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Medicaid Coverage for Tobacco Dependence Treatments in Massachusetts and Associated Decreases in Smoking Prevalence

Thomas Land[1]*, Donna Warner[1], Mark Paskowsky[1], Ayesha Cammaerts[2], LeAnn Wetherell[2], Rachel Kaufmann[3], Lei Zhang[3], Ann Malarcher[3], Terry Pechacek[3], Lois Keithly[4]

1 Massachusetts Tobacco Control Program, Boston, Massachusetts, United States of America, **2** Office of Medicaid Commonwealth of Massachusetts, Boston, Massachusetts, United States of America, **3** Office on Smoking and Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America, **4** Massachusetts Tobacco Control Program, Boston, Massachusetts, United States of America

Abstract

Background: Approximately 50% of smokers die prematurely from tobacco-related diseases. In July 2006, the Massachusetts health care reform law mandated tobacco cessation coverage for the Massachusetts Medicaid population. The new benefit included behavioral counseling and all medications approved for tobacco cessation treatment by the U.S. Food and Drug Administration (FDA). Between July 1, 2006 and December 31, 2008, a total of 70,140 unique Massachusetts Medicaid subscribers used the newly available benefit, which is approximately 37% of all Massachusetts Medicaid smokers. Given the high utilization rate, the objective of this study is to determine if smoking prevalence decreased significantly after the initiation of tobacco cessation coverage.

Methods and Findings: Smoking prevalence was evaluated pre- to post-benefit using 1999 through 2008 data from the Massachusetts Behavioral Risk Factor Survey (BRFSS). The crude smoking rate decreased from 38.3% (95% C.I. 33.6%–42.9%) in the pre-benefit period compared to 28.3% (95% C.I.: 24.0%–32.7%) in the post-benefit period, representing a decline of 26 percent. A demographically adjusted smoking rate showed a similar decrease in the post-benefit period. Trend analyses reflected prevalence decreases that accrued over time. Specifically, a joinpoint analysis of smoking prevalence among Massachusetts Medicaid benefit-eligible members (age 18–64) from 1999 through 2008 found a decreasing trend that was coincident with the implementation of the benefit. Finally, a logistic regression that controlled for demographic factors also showed that the trend in smoking decreased significantly from July 1, 2006 to December 31, 2008.

Conclusion: These findings suggest that a tobacco cessation benefit that includes coverage for medications and behavioral treatments, has few barriers to access, and involves broad promotion can significantly reduce smoking prevalence.

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* E-mail: Thomas.Land@state.ma.us

Introduction

Cigarette smoking continues to be the leading cause of preventable morbidity and mortality in the United States [1]. Despite recent overall declines in smoking prevalence in the United States, the prevalence in the Medicaid population – the health insurance program for the poor - has remained 65% higher than in the rest of the population [2,3]. In Massachusetts alone, smoking causes $1 billion annually in excess health care costs to the Medicaid program. In April 2006, the Massachusetts legislature passed Chapter 58 of the Acts of 2006 (“An Act Providing Access to Affordable, Quality, Accountable Health Care”) requiring all individuals in Massachusetts to have health insurance. In an effort to reduce smoking prevalence in the Medicaid population, the law mandated coverage for two types of tobacco cessation treatment: behavioral counseling and all Food and Drug Administration (FDA)-approved medications. Prior to 2006, MassHealth (the Massachusetts Medicaid program) did not provide tobacco cessation benefits.

With the implementation of this benefit, MassHealth subscribers are allowed two 90-day courses per year of FDA-approved medications for smoking cessation, including OTC medications like nicotine replacement therapy, and up to 16 individual or group counseling sessions. Medications require written prescriptions following an office visit. Prior authorization is not required to prescribe the nicotine patch, gum, lozenge, Chantix, or bupropion/Wellbutrin. With prior authorization, the nicotine inhaler and nasal spray may also be covered. The co-payment is minimal at $1.00 or $3.00. Detailed information on the benefit design and reimbursement rates is available at www.makesmokinghistory.org/quitworks/masshealth.html. A total of 70,140 unique MassHealth subscribers used the newly available benefit between July

1, 2006 and December 31, 2008, i.e., approximately 37% of all Medicaid smokers. All utilization data reported in this paper were obtained from MassHealth claims data.

It is the objective of this study to determine if smoking prevalence decreased in the Massachusetts Medicaid population after the initiation of mandated tobacco cessation coverage.

Methods

Data Source

The Behavioral Risk Factor Surveillance System (BRFSS) is the largest continuously conducted telephone health surveillance system of adults in the world [4]. The BRFSS is a state-based, cross-sectional telephone survey conducted by state health departments with technical and methodological assistance provided by the Centers for Disease Control and Prevention (CDC). BFRSS surveys focus data collection on behaviors, in contrast to attitudes or knowledge. States use BRFSS data to identify emerging health problems, establish health objectives, and track their progress toward meeting these objectives [4].

Main Outcome Measures

Although the BRFSS covers a wide variety of questions about health behaviors, this work focuses on responses to questions about tobacco use. Smoking status is divided into three groups: current smokers, former smokers, and never smokers. Current smokers are defined as having smoked at least 100 cigarettes in their lifetimes and smoke currently. Former smokers are defined as having smoked at least 100 cigarettes in their lifetimes but did not smoke currently. Individuals who have not smoked at least 100 cigarettes in their lifetimes were classified as never smokers. Quit attempts were measured by counting individuals who had stopped smoking for 1 day or more during the preceding 12 months in an attempt to quit. Recent quits were counted using individuals who had stopped smoking within the previous 12 months.

Other Variables of Interest

Unlike most states, the Massachusetts BFRSS includes health insurance questions. These questions make it possible to distinguish respondents by insurance status including coverage by MassHealth. Because the MassHealth tobacco cessation benefit was limited to subscribers between the ages of 18–64, this study was also limited to MassHealth subscribers ages 18–64. Approximately one in six (16%) Massachusetts BRFSS survey respondents identify their health insurance as MassHealth, the Massachusetts Medicaid program.

Statistical Analysis

This study is fundamentally ecological in nature; therefore, it was not possible to link specific utilization behavior with individual quits or quit attempts. Consequently, this analysis will look at the available BRFSS data from three perspectives in order to provide greater confidence in the results reported. Tests of proportional differences were followed by a trend analysis which was followed by logistic regression.

At the most basic level, differences in proportions were evaluated using t-tests. Since health care reform legislation in Massachusetts expanded eligibility for the MassHealth program, difference estimates were computed for population samples that were adjusted for demographic changes in the post-benefit period. Demographically-adjusted rates were calculated in such a way that the demographic characteristics of the post-benefit period (July 1, 2006 – December 31, 2008) were forced to match those in a specified pre-benefit period (January 1, 2003 – June 2006). Adjustments were made for age, gender, education, and race/ethnicity. Age was grouped into 5 categories: 18–24, 25–34, 35–44, 45–54, and 55–64 year olds. Education status was classified as (1) less than a high school education, (2) high school graduate or GED, (3) 1 to 3 years of college, or (4) 4+ years of college. Race/ethnicity was categorized as (1) white, non-Hispanic or (2) other.

