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SPECIAL ARTICLE

Economic Impact of Financial Incentives and Mailing Nicotine Patches to Help Medicaid Smokers Quit Smoking: A Cost–Benefit Analysis

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An RCT designed to increase Medicaid smokers' quitting success was conducted in California during 2012–2013. In the trial, alternative cessation treatment strategies were embedded in the state's ongoing quitline services. It found that modest financial incentives of up to $60 per participant and sending nicotine patches induced significantly higher cessation rates compared with usual care alone and usual care plus nicotine patches. Building upon that study, this study assessed potential population-level costs and benefits of integrating financial incentives and nicotine patches in a quitline setting for Medicaid smokers. A cost–benefit analysis was undertaken from the Medicaid program's perspective. The Cardiovascular Disease Policy Model was used to simulate future healthcare expenditures over a 10-year horizon for each treatment strategy for a study cohort of California Medicaid enrollees who were aged 35–64 years in 2014 (n=2,452,000). To simulate potential population-level benefits under each treatment strategy, each treatment was applied to all active smokers in the study cohort (n=478,300). Sensitivity analyses were conducted by varying key parameters, such as cessation costs, discount rate, relapse rates, and time horizon. Adding both financial incentives and nicotine patches to usual quitline care would result in $15 million net savings over 10 years, with a benefit–cost ratio of 1.30 compared with the usual care plus nicotine patches strategy. It would yield $44 million net savings, with a benefit–cost ratio of 1.90 compared with usual care alone. The strategy of providing financial incentives and mailing nicotine patches directly to Medicaid smokers who call the quitline is cost saving.

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INTRODUCTION

Medicaid recipients smoke at rates nearly double those of the general population.[1,2] In the U.S., while adult smoking prevalence declined significantly from 20.9% in 2005 to 15.5% in 2016,[3,4] it remained almost unchanged among Medicaid recipients during 1997–2013 (from 33.8% to 31.8%).[5] This disproportionately higher smoking prevalence places Medicaid recipients at greater risk for smoking-related morbidity and mortality. Nearly a quarter of the total smoking-attributable healthcare costs in the nation ($170 billion in 2010) were

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reimbursed by Medicaid, representing about 15% of annual Medicaid spending.[6,7]

California has the longest running and largest comprehensive tobacco control program in the nation, and its success has led to substantially lower smoking rates compared with the rest of nation, not only among the general population but also among certain subpopulations.[8–11] Among Medicaid recipients, smoking prevalence in California is also much lower than the national average (17.4% vs 25.3% in 2016).[12] Nonetheless, even in California, the disparity in smoking rate between Medicaid recipients and the general population still exists (17.4% vs 9.7% in 2016).[12] Because of the Medicaid expansion under the Affordable Care Act, the Medi-Cal (California's Medicaid program) population increased to more than 13 million individuals, nearly one third of Californians, in 2016.[13] As a result, the proportion of the state's adult smokers covered by Medi-Cal more than doubled from 19.3% in 2011–2012 to 41.2% in 2016.[14] To reduce smoking prevalence and the smoking-attributable health burden for the Medicaid population, it is important to implement effective smoking-cessation interventions to assist Medicaid smokers in quitting.

Toward this end, the California Department of Health Care Services launched the Medi-Cal Incentives to Quit Smoking (MIQS) program in 2011. Aimed at increasing smoking cessation among Medi-Cal smokers, the MIQS program included outreach strategies to motivate Medi-Cal smokers to call the California Smokers' Helpline and also an RCT to compare cessation treatment strategies that could be integrated into the ongoing Helpline services to increase Medi-Cal callers' success in quitting. There were two alternative treatment strategies. One strategy offered modest financial incentives (FIs) to encourage callers to complete the quitline counseling protocol, as well as nicotine patches (NPs) in addition to usual Helpline services. Although Medi-Cal already covers the cost of NPs, the MIQS program allowed the patches to be mailed directly to participants' homes. The other strategy included only home-mailed NPs and usual Helpline services. Anderson et al.[15] showed that offering both FIs and NPs to quitline callers induced significantly higher quit rates than usual care (UC) plus NPs or UC alone, but there was no significant difference in quit rates between the latter two strategies. Their findings raise the policy relevant question of whether it is cost effective and cost saving to integrate FIs and NPs into the quitline treatment for Medicaid smokers.

