade, Midwest
Incremental costs and cost savings with coverage of smoking cessation				
Increased cessation costs				
2 yr	$291,701	$106,641	$291,996	$367,596
5 yr	$674,726	$248,467	$675,110	$848,854
10 yr	$1,193,490	$440,336	$1,193,322	$1,502,226
20 yr	$1,900,065	$694,272	$1,898,295	$2,404,458
Health cost savings				
2 yr	$34,343	$12,935	$33,679	$37,542
5 yr	$297,638	$117,295	$302,193	$324,395
10 yr	$1,025,497	$403,217	$1,051,195	$1,127,724
20 yr	$2,728,048	$1,054,758	$2,695,280	$2,902,911
Workplace cost savings				
2 yr	$79,075	$27,824	$58,901	$70,410
5 yr	$620,520	$224,707	$473,080	$563,863
10 yr	$1,983,902	$715,328	$1,524,316	$1,782,921
20 yr	$4,670,315	$1,669,943	$3,519,565	$4,146,684
Health plus workplace cost savings				
2 yr	$113,418	$40,758	$92,580	$107,953
5 yr	$918,158	$342,001	$775,272	$888,259
10 yr	$3,009,399	$1,118,545	$2,575,511	$2,910,646
20 yr	$7,398,363	$2,724,702	$6,214,845	$7,049,595
Incremental costs per smokers and cost savings per smoker with coverage of smoking cessation				
Increased cessation costs				
2 yr	$91	$92	$91	$91
5 yr	$211	$213	$211	$210
10 yr	$373	$378	$373	$372
20 yr	$594	$596	$593	$596
Health cost savings				
2 yr	$11	$11	$11	$9
5 yr	$93	$101	$94	$80
10 yr	$321	$346	$328	$280
20 yr	$853	$905	$841	$720
Workplace cost savings				
2 yr	$25	$24	$18	$17
5 yr	$194	$193	$148	$140
10 yr	$620	$614	$476	$442
20 yr	$1460	$1433	$1099	$1028
Health plus workplace cost savings				
2 yr	$35	$35	$29	$27
5 yr	$287	$294	$242	$220
10 yr	$941	$960	$804	$722
20 yr	$2313	$2339	$1940	$1748

over $2.9 million for the wholesale and retail trades cohort.

As presented by Halpern et al,[7] smoking cessation also results in decreased absenteeism and increased productivity, leading to workplace cost savings. These workplace cost savings are greater than the medical care cost savings for all four cohorts. In the four groups, workplace savings range from 57% to 63% of total projected savings. Over the 20-year period, total savings (medical plus workplace) are projected to range from approximately $2.7 million for the education and health services cohort to almost $7.4 million for the wholesale and retail trade cohort.

The second half of Table 4 provides the same information as the first half but presents economic results in terms of cost or cost savings per smoker. Cessation costs are essentially identical across the four modeled cohorts. The increase in cessation costs over time reflects both multiple cessation attempts by a single smoker as well as individuals who successfully quit smoking, leave the model, and are replaced by new smokers. Healthcare savings per smoker range form $280 to $346 at 10 years and reach over $900 in one group at 20 years. Combined health and workplace savings per smoker are between $200 and $300 at 5 years, range from $722 to $960 by 10 years, and go from $1748 to more than $2300 by 20 years.

Figures 2A and 2B present the increased cessation costs versus the projected cost savings over time for

the first modeled scenario, business and professional services in the Northeast. In Figure 2A, only healthcare cost savings are considered. In this comparison, coverage of a smoking cessation benefit produces net cost savings in 12 years. However, as illustrated in Figure 2B, including workplace costs substantially decreases the time to the "break-even" point; in this comparison, savings from healthcare plus workplace costs equal the additional costs of the cessation benefit in approximately 4 years. After this point, provision of a smoking cessation benefit results in net savings for the employer.