For all tests of proportional differences, the sample population used in the pre-benefit period included only MassHealth subscribers despite an increase in MassHealth enrollment post-benefit. By December 2008, the number of adults covered by MassHealth increased by 11.3% when compared to 2006 levels. A 2009 Kaiser Commission study estimated that 76,000 previously uninsured adults received coverage through MassHealth by December 2008 [5]. Since the increased enrollment in MassHealth was only slightly higher than the 76,000 estimated by Kaiser, it would be tempting to include all uninsured adults in any analysis of the pre-benefit period. However, the Kaiser report also estimates that more than four times as many previously uninsured adults (354,000) obtained insurance coverage through other programs. The majority obtained private health insurance or used the state's subsidized insurance program (Commonwealth Care). As a result, including uninsured adults in the pre-benefit population would likely overestimate the impact of the uninsured within the total MassHealth population.

In addition to tests of proportions involving smoking prevalence, quit attempts as well as the success of those attempts also were examined. It was hypothesized that a result indicating a decrease in smoking prevalence that was coincident with the implementation of the MassHealth tobacco cessation benefit could occur for two reasons. First, more smokers could be making quit attempts. Or second, more smokers could be making successful quit attempts.

Trend analyses were computed using joinpoint analysis. The National Cancer Institute publishes joinpoint analysis software as a tool for assessing public health trends. More information on joinpoint analysis is available at the National Cancer Institute website at http://srab.cancer.gov/joinpoint/. The joinpoint software takes trend data and fits the simplest joinpoint model that the data will allow. No minimum or maximum joinpoints were specified for the models used in this analysis, thereby allowing the joinpoint software to select the most appropriate model for the data. The basic data element of the joinpoint analysis was a demographically-adjusted smoking prevalence estimate. These were computed for each six month period between 1999 and 2008.

Compared to the analysis of differences in proportions described above, a longer time period was used for the joinpoint analysis. This decision was made because a shorter time period would have reduced the likelihood of finding multiple joinpoints in the pre-benefit period. It was considered important to know whether post-benefit smoking prevalence levels in the MassHealth population had been matched in some earlier period. A longer time period increased the likelihood of seeing trends that would contradict the hypothesis that decreased prevalence might be attributed to the initiation of cessation coverage.

Finally, a logistic regression was computed so as to make individual level adjustments for demographics. Here, the target variable was current smoking status as recorded by the BRFSS. In addition to demographic variables, two more variables were added to the logistic model to assess trends. First, a monthly sequential variable from January 1999 to December 2008 was included. This was used to measure long-terms trends in prevalence. Second, a monthly sequential variable beginning in July 2006 and ending December 2008 was also included to capture trends that were limited to the post-benefit period. The demographic variables used in the analysis were gender, race/ethnicity, education status, and age which could account for changes in demographics.

Table 1. Comparison of Pre-, Post-Benefit Periods on Smoking Prevalence And Quitting Behavior.

	Pre-Benefit Period January 1, 2003 to June 30, 2006		Post-Benefit Period January 1, 2008 to December 31, 2008			
Measure	**Crude%**	**95% C.I.**	**Crude %**	**95% C.I.**	**Dem-Adj %**	**95% C.I.**
Current smoking	38.3	33.6 – 42.9	28.3*	24.0–32.7	28.8*	24.3 – 33.3
Quit Attempt	62.6	55.9 – 69.4	67.2	59.6 – 74.8	67.6	60.5 – 74.7
Recent Quit Success	6.6	3.8 – 9.3	18.9*	10.2 – 27.7	19.1*	13.0 – 25.2

*Statistically significant at the .05 level.
Data Source: BRFSS 2003 – 2008.
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The BRFSS survey has a multistage probability sample design. BRFSS data are directly weighted for the probability of selection of a telephone number, the number of adults in a household, and the number of telephones in a household. A final post-stratification adjustment is made for non-response and non-coverage of households without telephones. The weights for each factor are multiplied together to get a final weight. All reported estimates were weighted using statistical analysis software (SAS version 9.1). The a priori significance level used for statistical tests was 0.05.

Results

Smoking prevalence was examined in the MassHealth population from 1999 through 2008 using the Behavioral Risk Factor Surveillance System (BRFSS). The number of BRFSS respondents who were eligible for the benefit (i.e., MassHealth members aged 18 to 64) ranged from 402 respondents in 1999 to 1,969 respondents in 2008. Depending on the specific analysis, different time periods were studied.

It should be noted that the BRFSS relies on self-reports including questions about insurance status. To test the accuracy of self-reports about insurance, Massachusetts conducted a call-back survey with a subset of BRFSS respondents in 2007. The second call to the respondent took place an average of 31 days after the first call. The call-back survey found that more than 90% of respondents who had previously indicated that they had MassHealth coverage were able to confirm the presence of a valid MassHealth logo on their insurance card. The 2007 call-back survey suggests that the reliability of self-reported MassHealth subscriber status is high. (Source: Unpublished results of Massachusetts BRFSS 2007 follow-up interviews)

The unadjusted or crude estimate of smoking prevalence was significantly higher in the pre-benefit period when compared to

Table 2. Demographics for the MassHealth Population, Age 18–64 for the Pre- and Post- Benefit Periods with Crude Smoking Rates.

	Pre-Benefit Period January 1, 2003 to June 30, 2006				Post-Benefit Period January 1, 2008 to December 31, 2008				
Characteristic	**Sample Size**	**Weighted Sample Size**	**%**	**Crude Smoking (%)**	**Sample Size**	**Weighted Sample Size**	**%**	**Crude Smoking (%)**	**% Change in Smoking**
Overall Population	2,016	892,919	100	38.3	1,969	454,851	100	28.3*	−26%
Gender									
Male	414	264,897	29.7	41.8	561	174,919	38.5*	28.4	−32%
Female	1,602	628,022	70.3	36.8	1,408	279,931	61.5*	28.3	−23%
Age									
18–24	295	265,878	29.8	38.1	214	132,809	29.2	22.6	−41%
25–34	550	241,466	27.0	42.9	377	97,685	21.5	33.8	−21%
35–44	530	212,151	23.8	35.7	427	80,245	17.6*	34.4	−4%
45–54	383	107,135	12.0	42.6	534	91,774	20.2*	31.0*	−27%
55–64	258	66,289	7.4	23.2	417	52,338	11.5*	18.5	−20%
Education status									
< HS	534	155,736	24.9	36.1	441	61,627	19.2	39.6	+10%
HS graduate	604	232,242	37.1	43.0	582	107,146	33.4	31.7	−26%
College 1–3 years	389	155,035	24.8	42.1	411	81,309	25.4	31.2	−26%
College 4+ years	192	82,618	13.2	22.9	312	70,632	22.0*	20.1	−12%
Race/ethnicity									
White, non-Hispanic	970	477,377	53.9	51.5	1,036	266,608	58.8	33.0*	−36%
Other	1,025	408,022	46.1	22.7	918	186,676	41.2	21.7	−4%

*Statistically significant at the .05 level.
Data Source: BRFSS 2003 – 2008.
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the post-benefit period ($p<.05$). Specifically, smoking prevalence between 1/1/2003 and 6/30/2006 for MassHealth members 18–64 was estimated to be 38.3% (95% C.I. 33.6%–42.9%). In calendar year 2008, the most recently available data, prevalence for this population was estimated to be 28.3% (95% C.I.: 24.0%–32.7%). The above analyses were not adjusted for demographic changes in the post-benefit population.