Despite growing evidence in the U.S. showing that providing FIs for smoking cessation is effective to increase cessation rates,[16–19] little has been done to evaluate whether providing FIs for smoking cessation is cost effective or cost saving, except a few cost-effectiveness studies conducted outside the U.S.[20,21] Studies have shown that providing free NPs adjunct to quitline services or physician counseling is cost effective,[22–26] but these studies did not address home-mailed NPs and FIs. In a broader context, a few studies in the U.S. have evaluated the economic implications of comprehensive smoking-cessation programs.[27–30] Richard and colleagues[27] estimated that comprehensive coverage for pharmacotherapy and counseling in the Massachusetts Medicaid program yielded medical care savings of $3.12 for every $1 of program costs (i.e., benefit–cost ratio of 3.12) after 2.5 years. McCallum et al[28] estimated that covering counseling and nicotine replacement therapy for Alabama Medicaid beneficiaries achieved a net savings within 2 years, with a benefit–cost ratio of 1.95. Using data from three large MCOs, Warner and colleagues[29] simulated that covering smoking-cessation treatment in MCOs would induce a net loss, costing $0.61 per member per month over a 5-year period. Rumberger et al.[30] assessed the feasibility of adopting statewide smoking-cessation programs in Pennsylvania and estimated potential benefit–cost ratios varying from 0.97 to 2.76, depending upon the type of interventions. The mixed findings from these studies highlight the need for more research to understand the economic impact of smoking-cessation programs.

The goal of this study is to assess potential population-level costs and benefits of providing both FIs and NPs to Medicaid smokers in a quitline setting. Given that California's Medi-Cal population is larger than the population of many other states, the findings from this study will provide policy makers evidence-based knowledge about the financial implications of integrating alternative cessation interventions within a real-world quitline setting to increase quit rates in the Medicaid population.

METHODS

The Medi-Cal Incentives to Quit Smoking Program RCT

The trial upon which this economic evaluation is based recruited 3,816 Medi-Cal smokers who called the Helpline between July 2012 and May 2013. Participants were randomized to into three treatment groups: (1) UC of a standard five-session protocol,[31] including a 30-minute pre-quit counseling session and four 5- to 10-minute follow-up counseling sessions; (2) UC plus mailing NPs to participants' home; and (3) UC plus offering FIs of up to $60 per participant and mailing NPs. These groups are referred to as UC (n=1,004), UC+NP (n=1,405), and UC +FI+NP (n=1,407). The details, including the eligibility of participants, exclusion criteria, randomization, and study design of the trial, are published elsewhere.[15]

Economic Evaluation

A cost–benefit analysis was undertaken that analyzed Scenario 1: compare the UC+FI+NP treatment with the UC+NP treatment; and Scenario 2: compare the UC+FI+NP treatment with the UC treatment.

Cost–benefit analysis is an economic evaluation method assessing whether the costs of an intervention can be justified by the value (in monetary terms) of the benefits it provides. This cost–benefit analysis focused on the short-term costs and benefits of the UC+FI+NP treatment relative to other treatments from the Medi-Cal program's perspective. This perspective was used because the MIQS program was implemented by Medi-Cal to determine how to decrease smoking among its recipients. Benefits of smoking cessation were defined as the averted future healthcare expenditures due to quitting smoking, after adjusting for additional healthcare expenditures for quitters who live longer and experience normal aging-related costs.[32–34] Costs of providing cessation services included intervention program costs (e.g., FIs and postage for mailing NP kits to participants' homes) and cessation treatment costs (counseling, NPs, and other tobacco-cessation medications). The incremental benefit (cost) was the difference in benefits (costs) between the UC+NP+FI treatment and other treatment.

The two primary outcome measures of this analysis are net savings and benefit–cost ratio. Net savings were calculated by subtracting the incremental cost from the incremental benefit for the UC+NP+FI treatment versus other treatment. The benefit–cost ratio was calculated by dividing the incremental benefit by the incremental cost. A ratio greater than one indicates that benefits exceed costs. A ratio less than one indicates that costs exceed benefits.