Table 5 presents return on investment (ROI) and internal rate of return (IRR) metrics for the four scenarios at 10 and 20 years after initiation of a smoking cessation benefit. ROI represents the incremental amount of money saved over a given time period relative to the incremental amount of money spent on cessation. For example, if a cessation intervention costs $10,000 and saves $5000 in healthcare costs, the resultant ROI is $5000 divided by $10,000, or 50%. An ROI of greater than 100% indicates that an investment has returned more than it cost. As presented in Table 5, at 10 years, the ROI of the smoking cessation benefit considering only healthcare costs ranges from 75% to 92%, indicating that healthcare savings alone have repaid more than three fourths of the investment. As noted in Figure 2A, the break-even point, considering only healthcare costs, is not until approximately year 12. Considering healthcare plus workplace costs, the ROI at year 10 ranges from 194% to 254%, indicating that the cessation benefit has returned $1.94 to $2.54 for every dollar invested. By year 20, the ROI for healthcare costs is also greater than 100% with returns for just healthcare costs ranging from $1.21 to $1.52 for every dollar spent on cessation.

Table 5 also presents IRR, the interest rate that would make the net cash flow (spending money on cessation and saving money in healthcare and workplace expenditures) zero. That is, the IRR is the return a company would need to receive on the money it invests in cessation to equal the return it receives from resultant savings. Examining only the healthcare savings associated with a smoking cessation benefit, the IRR is negative at 10 years, indicating that the incremental cost of the benefit is more than the associated savings in healthcare costs. However, including healthcare and workplace costs, the IRR at 10 years ranges from 39% to 60%. By 20 years, the IRR considering just healthcare costs ranges from 5.5% to 12.1%, whereas the IRR for both healthcare and workplace costs ranges from 43% to 61%.

To evaluate the impact of a number of assumptions included in this model, sensitivity analyses were performed on key model parameters. Results from sensitivity analyses for the business and professional services in the Northeast scenario at 10 years are presented in Table 6. As expected, increasing or decreasing the proportion of smokers who attempt cessation each year by 50% has a substantial effect on the number who achieves successful cessation and associated costs and savings. Increasing the proportion of smokers attempting cessation has a slightly greater impact on changes in cessation costs (approximately 43%) than on changes in healthcare savings (41%), but the time to break even is not substantially different (data not shown). Increasing or decreasing the proportion of smokers attempting cessation using a prescription aid