Two comparisons were made with the demographically adjusted rates. First, the demographically adjusted rates were compared to the unadjusted rates for the post-benefit period. Here, there were no significant differences between the adjusted and unadjusted rates for current smoking prevalence, percentage of smoker making quit attempts, and recent quit success. See Table 1 for details. The absence of significant differences suggests that the effects of demographic changes in the MassHealth population with respect to smoking behavior were minimal.

Given the above result, comparisons also were made for smoking behavior between the pre-benefit period and post-benefit period using the demographically adjusted rates. As shown in Table 1, there were significant differences in the rate of current smoking (38.3% pre-benefit vs. 28.8% post-benefit) and recent quit success (6.6% pre-benefit vs. 19.1% post-benefit) using the demographically adjusted data. There were no differences for the percentage of smokers making quit attempts. For a full breakdown of the demographics for the pre-benefit period compared to the post-benefit period, see Table 2.

Joinpoint trend analyses were computed for smoking prevalence between 1999 and 2008. Since information about quit success was not asked in every year, trend analyses were not computed for quit success. Results showed that a model with one joinpoint was the best fit for prevalence estimates between 1999 through 2008. The sole joinpoint corresponded precisely with the implementation of the MassHealth tobacco cessation benefit (see Figure 1). Prior to July 2006, there was no significant change in smoking prevalence among the MassHealth population. Beginning in July 2006, demographically adjusted smoking prevalence dropped at an annual rate of 15.2% (see Table 3).

Finally, in order to make individual level adjustments for demographics, a logistic regression was computed. The target variable was current smoking as recorded by the BRFSS. Two time variables were included in this analysis: a long-term trend variable and one that would measure changes in the post-benefit

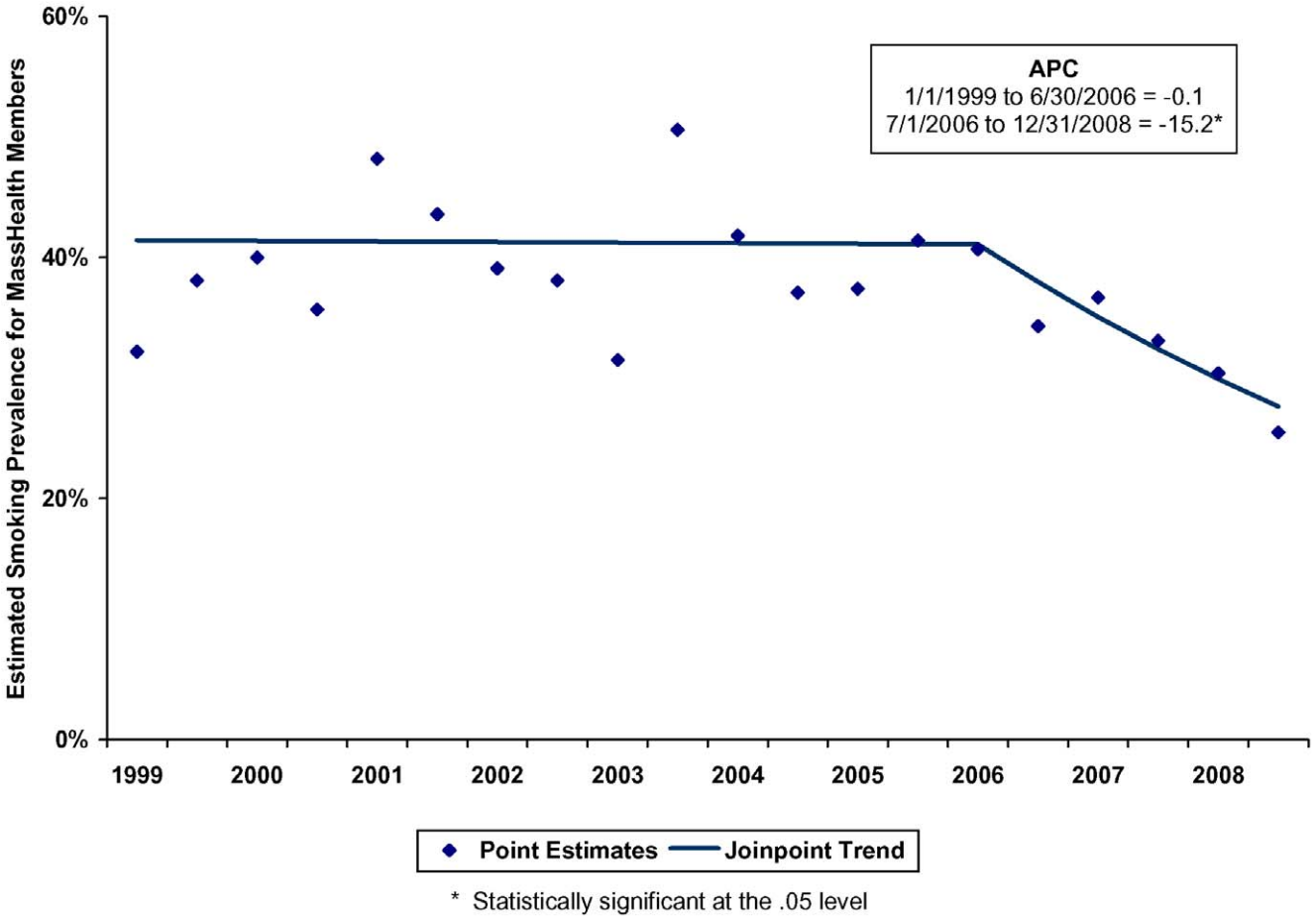

Figure 1. Demographic-Adjusted Smoking Prevalence of MassHealth Members, Age 18–64, 1999 to 2008 (Joinpoint Trend). (1) The diamonds on the chart represent the 6-month smoking prevalence estimates based on responses to the BRFSS. Initial weighting of prevalence estimates used a standard BRFSS weighting scheme in which data are directly weighted for the probability of selection of a telephone number, the number of adults in a household, and the number of telephones in a household. A final post-stratification adjustment is made for non-response and non-coverage of households without telephones. Data were also weighted in such a way to force prevalence estimates to match demographic characteristics for the period from 1/1/2003 through 6/30/2006. (2) The lines on the chart represent the smoking prevalence trends for the MassHealth population as estimated by the joinpoint analysis. The period between 1/1/1999 and 6/30/2006 showed no significant change ($p = 0.93$). Beginning 7/1/2006, there was a significant downward trend ($p<0.05$).
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Table 3. Demographic-Adjusted Smoking Prevalence for Joinpoint Analysis, 1999–2008.

Six Month Period	Demographic-Adjusted Smoking Prevalence		Joinpoint Predicted Value
	Estimate	Standard Error	
1	32.2%	5.4%	41.42%
2	38.1%	4.7%	41.39%
3	40.0%	4.4%	41.37%
4	35.7%	4.1%	41.35%
5	48.2%	4.0%	41.33%
6	43.6%	1.8%	41.30%
7	39.1%	4.0%	41.28%
8	38.1%	4.0%	41.26%
9	31.5%	4.0%	41.24%
10	50.6%	7.7%	41.21%
11	41.8%	7.7%	41.19%
12	37.1%	5.1%	41.17%
13	37.4%	5.1%	41.15%
14	41.4%	1.6%	41.12%
15 (Joinpoint 1)	40.7%	3.7%	41.10%
16	34.3%	3.7%	37.97%
17	36.7%	3.0%	35.08%
18	33.1%	2.2%	32.40%
19	30.4%	2.4%	29.93%
20	25.5%	3.0%	27.65%

Data Source: BRFSS 1999 – 2008.
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period only. Demographic adjusters were also included. The long-term trend in smoking prevalence over the entire time period (1999 through 2008) was non-significant ($p = 0.60$). However, the trend in the post-benefit period showed a significant decrease ($p<.001$) with an estimated annual decrease of 15.0% per year. See Table 4 for details.