Benefits of Smoking Cessation

Simulation modeling. This study used the Cardiovascular Disease (CVD) Policy Model to simulate the impact of smoking cessation on future healthcare expenditures under each treatment for a cohort of California Medicaid enrollees. The CVD Policy Model is a computer simulation, state-transition (Markov) model of coronary heart disease and stroke incidence, prevalence, mortality, and costs, designed for U.S. adults aged 35 years and older.[35–40] For this study, the CVD Policy Model was applied to the California cohort. The model separates the population into those with and without a history of CVD, including coronary heart disease (angina, myocardial infarction, and cardiac arrest) and stroke. The population without prior CVD is stratified into clusters by age, gender, and CVD risk factors: smoking status, overweight or obesity status, diabetes, systolic blood pressure, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol. The model predicts the incidence of coronary heart disease or stroke, and non–CVD-caused death each year according to age, gender, and CVD risk factors using risk functions estimated from the 1971–2001 Framingham Original and Offspring Cohort data.[41,42] Smoking cessation in those without prior CVD has a direct effect on the probability of transitioning to incident coronary heart disease, stroke, or non-CVD death, as well as an indirect effect on these outcomes through changes in other CVD risk factors.[43,44] The population with prior CVD has annual rates of recurrent CVD events or CVD deaths, with transition probabilities dependent on CVD history, age, and gender as determined from natural history studies[45] and hospital databases; and these annual rates were calibrated to achieve total events or deaths of coronary heart disease and stroke observed in 2010 U.S. vital statistics.[46–48]

The model estimates inpatient costs for acute CVD events and procedures (fatal and non-fatal myocardial infarctions, strokes, cardiac arrests, and revascularizations) using the 2008 California Patient Discharge data[49]; and total healthcare costs for chronic CVD, non-CVD diseases, and injuries using national estimates from the 1999–2008 Medical Expenditure Panel Survey data, assuming that the unit costs are the same in California and the rest of the U.S.[50] All costs are indexed to 2010 using the medical care component of the Consumer Price Index and, for this study, were converted into 2015 dollars using an inflation factor of 1.17 based on the Consumer Price Index for medical care (Table 1).[51]

Input parameters and data sources. Using data from the 2014 California Health Interview Survey (CHIS), the authors identified the study cohort of all Medi-Cal enrollees aged 35–64 years in 2014 (n=2,452,000). The 2013–2014 CHIS data were used to obtain the prevalence of active smoking, overweight and obesity, diabetes, and pre-existing CVD among Medi-Cal adults by gender and 10-year age categories. Because the CHIS does not include clinical measures and serum collection, estimates for systolic blood pressure, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol were generated using the 2011–2016 National Health and Nutrition Examination Surveys data for U.S. adults of low SES, by gender and 10-year age categories, as a proxy for the Medi-Cal population.[55] The incidence of coronary heart disease, stroke, and non-CVD death, initially determined using Framingham data,[41,42] was adjusted to reflect the distribution of CVD risk factors assumed for the Medi-Cal population.

This study used 180-day continuous smoking abstinence rates of 19.3% for the UC+FI+NP group, 15.8%

Table 1. Input Parameters, Assumptions, and Sources Used in the CVD Policy Model for the Base Case

Parameter	Estimate	Sources
Size of initial (2014) Medi-Cal cohort	2,451,523	2014 CHIS
Number of current smokers in 2014	478,336	2013–2014 CHIS smoking prevalence
180-day continuous abstinence rate (%)		Anderson et al.[15]
Helpline UC+FI+NP	19.3	
Helpline UC+NP	15.8	
Helpline UC	14.1	
Estimated number of 180-day quitters		2013–2014 CHIS smoking prevalence applied to 2014 total CHIS population
Helpline UC+FI+NP	92,300	
Helpline UC+NP	75,600	
Helpline UC	67,400	
Annual relapse rate among 180-day quitters		Hawkins et al.[52] and an unpublished study
Year 1	17.7	
Year 2	11.4	
Year 3	9.2	
Year 4	6.1	
Year 5	5.2	
Year 6	5.0	
Year 7	4.0	
Year 8	2.1	
Year 9	1.9	
Year 10	1.6	
Year 11 and beyond	0	
Healthcare cost inflation factor (from 2010 to 2015 dollars)	1.17	Bureau of Labor Statistics, CPI–medical care[51]
Discount rate	3%	Haddix et al.[53]; Weinstein et al.[54]