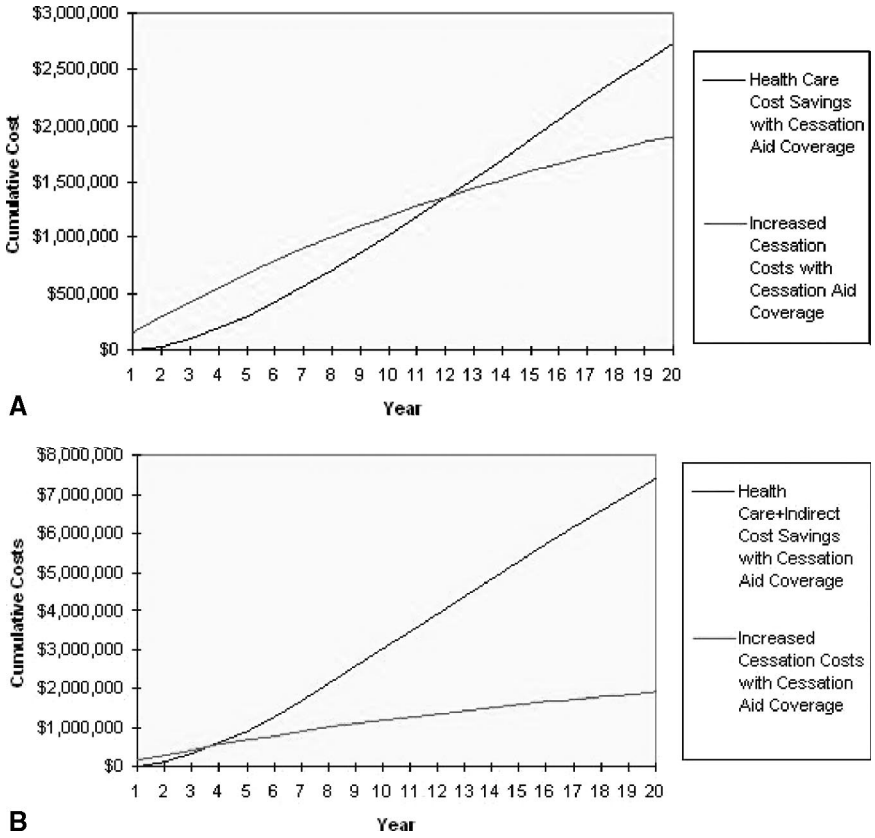

Fig. 2. (A) Time to break-even, healthcare costs only. Increased cessation costs versus projected cost healthcare cost savings over time for the first modeled scenario, business and professional services in the Northeast. In this comparison, coverage of a smoking cessation benefit produces net cost savings in 12 years. (B) Time to break-even, healthcare plus workplace costs. Increased cessation costs versus projected cost healthcare plus workplace cost savings over time for the first modeled scenario, business and professional services in the Northeast. In this comparison, savings from healthcare plus workplace costs equal the additional costs of the cessation benefit in approximately 4 years.

TABLE 5
Return on Investment and Internal Rate of Return for Coverage of Smoking Cessation

Time Interval (yr)	Business and Professional Services, Northeast	Education and Health, West	Manufacturing, South	Wholesale and Retail Trade, Midwest
10 years				
ROI—health only	85.9%	91.6%	88.1%	75.1%
ROI—health + workplace	252.2%	254.0%	215.8%	193.8%
IRR—health only	−8.6%	−4.9%	−7.0%	−16.6%
IRR—health + workplace	58.9%	59.5%	45.9%	38.7%
20 years				
ROI—health only	143.6%	151.9%	142.0%	120.7%
ROI—health + workplace	389.4%	392.5%	327.4%	293.2%
IRR—health only	10.3%	12.1%	10.3%	5.5%
IRR—health + workplace	60.8%	61.4%	48.8%	42.5%

ROI indicates return on investment; IRR, internal rate of return.

TABLE 6
Sensitivity Analysis of Model Assumptions (based on outcomes from the business and professional services in the Northeast scenario at 10 yr)

Sensitivity Analysis (base model values)	No. of Additional Smoking Cessations With Coverage	Increased Cessation Costs With Coverage	Health Cost Savings With Coverage	Workplace Cost Savings With Coverage
Base model	324.5	$1,193,490	$1,025,497	$1,983,902
Proportion of smokers attempting cessation (43%)				
64.5%	449.2	$1,710,982	$1,441,321	$2,854,485
21.5%	175.6	$624,987	$572,224	$1,061,241
Proportion of smokers attempting cessation using a prescription aid (14% with cessation coverage, 7% without coverage)				
21% and 10.5%, respectively	372.1	$1,372,630	$1,229,266	$2,368,313
7% and 3.5%, respectively	274.0	$1,009,610	$852,043	$1,649,578
Proportion of smokers attempting cessation using a prescription aid who use varenicline (50%)				
75%	336.4	$1,180,513	$1,111,809	$2,123,898
25%	311.8	$1,206,568	$981,937	$1,897,416
Proportion of smokers attempting cessation *not* using a prescription aid who use nicotine replacement therapy vs no pharmacologic aid (30% and 70%, respectively)				
15% and 85%, respectively	343.9	$1,207,163	$1,084,866	$2,088,490
45% and 55%, respectively	304.9	$1,180,070	$1,020,198	$1,952,275
Decrease in effectiveness of pharmacologic aids with minimal counseling vs low/moderate counseling (1.7%)				
0.85%	287.9	$1,193,490	$952,414	$1,820,424
2.55%	360.6	$1,193,490	$1,141,478	$2,208,032
Increased absenteeism of current and former smokers vs never smokers (2.66 and 1.07 d, respectively)				
1.33 and 0.54 d, respectively	324.5	$1,193,490	$1,025,497	$1,860,470
3.99 and 1.61 d, respectively	324.5	$1,193,490	$1,025,497	$2,105,784
Decreased productivity of current smokers vs former and never smokers (4.5%)				
2.25%	324.5	$1,193,490	$1,025,497	$1,114,608
6.75%	324.5	$1,193,490	$1,025,497	$2,853,195