Table 4. Logistic Regression on Smoking Prevalence with Trend and Demographic Independent Variables, 1999–2008.

Parameter	Estimate	Odds Ratio	Pr > ChiSq
Overall Trend (monthly)	0.000582	1.001	0.60
Post-Benefit Trend (monthly)	−0.0135	0.987	0.0004
Age	−0.0128	0.987	<.0001
Gender			
• Male vs. Female (ref.)	0.0554	1.117	0.06
Race/ethnicity			
• White vs. non-White (ref.)	0.5608	3.070	<.0001
Education			
• < HS vs. 4+ years of college (ref.)	0.5190	3.868	<.0001
• HS vs. 4+ years of college (ref.)	0.2500	2.956	<.0001
• Some college vs. 4+ years (ref.)	0.0649	2.956	<.0001

Data Source: BRFSS 1999 – 2008.
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Discussion

The Massachusetts experience suggests that a good benefit design, combined with broad promotion, can result in a significant reduction in smoking prevalence. In the past 20 years, dramatic reductions occurred in smoking prevalence among the college educated in Massachusetts. These results suggest that when offered easy access to low-cost medications, the Medicaid population can also show significant reductions in smoking prevalence. Furthermore, there was a significant increase in quit success without any corresponding increase in the proportion of smokers making quit attempts. Further research is required to determine the role of promotion in the decrease in smoking prevalence in this population. Data was not available in the Massachusetts BRFSS to determine whether there was any increase in evidence-based quit attempts in the post-benefit period.

Several limitations should be noted. Smoking prevalence might be increasingly underestimated by BRFSS traditional survey method because adults lacking landlines are more likely than the general population to smoke [6]. However, systematic bias introduced by declining response rates or the ongoing trend away from landlines would have been gradual. In contrast, the joinpoint analysis and logistic regression suggest a sharp change in smoking prevalence trend. Estimates of smoking prevalence were based on self-report, but self-reported smoking status has been shown to have high validity [7].

Also, enrollment in MassHealth increased following health reform. While much of this increase may have come from the rolls of the previously uninsured, most uninsured found insurance through other programs [6]. Responses to the BRFSS did not include questions about the length of time one was insured through any particular insurer, therefore it cannot be precisely determined how much the increased enrollment affected prevalence estimates. To partially account for these demographic changes resulting from enrollment increases, prevalence estimates were computed using a weighting scheme that forced the demographic characteristics of the post-benefit period to match those in the pre-benefit period.

Finally, smoking cessation was promoted broadly to the full Massachusetts population in several ways during the study time period. For example, MTCP ran a general media campaign November 2007 – January 2008; pharmaceutical companies advertised products for cessation; and on July 1, 2008, the state excise tax increased by $1 per pack and the state quitline began offering free nicotine patches to callers. The proportion of MassHealth subscribers among quitline callers did not change between 2005 and 2008. Thus, it seems unlikely that broad-based actions such as advertising, as opposed to the tobacco cessation treatment itself, are the primary explanations for MassHealth subscribers' higher quit rate over the last 2 years.

Information comparable to that reported here for Massachusetts has not been published for other states or the U.S. as a whole. The crucial health implications of preliminary findings from Massachusetts strongly suggest that similar analyses be undertaken in other states. Variations across states in level of benefits, ease of access to services, extent of advertising and other promotion of benefits, and baseline smoking prevalence provide opportunities for comparative analyses that could help identify variables that foster the largest possible impacts of benefits. Subsequent research might focus on linking drops in smoking prevalence to improved health outcomes, reduction in claims, and specific cost-containment strategies.

The Public Health Service's Clinical Practice Guideline for treating tobacco use and dependence recommends that both

medication and counseling be offered to patients [8]. Similarly, offering cessation services is an integral part of the World Health Organization's MPOWER policy package for reversing the tobacco epidemic [9]. The Massachusetts tobacco cessation benefit claims utilization data are, by inspection, suggestive that pharmacotherapy treatments might be particularly promising in terms of probability of being utilized. One possible reason why cessation counseling was little used by MassHealth subscribers is that relatively few primary care settings had the staff resources needed to make 30- or 60-minute tobacco treatment sessions readily available. Although speculative, it seems likely that many office encounters leading to prescriptions for tobacco cessation medications also included caregiver discussion and advice on quitting, even if counseling was not the primary purpose of the visit.

The Massachusetts findings suggest that a broadly-promoted, accessible, comprehensive smoking cessation benefit can reduce smoking prevalence in the Medicaid population. In 2004, U.S. Medicaid expenditures for smoking-related conditions totaled $22 billion [10]. Tobacco cessation treatment is cost-effective and should be made available to all smokers [11] via health insurance benefits. Fully implementing known tobacco control strategies has strong promise to end the U.S. tobacco epidemic [12].

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Author Contributions

Conceived and designed the experiments: TL DW. Performed the experiments: TL. Analyzed the data: TL MP LW. Contributed reagents/materials/analysis tools: DW AC. Wrote the paper: TL MP LK. Revised and edited manuscript: RK, LZ, AM, TFP.

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The Return on Investment of a Medicaid Tobacco Cessation Program in Massachusetts

Patrick Richard[1¤], Kristina West[1], Leighton Ku[2]*

1 Department of Health Policy, School of Public Health and Health Services, The George Washington University, Washington, District of Columbia, United States of America, **2** Center for Health Policy Research, School of Public Health and Health Services, The George Washington University, Washington, District of Columbia, United States of America

Abstract

Background and Objective: A high proportion of low-income people insured by the Medicaid program smoke. Earlier research concerning a comprehensive tobacco cessation program implemented by the state of Massachusetts indicated that it was successful in reducing smoking prevalence and those who received tobacco cessation benefits had lower rates of in-patient admissions for cardiovascular conditions, including acute myocardial infarction, coronary atherosclerosis and non-specific chest pain. This study estimates the costs of the tobacco cessation benefit and the short-term Medicaid savings attributable to the aversion of inpatient hospitalization for cardiovascular conditions.

Methods: A cost-benefit analysis approach was used to estimate the program's return on investment. Administrative data were used to compute annual cost per participant. Data from the 2002–2008 Medical Expenditure Panel Survey and from the Behavioral Risk Factor Surveillance Surveys were used to estimate the costs of hospital inpatient admissions by Medicaid smokers. These were combined with earlier estimates of the rate of reduction in cardiovascular hospital admissions attributable to the tobacco cessation program to calculate the return on investment.

Findings: Administrative data indicated that program costs including pharmacotherapy, counseling and outreach costs about $183 per program participant (2010 $). We estimated inpatient savings per participant of $571 (range $549 to $583). Every $1 in program costs was associated with $3.12 (range $3.00 to $3.25) in medical savings, for a $2.12 (range $2.00 to $2.25) return on investment to the Medicaid program for every dollar spent.