CHIS, California Health Interview Survey; CPI, Consumer Price Index; CVD, cardiovascular disease; FI, financial incentive; Medi-Cal, California Medicaid program; NP, nicotine patch; UC, usual care.

for the UC+NP group, and 14.1% for the UC group from a study of the MIQS program RCT,[15] to estimate the number of 180-day quitters under each treatment (Table 1). From a published British study[52] and an unpublished U.S. study using the 2002–2003 longitudinal Tobacco Use Supplement to Current Population Survey data, authors estimated that after the initial 180-day abstinence, 17.7% of these quitters will relapse in the subsequent year (Table 1). As the length of abstinence increases, the annual relapse rate will decline sharply, and it will be zero in year 11 and after.

To simulate potential population-level benefits under each treatment, each treatment was applied to all active smokers in 2014 (n=478,300) in the study cohort. In the base case, a time horizon of 10 years was assumed. It was also assumed that the average annual healthcare costs (in 2015 dollars) remain constant through future years per acute CVD event or procedure per person for those with chronic CVD, and per person for those with non-CVD diseases or injuries. The projected future healthcare costs were discounted to the present value using a real social discount rate of 3%.[53,54]

Costs of Providing Smoking-Cessation Services

On average, participants in the UC+NP+FI and UC+NP groups received 6 weeks of NPs at a total cost of $81. It was assumed that the cost of patches for those UC group participants who reported using NPs to assist their quitting is also $81, and those who reported using other medication also used 6 weeks of that medication. The cost of 6-week gum, lozenge, bupropion, and varenicline was estimated at $116, $146, $227, and $499, respectively, based on the Pharmacologic Product Guide.[56] The first telephone counseling session cost $70, and each follow-up counseling session cost $40, according to California Smokers' Helpline data.

The FIs were only offered to participants in the UC+NP+FI group to motivate them to complete all five counseling sessions. A $20 gift card was sent immediately after participants completed the first counseling call. The second card, the value of which was determined by the number of follow-up counseling sessions they completed ($10 per call, up to a maximum of $40), was sent 6 weeks after enrollment.[15] At the time of the trial, there was an outreach campaign to incentivize Medi-Cal

smokers to call the Helpline and ask for a $20 gift card, which they would receive only if they completed the first counseling session. Approximately one fifth of participants in the three groups requested and received this advertised $20 gift card.[15]

Applying the unit cost to the percentage of participants who used the corresponding type of cessation aids,[15] and then incorporating the value of gift card with the percentage of participants who received that card,[15] the average cost of providing smoking-cessation services per participant for each group was derived.

Sensitivity Analysis

Several sensitivity analyses were conducted. First, the discount rate was changed from 3% to 0% or 5%. Second, the cessation costs were varied by minus or plus 25%. Third, the inflation factor was changed, from 1.17 (Consumer Price Index for medical care) to 1.082 (Personal Consumption Expenditures Index for health care).[57] Fourth, the relapse rates were varied according to the assumption adopted by a cost–benefit study of Alabama's Medicaid smoking-cessation programs[28] and two studies about relapse rates.[58,59] Specifically, it was assumed that the annual relapse rate will be 10% in year 1, 4% in years 2–6, and 2% in years 7–10; it will be zero in year 11 and after. Finally, the time horizon was varied from 10 years to 5, 20, or 30 years.