(with or without coverage) by 50% also shows changes in the expected directions, but the change in healthcare savings (approximately 20%) is greater than the change in cessation costs (15%). This reflects the greater likelihood of success associated with cessation attempts using prescription aids. Changes in the relative proportion of smokers using prescription cessation aids who use varenicline versus bupropion had little impact on model projections; this impact would be greater if more smokers used prescription aids to attempt cessation.

Among smokers who do not use prescription aids for cessation, the proportion using NRT (as opposed to no pharmacologic aid) was halved and doubled. Although the impacts of these changes are small, the results are opposite what might be expected: decreasing the proportion of smokers using NRT increased the number of additional successful cessations with coverage. This reflects the differences in the proportions of smokers who use NRT in the coverage versus no coverage models. With coverage of a smoking cessation benefit, 14% of smokers will use a prescription aid, whereas 86% will use either NRT or no aid. Without coverage, 7% of smokers will use a prescription aid, whereas 93% will use NRT or

no aid. Thus, the impact of reducing the proportion of smokers using NRT is greater among those without coverage, and the difference in successful cessation between coverage and no coverage increases when the rate of NRT use in both models decreases.

As stated in the "Methods" section, we assumed that smokers attempting cessation without coverage would receive minimal/no counseling versus low/moderate counseling for those attempting cessation with coverage; among those using a pharmacologic aid, minimal/no counseling was associated with a 1.7% lower success rate than was low/moderate counseling. This difference in the rate of successful cessation with pharmacologic aids was increased and decreased by 50%. Decreasing the difference to 0.85% (ie, making the rate of successful cessation without coverage closer to the rate with coverage), the number of additional cessations with coverage decreased by approximately 11%. The cost difference remained the same, because the number of smokers attempting cessation was the same as the base model; the difference is in the proportion of those attempting who achieve success. Healthcare and workplace saving with coverage versus no coverage decreases as well. Increasing the difference between minimal/no counseling and low/moderate counseling to 2.55%, the reverse is seen; more smokers successfully quit with coverage, and cost savings are greater. Thus, the model is somewhat sensitive to the level of counseling offered to smokers attempting cessation with and without coverage and the expected difference in success based on the offered counseling.

The final sensitivity analyses evaluated changes in model assumptions on workplace parameters (absenteeism and productivity). These analyses changed only the workplace savings associated with coverage of a smoking cessation program. Increasing or decreasing the additional number of days of absenteeism for current and former smokers by 50% had relatively minor impacts on model projections. However, increasing or decreasing the impact of smoking on workplace productivity had substantial impacts. Thus, model projections are sensitive to assumption regarding changes in productivity between current and former/never smokers. Further work should be performed to provide additional details on this factor.

Discussion

To our knowledge, this is the first study to project the economic and outcomes impacts to employers of covering a smoking cessation benefit including varenicline compared with no coverage of cessation aids or counseling. Using this model, we found that although coverage of a cessation benefit increases costs related to cessation, it will also produce substantial offsets from decreased healthcare and workplace costs. Considering the total costs affecting an employer, we project that coverage of a smoking cessation benefit would result in net cost savings starting at 4 years. These results remained constant across different employer scenarios. Model projects were sensitive to the proportion of smokers attempting cessation, the proportion using prescription aids, the level and effectiveness of counseling offered to smokers with versus without cessation coverage, and the impact of cessation on workplace productivity.