Conclusions: These results suggest that an investment in comprehensive tobacco cessation services may result in substantial savings for Medicaid programs. Further federal and state policy actions to promote and cover comprehensive tobacco cessation services in Medicaid may be a cost-effective approach to improve health outcomes for low-income populations.

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* E-mail: lku@gwu.edu

¤ Current address: Department of Preventive Medicine and Biometrics, Uniformed Services of the Health Sciences, Bethesda, Maryland, United States of America

Introduction

Smoking is a leading cause of preventable death in the United States, resulting in an estimated 450,000 annual premature deaths, or nearly one of every five deaths. It is responsible for roughly 30% of all cancer deaths, for nearly 80% of deaths from chronic obstructive pulmonary disease, and for early cardiovascular disease deaths [1–3]. More than one-third of the smoking-attributable years of potential life lost are related to cardiovascular disease [4]. The annual economic burden of smoking in the U.S. has been estimated at nearly $193 billion in direct medical costs and productivity losses [2]. While the life-time prevalence rate for adult smokers in the U.S. population is about 20% of this rate is about twice as high among adults insured by Medicaid [1–3]. Smoking-related medical costs are responsible for 11% of Medicaid expenditures, representing an estimated $22 billion in 2004 [5].

Federal policy has sought to reduce smoking by Medicaid beneficiaries as an important public health goal. For instance, one of the key objectives of Healthy People 2020 is to "increase comprehensive Medicaid insurance coverage of evidence-based treatment for nicotine dependency in States and the District of Columbia [6]." Considerable efforts have been made at the state level to reduce smoking. In 2009, Medicaid programs in 47 states and the District of Columbia offered at least some form of coverage for tobacco-dependence treatments, although most had a limited range of benefits [7]. The Patient Protection and Affordable Care Act will increase this coverage; it requires all states to offer comprehensive tobacco cessation services for pregnant women as of 2010 (Section 4107 of the Act) and to

cover anti-smoking medications under Medicaid by 2014 (Section 2502).

The state of Massachusetts initiated early efforts to provide comprehensive tobacco cessation medications and services to low-income Medicaid enrollees under its Tobacco Cessation & Prevention Program, starting in 2006. Under the program, with a physician's prescription, Medicaid beneficiaries could obtain FDA-approved smoking cessation medications with a copayment ranging from $1 to $3 per month. No preauthorization was required for a nicotine patch, gum or lozenge, bupropion (e.g., Zyban) or varenicline (Chantix) [8]. Massachusetts also offered up to five sessions of free telephone counseling for the state's quit line (although this was not required to get medications).

Research by Thomas Land, et al. found that this program reached a substantial share of smokers in Medicaid, achieving about a 37% use rate, and was successful in contributing to a 10% reduction in the rate of smoking by Medicaid beneficiaries [9]. Further analyses by Land, et al. examined the inpatient hospital utilization of Medicaid enrollees who used the smoking cessation benefit. The study used generalized estimating equations to examine changes in hospitalization trends among 21,656 Medicaid beneficiaries before and after the use of the tobacco cessation benefit, adjusting for demographics, comorbidities, seasonality, and other factors. On average, study participants were followed over four years, with 70 weeks in the post-benefit period. The study found that participation in the program was associated with statistically significant reductions of 46% in hospital inpatient admissions for acute myocardial infarction (AMI) ($p<.05$), 49% for coronary atherosclerosis and other heart disease ($p<.05$), and 32% for non-specific chest pain ($p<.1$), relative to the rate without the benefit [10]. There were no significant differences in hospitalizations for respiratory conditions or other seven other diagnostic groups evaluated.

In this study, we estimated the economic value of Massachusetts' tobacco cessation program's reduction on cardiovascular hospitalizations relative to program costs. We use the estimate of reductions in cardiovascular hospitalizations reported in Land's inpatient study [10]. Previous research has examined the efficacy of smoking cessation methods and found that pharmacotherapy can be a cost-effective treatment modality [11–18]. A recent study by Ladapo simulated the lifetime cost-effectiveness of a smoking counseling program for smokers hospitalized with AMI and concluded that counseling would reduce hospitalization costs but might increase lifetime healthcare costs by extending longevity [19]. In contrast, our study focuses on prevention of cardiovascular problems among smokers prior to hospitalization, primarily using pharmacotherapy, and focuses on short-term costs and savings, as opposed to lifetime cost-effectiveness. This study does not seek to measure all potential long-term savings due to the implementation of the tobacco cessation program, but represents a conservative estimate of short-term savings solely related to the avoidance of inpatient hospital admissions and treatment of cardiovascular diseases among Massachusetts Medicaid beneficiaries and smokers.

Methods

Objective

This study provides an independent estimate of cost savings and the return on investment (ROI) associated with reductions in inpatient hospital admissions for cardiovascular conditions by Medicaid beneficiaries participating in the Massachusetts Tobacco Cessation & Prevention Program from 2007 to 2009. It focuses on the costs and savings from the perspective of the Medicaid program.

Study Design and Analytical Framework

This study uses cost-benefit analysis to estimate short-term ROI of the Massachusetts tobacco cessation benefit, based on estimated program costs and savings attributable to reduced cardiovascular admissions among adult Medicaid enrollees. We used a blend of national and state data to estimate costs and savings, as described in the data section below. National data sources include the Medical Expenditure Panel Survey (MEPS), while state data include administrative program cost data, the Massachusetts Behavioral Risk Factor Surveillance System, and the Massachusetts hospital reduction estimates of Land, et al [10]. Figure 1 is a flowchart that summarizes the stages of this analysis and the data sources used at each stage.

Patient Population

The patient population is limited to Massachusetts Medicaid beneficiaries aged 18 to 64 years who are smokers. We excluded those enrolled in both Medicaid and Medicare (also known as "dual eligibles"), since most of their inpatient costs are paid by Medicare. The MEPS analytic sample included 805 Medicaid beneficiaries who are smokers. Smokers were defined as those who reported that they are current smokers as of the last year of participation in the survey.

Analytical Horizon, Perspective, and Setting of the Study

Land's study examined changes in hospital admissions in the period before and after use of tobacco cessation benefits; on average, patients were followed for 70 weeks after they began using tobacco cessation medications [10]. Thus, the time horizon of potential savings is about 1.3 years after the receipt of benefits. Our study does not seek to extrapolate longer term benefits associated with smoking reduction. Nor does it seek to extrapolate to benefits beyond reduced hospitalizations for cardiovascular conditions among Medicaid beneficiaries that smoke. Examples of benefits omitted from this analysis include benefits for other averted diseases, increases in worker productivity, and potential life years saved. It focuses on costs and savings incurred by the Medicaid program in Massachusetts.

Clinical Benefits and Economic Measures

Our primary clinical benefits are reduced admissions for certain cardiovascular diseases. Land, et al. grouped inpatient admissions into groups that had been defined by the Healthcare Utilization Project (HCUP) using clinical classification software (CCS) codes of 100 for acute myocardial infarction (AMI), 101 for coronary atherosclerosis and other heart disease, and 102 for non-specific chest pain. The same system is used in the MEPS data that we analyzed. These group codes are based on numerous specific CPT-9-CM procedure codes reported in hospital claims records and grouped by the CCS system [20]. It should be noted that non-specific chest pain may have multiple etiologies, which may include cardiovascular problems but might also include other problems, such as reflux disease or pleuritis. Following the CCS and Land, et al., we classified these as cardiovascular problems, but recognize that some could have other etiologies.