Statistical Analysis

The CVD Policy Model's inputs such as smoking prevalence, and the means and prevalence values of other CVD risk factors were derived from weighted analyses of CHIS or National Health and Nutrition Examination Surveys data accounting for survey sampling weights. The β coefficients for the risk functions between CVD risk factors and incident coronary heart disease, incident stroke, and non-CVD death were generated from Framingham data using a separate Cox proportional hazards model, with censoring at first event. Using Monte Carlo methods, 95% CIs were constructed for the base case results from 1,000 probabilistic iterations, each taking random draws from the distributions of the β coefficients for the risk functions.

RESULTS

Costs of Smoking-Cessation Services

The average cost of providing smoking-cessation services per participant was estimated to be $464.08 for the UC+NP+FI treatment, $364.02 for the UC+NP treatment, and $361.16 for UC (Table 2). Therefore, the incremental cessation cost per participant is $100.06 for the UC+NP+FI versus UC+NP treatment and $102.92 for the UC+NP+FI versus UC treatment.

Cost–Benefit Analysis

CVD Policy Model simulations that applied the UC+FI+NP treatment to all Medi-Cal active smokers in the study cohort under base-case assumptions resulted in total projected 10-year healthcare expenditures of $28,068 million, including $7,290 million in CVD-related expenditures and $20,778 million in non–CVD-related expenditures (Table 3). This 10-year projection is $62 million lower than those under the UC+NP treatment, and $94 million lower than those under UC. Therefore, the 10-year incremental benefits are $62 million for Scenario 1 and $94 million for Scenario 2.

Applying the average per participant cost of providing the UC+FI+NP treatment to all active Medi-Cal smokers in the study cohort, the authors estimated that the one-time total cessation cost is $222 million for the UC+FI +NP treatment, $174 million for the UC+NP treatment, and $173 million for UC. Therefore, the one-time total incremental cessation costs are $48 million for Scenario 1 and $49 million for Scenario 2.

Given the estimated incremental costs and benefits, over a 10-year period, the UC+FI+NP treatment would result in $15 million (95% CI=$6 million, $23 million) net savings with a benefit–cost ratio of 1.30 (95% CI=1.14, 1.48) compared with the UC+NP treatment. It would yield $44 million (95% CI=$32 million, $57 million) net savings with a benefit–cost ratio of 1.90 (95% CI=1.66, 2.16) compared with UC.

Sensitivity Analysis

For Scenario 1, varying the discount rate, cessation costs, healthcare cost inflation factor, or relapse rates for the 10-year simulation consistently showed a positive net savings with benefit–cost ratios ranging from 1.04 to 1.74 (Table 4). Varying time horizon showed a net loss in the short term (5 years). Even though there will be a benefit of $38 million in averted healthcare expenditures within 5 years, these reduced healthcare expenditures are not enough to recoup the one-time incremental cessation costs of $48 million. The benefit–cost ratios peak at 1.76 for the 20-year time horizon, generating a net savings of $37 million. Using 30-year time horizon for assessing a steady-state or life-time outcome,[29] the net savings are $32 million with a benefit–cost ratio of 1.67.

The sensitivity analyses for Scenario 2 show robust results: net savings are all positive under a wide range of assumptions. Within 5 years, this scenario will show a net savings of $9 million with a benefit–cost ratio of 1.18. Similar to Scenario 1, the magnitudes of the net

Table 2. Costs of Providing Smoking-Cessation Services

Variable	Unit cost ($)	Percentage of participants who use cessation aids or received incentives[a]		
		UC+NP+FI	UC+NP	UC
Pharmacotherapy				
Patch (6-week)	81[b]	89.4[d]	86.5[d]	51.8
Gum (6-week)	116[c]	7.1	6.3	6.3
Lozenge (6-week)	146[c]	1.8	1.2	2.7
Bupropion (6-week)	227[c]	4.9	3.7	4.5
Varenicline (6-week)	499[c]	10.0	10.8	15.8
Counseling				
First call	70	95.5	89.9	93.2
Number of follow-up calls[e]	40			
Mean		6.2	5.1	4.9
Median		5	4	4
Incentives for counseling				
$20 gift card for first call	20	95.5	21.3	19.7
Incentives for follow-up calls				
1 call	10	7.4[e]		—
2 calls	20	9.7[e]		—
3 calls	30	14.3[e]		—
≥ 4 calls	40	58.0[e]		—
Mailing cost per gift card	3[b]			
Average cessation costs per participant, $		464.08[f]	364.02[g]	361.16[h]