There are a number of limitations to this model. First, the model compares coverage of a full cessation benefit with no coverage of smoking cessation aids or counseling. This can be considered an extreme comparison in that employers may choose to cover partial cessation benefits (eg, counseling only). Even if an employer does not specifically cover any prescription cessation aids or counseling for smoking cessation, it is likely that a subset of smoking employees will receive these under their current health insurance associated with diagnosis codes for other medical conditions. For example, even if an employer does not cover pharmacologic aids for smoking cessation, bupropion may be covered if prescribed in association with a diagnosis of depression. Thus, the increased cessation costs associated with the benefit in this model are a conservative projection representing a "worst case" scenario.

Second, the only effects associated with the smoking cessation benefit in the model are for smoking cessation; no impact of the benefit (either pharmacologic aids and/or counseling) on recidivism (returning to smoking after cessation) is included. Because varenicline is a nicotinic receptor partial agonist,[9] this agent may also affect recidivism rates. As additional data on recidivism with varenicline and other pharmacologic interventions are collected, the model can be updated to incorporate these effects.

Third, employee populations are not homogenous. There is likely to be substantial variation in employee smoking behaviors, interest in cessation, and related factors even within a single geographic region and industry type. However, the values used to define the employee populations in this model were derived from the NHIS, a nationally representative survey, and are thus likely to broadly represent employee groups. Similar results were observed among varying geographic regions and industry types, indicating that the projected health and economic benefits of smoking cessation coverage are not limited to a single area or type of employer. In addition, the impacts of smoking cessation on additional days of workplace absenteeism used in this model (2.66 additional days for current smokers and 1.07 days for former smokers compared with never smokers) were collected from airline reservation agents.[7] However, these values are very similar to those reported by Tsai et al from a different employed population, chemical and refinery workers (2.9 additional days for current smokers and 1.3 additional days for former smokers).[28] Thus, the workplace benefits of a particular smoking cessation program are likely the be relatively

similar across different worksites and employee populations.

This model was based in large part on a previous model evaluating the impacts of a workplace cessation benefit.[8] Outcomes presented from that model focused on the entire "working life" of a group of employees from their current age to retirement at age 65. In this model, we have focused on shorter periods (2–20 years) to provide information for employers that need to make decisions based on relatively short-term impacts. Like in the previous model, we have demonstrated that coverage of a smoking cessation benefit is a good investment. When considering the total range of costs (workplace and health care) experienced by employers, coverage of a cessation benefit becomes cost saving by year 4 and provides substantial returns on this investment over 10 to 20 years.

Few other studies have evaluated the economic and health impacts of a workplace cessation benefit; however, a number studies have assessed a particular smoking cessation intervention or program based in the workplace. Javitz et al[29] evaluated the impact on employers of two doses of sustained-release bupropion in combination with two levels of counseling. These researchers found that use of bupropion resulted in competitive levels of return on investment. Nielsen and Fiore[30] also evaluated bupropion for smoking cessation use from an employer's perspective and found it cost-effective or cost-beneficial compared with nicotine replacement therapy or placebo. Warner et al[31] also noted that workplace smoking cessation interventions can be a good investment, eventually resulting in cost–benefit ratios greater than one (ie, net savings). A recent review by the Cochrane Collaboration concluded that substantial evidence exists supporting workplace interventions such as pharmacologic treatment and counseling, whereas self-help interventions are less effective.[32]

Coverage of smoking cessation benefits is likely to become more common over time. In 2000, the U.S Public Health Service recommended that employers provide insurance coverage for smoking cessation treatments.[33] By 2003, 44% of state governments reported covering smoking cessation treatments,[34] although this rate is likely lower among private sector employers. Because employers are playing an increasing role in designing the health benefits available to their workers, information on the range of workplace costs affected by smoking and smoking cessation is crucial for making informed decisions. The results presented in the study provide additional support for coverage of workplace smoking cessation benefits and allow employers to estimate the health and economic impacts such coverage would have on their workforce over time. Given the tremendous health benefits of smoking cessation as well as the resultant economic savings, we hope that these results will encourage employers to provide smoking cessation assistance.

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