Our economic benefit data include costs to the Medicaid program for prescription drugs and counseling costs and savings due to averted inpatient admissions. All costs and savings were converted to 2010 dollars using medical price inflation data from the Bureau of Labor Statistics.

Data Sources

A variety of data sources were used. Administrative data on program costs were used to compute the annual average cost per

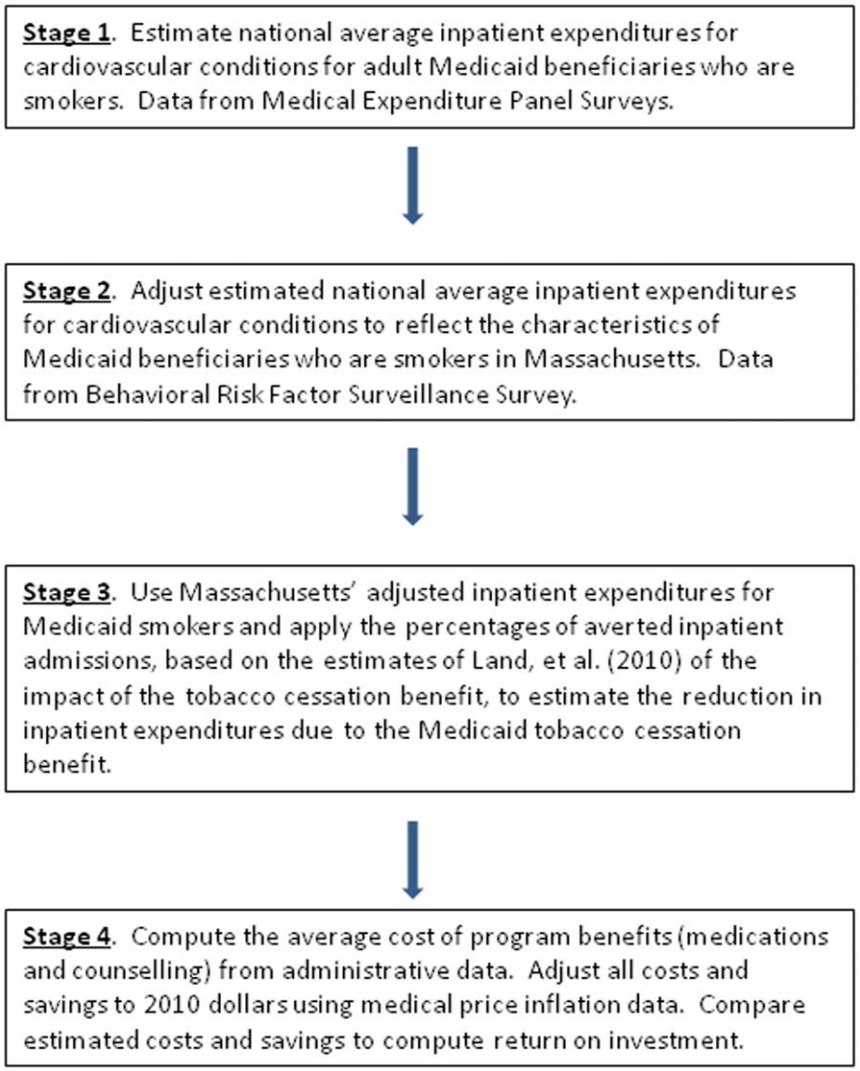

Figure 1. Flowchart summarizing the analyses.
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patient in implementing the program. Data on program costs for fiscal years 2007, 2008, and 2009 were provided by the Massachusetts Tobacco Cessation & Prevention Program, based on Medicaid (known as MassHealth in Massachusetts) administrative cost data. These included the cost of pharmacotherapy, counseling, and program outreach and promotion for fiscal years 2007, 2008, and 2009.

To compute the economic value of program benefits such as averted hospital inpatient admissions we used data from the *Medical Expenditure Panel Survey (MEPS). To increase the sample size of the study we pooled data from the 2002–8 MEPS. MEPS is a nationally representative survey of non-institutionalized individuals conducted by the Agency for Healthcare Research and Quality. It is a widely used survey* that collects information on socio-demographic characteristics, health services use, health conditions, access to care, health insurance coverage, medical expenditures, sources of payment, and income for each person surveyed, drawn both from surveys of individuals and health care providers. *We restricted t*he analytic sample to unique individuals reported as 18 to 64 year old Medicaid beneficiaries who were current smokers. The MEPS longitudinal design allows repeated observations on the same individuals several times during the year. By restricting the sample to unique individuals we were able to compute robust *standard errors*. The MEPS data reflect a national sample of Medicaid smokers and is one of the few data sets that contain expenditures. (It is worth noting that we could not obtain hospital savings from administrative data; a substantial share of the hospital data from Massachusetts was from managed care systems and lacked cost or expenditure data.)

To adjust the results of the models to reflect the characteristics of adult Medicaid beneficiaries and smokers living in Massachusetts, we used data from the Massachusetts Department of Health's Behavioral Risk Factor Surveillance Survey (BRFSS) for 2007–9. The BRFSS does not contain data on medical expenditures. The state BRFSS survey includes some questions not included in other states' BRFSS data that permits identification of Medicaid smokers. We also used the Consumer Price Index for inpatient hospital data from the Bureau of Labor and Statistics (BLS) to inflate program costs and economic value of program benefits to 2010 dollars.

Analytical Approach and Models

Figure 1 summarizes the overall flow of analyses in this paper. For the first stage, *we estimated expenditure models for inpatient hospital expenditures for cardiovascular conditions for adult Medicaid beneficiaries who*

*are smokers, using MEPS data. To specify the model, w*e used a modified version of Aday and Andersen's behavioral model of factors affecting health utilization [21]. This model hypothesizes that *utilization* depends on predisposing, enabling and health need factors. The predisposing factors included age, race/ethnicity, gender and marital status. The enabling factors included income as a percent of poverty, educational attainment and health insurance status. Health need factors included self-reported health status (fair or poor health), whether the respondent exercised and obesity status. We also included geographic factors that may affect use of care, including rural/urban status and Census region.

To test the robustness of the models, we tested different specifications. We estimated a version including having a diagnosis of diabetes as an additional health factor and a version with diabetes and hypertension. These variables were not significant in any of the models, so we reverted to our base models.

There are two well-recognized econometric problems in estimating medical expenditures. The first is that there are many zero observations leading to systematic differences in characteristics between patients with zero expenditure compared to those with positive expenditures. The second problem is that medical expenditures are highly skewed because a subset of patients with positive expenditures has very large expenditures [22–23]. Two-part models that take into consideration patients with zero expenditures and patient with positive expenditures are typically used to address the problem of many zero observations. However, in our case, we only look at those who have inpatient admissions and virtually all have non-zero expenditures. Hence, there is no need to use the first part of the two-part model, usually logistic or probit regressions, to account for the probability of using any medical care.