[a]*Source:* Anderson et al.[15]
[b]*Source:* California Smokers' Helpline program.
[c]*Source:* Pharmacologic Product Guide.[56]
[d]Because nicotine patches were delivered to the homes of all participants, patch costs are calculated for 100% of participants in this group.
[e]Among those who completed the first counseling.
[f]$81*1 + $116*0.071 + $146*0.018 + $227*0.049 + $499*0.1 + $70*0.955 + ($40+$3)*5*0.955 + ($20+$3)*0.955 + ($10+$3)*0.074 + ($20+$3)*0.097 + ($30+$3)*0.143 + ($40+$3)*0.58.
[g]$81*1 + $116*0.063 + $146*0.012 + $227*0.037 + $499*0.108 + $70*0.899 + $40*4*0.899 + ($20+$3)*0.213.
[h]$81*0.518 + $116*0.063 + $146*0.027 + $227*0.045 + $499*0.158 + $70*0.932 + $40*4*0.932 + ($20+$3)*0.197.
FI, financial incentive; NP, nicotine patch; UC, usual care.

savings and benefit–cost ratios increase over time up to the 20-year time horizon.

DISCUSSION

This economic evaluation found that the strategy of providing modest FIs and mailing NPs directly to Medicaid smokers who call the quitline is cost saving. Compared with adding only home-mailed NPs to UC, this strategy will induce a net savings of $15 million with a benefit–cost ratio of 1.30 over a 10-year period. Compared with UC alone, this strategy would yield a net savings of $44 million with a benefit–cost ratio of 1.90 over 10 years.

These findings are consistent with two other U.S. cost–benefit studies of smoking-cessation programs. Richard and colleagues[27] found that comprehensive coverage for pharmacotherapy and counseling for Massachusetts Medicaid beneficiaries yielded a net savings with a benefit–cost ratio of 3.12 in 2.5 years. McCallum et al.[28] found that covering counseling and nicotine replacement therapy for Alabama Medicaid beneficiaries achieved a net savings with a benefit–cost ratio of 1.95 within 2 years. This study showed that the UC+NP+FI versus UC treatment would yield positive savings, though the savings would not occur as quickly. In addition to different study designs, the difference in timing and magnitude of results is due to the highly effective quitline in California,[31] whereby the UC group in this study has a relatively high quit rate compared with the control groups in the aforementioned studies. Also, the participants in the MIQS program RCT may have been more motivated to quit smoking than the Medicaid population in other states because of the strong anti-smoking environment in California. This study compared the outcomes of alternative cessation treatments with an already effective cessation treatment, whereas these two studies compared the outcomes of introducing a

Table 3. Cost–Benefit Analysis Results Under Base-Case Assumptions Over a 10-year Time Horizon

Treatment alternative	Total cessation costs, $ millions	Projected 10-year healthcare expenditures among all active smokers in 2014 in the study cohort, $ millions,[a,b] M (95% CI)			Net savings, $ millions,[a,b] M (95% CI)	Benefit–cost ratio, M (95% CI)
		CVD-related	Non–CVD-related	All		
UC+FI+NP	221.98	7,290.33 (7,265.98 to 7,314.96)	20,778.03 (20,642.33 to 20,864.58)	28,068.36 (27,935.27 to 28,155.73)		
UC+NP	174.11	7,306.62 (7,284.91 to 7,327.21)	20,824.14 (20,691.65 to 20,908.38)	28,130.76 (28,001.89 to 28,214.89)		
UC	172.75	7,314.87 (7,294.79 to 7,333.62)	20,847.12 (20,715.36 to 20,929.65)	28,161.99 (28,034.44 to 28,245.55)		
Difference (Δ)						
Scenario 1: UC+FI+NP vs UC+NP	47.86	−16.29 (−12.50 to −20.00)	−46.11 (−38.46 to −53.25)	−62.40 (−54.37 to −70.81)	14.54 (6.49 to 22.93)	1.30 (1.14 to 1.48)
Scenario 2: UC+FI+NP vs UC	49.23	−24.53 (−18.84 to −30.12)	−69.09 (−57.60 to −79.80)	−93.62 (−81.58 to −106.26)	44.39 (32.36 to 57.04)	1.90 (1.66 to 2.16)