To address the skewness in expenditures, we used log-transformed generalized linear models (GLM) with log link and Gamma distribution to estimate direct hospital inpatient expenditures associated with cardiovascular services noted above by adult Medicaid beneficiaries who are also smokers. The log link was incorporated into the model specifically to address the skewness observed in the expenditures data. We developed several models to predict total healthcare expenditures and conducted sensitivity analyses for robustness. We used the diagnostic and specification tests recommended by Manning and Mullahy to select the final models [24]. Final models were adjusted for MEPS' complex survey design and weighting, using the survey design adjustment procedures in Stata 11.

The expenditure models using MEPS data reflect characteristics of Medicaid smokers nationwide. In order to calibrate our estimates to more closely correspond to Massachusetts residents, we then used data from the Massachusetts BRFSS to identify characteristics of adult Medicaid beneficiaries in Massachusetts. We then adjusted our expenditure estimates based on the demographic, socioeconomic, access, behavioral, health status and health condition variables of Massachusetts Medicaid smokers (see Table 1).

After that stage, we computed cost savings associated with inpatient expenditures related reductions in AMI, acute coronary heart disease, and non-specific chest pain among Medicaid smokers. Costs were based on administrative data provided by Massachusetts officials. All program costs and estimated savings were inflated to 2010 dollars using the Consumer Price Index for inpatient hospital costs from the Bureau of Labor Statistics.

We computed the return on investment (ROI) as:

$$ROI = \frac{Averted\ cost\ of\ hospitalization - Program\ cost}{Program\ cost}$$

That is, any ROI greater than zero means that more was saved (or gained) than was spent on the initiative.

To assess the uncertainty of the estimates, we computed different levels of ROI by using the 95% confidence intervals of the predicted expenditures for the noted cardiovascular conditions by adult Medicaid smokers into account. This enabled us to compute low, medium and high estimates of the potential savings due to reduced cardiovascular admissions.

Results

Descriptive Statistics

In our initial analyses of the 2002–8 MEPS data, 98% of adult Medicaid smokers 18 to 64 who had inpatient hospital admissions also had hospital expenditures reported. (We believe that the 2% without expenditures are due to the fact that MEPS does not report expenditures in cases where certain hospitals provide care without charge, on a "charity" basis.) The average expenditure for a Medicaid smoker's admission was $13,950. However, the average adult hospital in-patient in the U.S. spent about $28,691 with AMI diagnoses, $9,828 for coronary atherosclerosis and other heart disease, and $6,874 for non-specific chest pain.

Table 1 compares the characteristics of the overall sample of adult Medicaid beneficiaries who were smokers at the national level (based on MEPS data) and in Massachusetts (based on BRFSS data), regardless of whether they had an inpatient admission. A slightly higher proportion of Medicaid beneficiaries residing in Massachusetts were admitted for hospital inpatient services for AMI and coronary atherosclerosis and other heart disease, compared to the national average. But these differences were small and not significant. Other socio-demographic characteristics of Massachusetts Medicaid beneficiaries were similar to the national average, except that there were a higher proportion of males among Medicaid smokers compared to the national average. A higher proportion of Massachusetts residents had higher incomes or were college graduates, compared to adults at the national level, probably because Massachusetts has more generous Medicaid eligibility than most other states. In terms of behavioral factors, Massachusetts residents exercised more and reported a lower percentage of adults with obesity compared to the U.S. (though the lower percentage of adults with obesity was offset by higher rates over overweight). Similarly, those in the Massachusetts Medicaid program were more likely to report that they were in excellent, very or good health, and less likely to report diabetes and hypertension than those at the national level.

Program Costs

As indicated in Table 2, $20,178,210 was spent for medications or counseling under the state's Tobacco Cessation and Prevention Program from FY 2007 to 2009, representing an average of $6,726,070 per year. Additionally, $558,500 was spent on program's promotion and outreach during the three years, representing an average of $186,167 annually. A total of 550,067 individuals who were between 18 and 64 years old participated in the state's Medicaid program during fiscal years 2007–2009, of which 188,123 (34.2%) were identified as smokers. Over 75,000 unique Medicaid beneficiaries participated in the tobacco cessation program during the three-year period. During 2007–9, an annual average of 37,762 participants who were smokers used medications or counseling services. The annual average cost per user of medication and counseling services was $178; an additional $5 was spent on program outreach and promotion. In sum, a total of $183 was spent annually per user to implement the program from 2007–2009.

Table 1. Descriptive Characteristics of 18–64 Year Old Medicaid Beneficiaries Who are Current Smokers.

Variables	U.S. (from MEPS)	Massachusetts (from BRFSS)
Percent Admitted to Hospital by Diagnosis Group		
Acute myocardial infarction	1%	3%
Coronary atherosclerosis & other heart disease	1%	2%
Non-specific chest pain	3%	3%
Demographic Variables		
Mean Age	37.4 years	34.5 years
Gender		
Male	29%	42%
Female	71%	57%
Race/Ethnicity		
White	69%	66%
Hispanic	10%	17%
Black or African American	20%	9%
Asian	1%	1%
Marital status		
Married	27%	33%
Divorced	23%	15%
Widowed	3%	2%
Separated	6%	4%
Never married	47%	44%
Socioeconomic Status		
Income as % of Poverty		
0–100% of poverty	61%	63%
100–200% of poverty	23%	22%
200–400% of poverty	12%	9%
Over 400% of poverty	0.04	0.06
Education		
Less than high school degree	44%	24%
High school graduate	53%	66%
College graduate or more	03%	10%
Behavioral Variables		
No physical activity	59%	32%
Physical Activity	41%	68%
Normal weight	41%	39%
Overweight	24%	35%
Obese	35%	23%
Health Status		
Excellent/Very good/Good	54%	72%
Fair/Poor	46%	30%
Morbidity		
No diabetes	85%	94%
Diabetes	15%	6%
No Hypertension	69%	80%
Hypertension	31%	20%
Residence/Region		
Non-Metropolitan Statistical Area	22%	
Metropolitan Statistical Area	78%	

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Table 2. Program Costs for Adult Medicaid Smokers Who Participated in the Tobacco Cessation Program during Fiscal Years 2007–2009 (US $ 2010).

Category of Services	Total Program Costs	Annual Average Total Costs	Annual Average Number of Users	Annual Average Cost per User
Medications & counseling	$20,178,210	$6,726,070	37,762	$178
Program outreach and promotion	$558,500	$186,167	---	$5
Total	$20,736,710	$6,912,237	37,762	$183

Source: Based on authors' calculations using data from MassHealth, Office of Clinical Affairs.
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Economic Value of Hospital Inpatient Admissions for Cardiovascular Conditions

As shown in Table 3, results from expenditure models that were calibrated using characteristics of Medicaid smokers in Massachusetts showed adjusted inpatient expenditures of $26,044 for AMI (95% confidence interval from $25,026 to $27,060), of $12,760 for coronary atherosclerosis and other heart disease (95% confidence interval from $12,260 to $13,258) and $7,367 for non-specific chest pain (95% confidence interval from $7,086 to $7,647). The models were adjusted for socio-demographic, socio-economic, access, behavioral, health status and health condition variables of Massachusetts Medicaid smokers, as described in the methods section.