[a]In 2015 dollars.
[b]Healthcare expenditure estimates are discounted to the present (i.e., year 1, which is 2015 for this study).
CVD, cardiovascular disease; FI, financial incentive; NP, nicotine patch; UC, usual care.

cessation program where one had not previously been in effect. Therefore, their benefit–cost analyses were based on a larger effect size of treatment as reflected in the incremental quit rates (12.7 percentage points from the Massachusetts study,[27,60] and 28 percentage points from the Alabama study[28]) compared with this study (5.2 percentage points). Finally, the present study assumed relatively high relapse rates, whereas these other studies assumed either no relapse,[27] or lower relapse rates.[28] The present study's sensitivity analysis using lower relapse rates showed larger cessation-induced healthcare savings.

The present study's sensitivity analyses of varying the time horizon showed that healthcare expenditures would decrease within 5 years by $38 million because of the increased number of quitters under Scenario 1, and by $58 million under Scenario 2. These findings are consistent with a simulation study showing that a 1% reduction in adult (aged 35–64 years) smoking prevalence would lead to an immediate medical cost savings of $44 million in the next year through prevented acute myocardial infarctions and strokes,[61] and an RCT showing that successful quitters showed lower healthcare costs than continuing smokers starting the sixth quarter post-cessation.[62] Also, the present study found that, for both scenarios, the accumulated savings in healthcare expenditures increase over time, peak for the 20-year time horizon, and then decline for the 30-year time horizon. These findings are consistent with a study in Finland showing that if all smokers quit, healthcare costs would initially decrease but after 15 years there would be a net increase in healthcare costs.[63]

The present study's cost–benefit analysis was undertaken from the Medi-Cal program's perspective. Previous U.S. cost–benefit studies evaluating smoking-cessation programs were conducted from the state government's perspective,[27,28,30] health provider's perspective,[29] or employer's perspective.[64–66] None were from a societal perspective. From the societal perspective, the costs of smoking-cessation programs would also include lost tax revenues, and lost retail revenues because smokers will no longer purchase cigarettes.[30] As a result of increased number of quitters, society would also benefit from years of life gained,[34,67] the value of improved workplace productivity because of reduced absenteeism, future earnings from successful quitters, reduced healthcare expenditures for smokers' nonsmoking family members or friends who were exposed to their secondhand smoke, and reduced suffering from smoking-related illness. Other societal "benefits" of smoking cessation include the longer-term impact on Social Security payments, Medicare spending, pension payments, and life insurance programs.[33,68,69] Although long-term costs and benefits are certainly of interest, there

Table 4. Cost–Benefit Analysis Results Under Sensitivity Analysis Assumptions

Variable	Sensitivity analysis value	Scenario 1: UC+FI+NP vs UC+NP				Scenario 2: UC+FI+NP vs UC			
		Incremental cessation costs, $ millions	Incremental healthcare expenditures, $ millions	Net savings, $ millions	Benefit–cost ratio	Incremental cessation costs, $ millions	Incremental healthcare expenditures, $ millions	Net savings, $ millions	Benefit–cost ratio
Given 10-year time horizon									
Discount rate	0%	47.86	−69.80	21.94	1.46	49.23	−104.71	55.48	2.13
Discount rate	5%	47.86	−58.23	10.37	1.22	49.23	−87.38	38.15	1.77
% change in cessation costs per participant	−25	35.90	−62.40	26.51	1.74	36.92	−93.62	56.70	2.54
% change in cessation costs per participant	+25	59.83	−62.40	2.58	1.04	61.54	−93.62	32.09	1.52
Healthcare cost inflation factor[a]	1.082	47.86	−57.71	9.85	1.21	49.23	−86.58	37.35	1.76
Alternative relapse rates	[b]	47.86	−73.53	25.67	1.54	49.23	−107.43	58.20	2.18
Time horizon									
5-year[c]	5 years	47.86	−38.49	−9.37	0.80	49.23	−57.85	8.62	1.18
10-year (base case)	10 years	47.86	−62.40	14.54	1.30	49.23	−93.62	44.39	1.90
20-year[c]	20 years	47.86	−84.41	36.55	1.76	49.23	−126.04	76.81	2.56
30-year[c]	30 years	47.86	−79.95	32.09	1.67	49.23	−119.22	69.99	2.42

[a]From 2010 to 2015 dollars.
[b]Assuming that the annual relapse rate is 10% for year 1, 4% for years 2–6, 2% for years 7–10, and zero for year 11 and after.
[c]All other parameters remain the same as in the base case analysis.
FI, financial incentive; NP, nicotine patch; UC, usual care.

is a need to consider the more immediate impacts of smoking cessation relevant to the policy makers in the state. Because a key purpose of the MIQS Program was to determine ways to reduce Medi-Cal costs and whether the Medi-Cal program should offer increased incentives for smoking cessation to its beneficiaries, the authors chose to include those costs and benefits that are relevant to the Medicaid program in California.

As Medicaid enrollment rises, more and more smokers are Medicaid recipients. The lack of change in high smoking prevalence among Medicaid enrollees highlights the urgent need for effective tobacco control initiatives to reduce their smoking rates. Increasing tobacco taxes and non-price measures, such as smoke-free laws, were shown to be more cost effective than nicotine-replacement therapies.[70] The California Tobacco Control Program includes multipronged comprehensive tobacco control programs, such as tobacco taxation, an anti-smoking media campaign, smoke-free policies, and initiatives to change social norms against smoking. Its success has led to significantly lower smoking prevalence compared with the national average.[8–11,71,72] Nonetheless, even in California, disparities in smoking prevalence still exist between Medicaid recipients and the non-Medicaid population. Both national and California data show that Medicaid smokers are just as likely as non-Medicaid smokers to make a quit attempt; but their successful cessation rates are lower.[5,14] This suggests that targeted cessation interventions for Medi-Cal smokers to increase their success in quitting are needed.

Limitations

This study is subject to several limitations. First, nursing home costs were not included in the model because data were unavailable. Therefore, the estimated benefits are likely underestimated. Second, at the time of the MIQS trial, there was an outreach campaign to incentivize Medi-Cal smokers to call the Helpline. About one fifth of participants in the UC and UC+NP groups requested and received the incentivized $20 gift card, thus possibly reducing the detectable effect size of the UC+FI+NP versus other treatments in quit rates,[15] which might affect estimated benefits. Third, the relapse rates were assumed based on a British study[52] and unpublished U.S. estimates. Relapse rates specific to California and Medicaid populations are unknown and require future research. Fourth, it was assumed that all active Medi-Cal smokers had already called the quitline and received a particular treatment. Although all active smokers will certainly not call the quitline, this assumption would affect the magnitude of the net savings but not the benefit–cost ratio because its numerator and denominator would be affected in the same way.

CONCLUSIONS

Medi-Cal is one of ten Medicaid programs in the country that now covers all Food and Drug Administration–approved evidence-based tobacco-cessation treatments.[2] However, the increase in Medi-Cal enrollment as a result of the Affordable Care Act and the elevated cigarette smoking prevalence among Medi-Cal enrollees make it urgent to implement innovative strategies to increase smoking cessation among Medicaid smokers to reduce mortality, morbidity, and healthcare costs. This study provides supportive evidence that the strategy of providing modest FIs and mailing NPs directly to Medicaid smokers who call the quitline not only increases cessation rates, but is also cost saving within 5 years.

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HYS wrote the first draft of this article, estimated input parameters, and finalized the analytic plan. NDK was principal investigator for the overall grant and approved the study design. WM and SHZ refined the study design. WM and KB-D conceptualized and coordinated the study. JP performed all of the simulation analyses of the economic modeling. SHZ and SEC contributed to data collection for input parameters. All authors reviewed the findings, edited the drafts of the article, and approved the final version.

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