To compute the economic value of averted hospital inpatient admissions for cardiovascular conditions by adult Medicaid smokers in Massachusetts (or the benefits of the program), we multiplied the adjusted inpatient expenditures of the each of the conditions by their corresponding rate of reductions in hospital inpatient admissions estimated by Land et al [10]: AMI (46%), coronary atherosclerosis and other related conditions (49%) and non-specific chest pains (32%). Subsequently, we multiplied each of the respective results by the rate of hospital inpatient admissions among Medicaid smokers in Massachusetts, as reported in BRFSS (3% for AMI, 2% for coronary atherosclerosis, 3% for non-specific chest pain). As indicated in Table 4, we found that the economic value of averted hospital inpatient admissions for cardiovascular conditions per adult Medicaid smoker in Massachusetts ranged from $368 to $398 for AMI, from $113 to $117 for coronary atherosclerosis and other heart disease, and from $68 to $78 for non-specific chest pain. This resulted in total program benefits per adult Medicaid smokers in Massachusetts user of $571, ranging from $549 to $593.

Net Savings and Return on Investment

As reported in Table 5, we estimated net annual savings of $388 (ranging from $366 to $410) per user in Massachusetts, compared to program costs of $183 per user. This leads to an annual average ROI per adult Medicaid smoker in Massachusetts of $2.12, with a range from $2.00 to about $2.25. In other words, each $1 spent on medications and counseling, and promotion and outreach for Medicaid smokers was associated with a reduction of $3.12 (range $3.00 to $3.25) in Medicaid expenditures for cardiovascular hospital admissions, resulting in net savings between $2.00 and $2.25.

As noted earlier in this paper, it is possible that some of the admissions due to non-specific chest pain are not actually due to cardiovascular conditions, but disorders like reflux disease or pleuritis. Even if we net out these savings related to non-specific chest pain, the estimated ROI remains highly positive, ranging from $1.63 to $1.84.

Table 3. Estimated (Adjusted) Annual Average Expenditures Per Inpatient for Cardiovascular Conditions for Adult Medicaid Smokers in Massachusetts (US $ 2010).

Cardiovascular conditions	Low	Midpoint	High
Acute myocardial infarction	$25,026	$26,044	$27,060
Coronary atherosclerosis	$12,260	$12,760	$13,258
Non-specific chest pain	$7,086	$7,367	$7,647

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Discussion

The current study advances the literature on the economic evaluation of smoking cessation programs at the state level in the United States. Findings from this study indicate that a well-promoted program of comprehensive access to tobacco medications and counseling implemented in Massachusetts was cost beneficial. Over an average of 70 weeks after beginning to use smoking cessation medications, Medicaid beneficiaries experienced fewer hospital admissions due to cardiovascular conditions, leading to a net annual savings of $366 to $410 per Medicaid user or an ROI of $2.00 to $2.25 during the period of 2007–2009. These results were adjusted for an extensive set of control variables and the findings were robust to different model specifications.

This study has strengths and limitations. In terms of strengths, the study used detailed administrative data about program costs and relied on estimates of reductions in hospital admissions based on detailed hospital data analyzed by Land, et al [10]. Because we lacked actual administrative data on the costs of hospitalizations averted, we used a comprehensive national data set (MEPS) to estimate the costs of cardiovascular hospital admissions among adult Medicaid smokers. To control for

Table 4. Estimated Annual Value of Averted Hospital Inpatient Admissions for Cardiovascular Conditions Per User in Massachusetts (US $ 2010).

Cardiovascular Conditions	Low	Midpoint	High
Acute myocardial infarction	$368	$383	$398
Coronary atherosclerosis	$113	$117	$122
Non-specific chest pain	$68	$71	$68
Total	**$549**	**$571**	**$593**

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Table 5. Estimated Net Annual Savings Per User and Estimated Return on Investment Associated with Reduced Cardiovascular Admissions among Medicaid Smokers in Massachusetts (US $ 2010).

	Low	Midpoint	High
Net annual savings	$366	$388	$410
Return on investment	**$2.00**	**$2.12**	**$2.25**

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variations in the factors associated with expenditures, we controlled for an extensive set of demographic and health characteristics and then calibrated these to correspond the risk profile of Medicaid smokers in Massachusetts, using the BRFSS data. Our study is also limited by the limitations of Land's study [10] which generated estimates of reductions in hospitalization among Medicaid beneficiaries. That paper discussed its limitations, notably the use of claims data as a proxy for health events and of the receipt of the tobacco cessation benefit as a proxy for actual smoking cessation.

A key limitation of our analysis is that we assume that actual hospital savings are equivalent to the average costs per admission multiplied by the number of averted hospital admissions. This may introduce error in two ways. First, it is possible that averted admissions occur among either healthier or sicker patients who have lower (or higher) inpatient expenditures. If, for example, admissions were only averted among healthier patients, more expensive patients would still be admitted and our estimates would overstate cost savings. The second source of error is that in addition to reducing admissions, tobacco cessation programs may reduce the severity of problems among those admitted. In this case, there would be additional savings through the result of reduces expenditures even among those who were hospitalized, which our study has not captured. Our inclusion of a range of hospital expenditures, based on the confidence intervals incorporates some of the uncertainty about the actual savings and the heterogeneity of patient health.

Results from this study are consistent with previous research which has indicated the efficacy and cost-effectiveness of certain drug therapies in reducing smoking and the health benefits of smoking cessation. In particular, it has focused on reductions in medical expenditures related to hospitalizations for cardiovascular disease. It did not measure the long-term or lifetime impacts on medical expenditures. On the other hand, prior analyses have suggested that smoking cessation may be the most cost-beneficial long-term strategy for the reduction of the burden of cardiovascular disease in the United States [25].

Conclusions and Policy Recommendations

A disproportionate number of smokers in the United States are low-income and insured by Medicaid. Findings from Land, et al. [9–10] and from this study suggest that comprehensive tobacco cessation efforts can reduce the prevalence of smoking in a high risk population and reduce net costs for the Medicaid program. This analysis focused solely on medical care savings resulting from reduced cardiovascular admissions among program participants. For example, it did not estimate potential health improvements or savings that might be associated with reduced second hand smoke exposure for family members or intrauterine exposure from pregnant smokers. Nor did it consider other potential savings, such as the reduced burden to low-income families from the cost of purchasing cigarettes or the potential for improved productivity and confidence associated with quitting smoking.

It is well understood that it is difficult to stop smoking and that while many may successfully quit in the short- term, there is a substantial risk of recidivism. While we cannot be assured that Medicaid beneficiaries who quit smoking remain abstinent in the long run, there appear to be near-term reductions in smoking rates that lead to near-term Medicaid savings within the following year or so. These are conservative estimates given that we only measured short-term benefits associated with reductions in inpatient hospital admissions due to cardiovascular conditions. But program administrators are often most interested in near-term savings, since they do not know how long beneficiaries will remain covered by Medicaid and because fiscal concerns lead to pressure for near-term savings.

Both the federal and state governments share in the costs and savings related to stronger tobacco cessation efforts for Medicaid beneficiaries. Although both the federal and state governments are under substantial budgetary pressure, this research suggests that further investments in comprehensive tobacco cessation under Medicaid would be a sound investment that reduces medical expenditures relatively quickly. As noted earlier, the Patient Protection and Affordable Care Act already includes efforts to strengthen tobacco cessation services in Medicaid, including mandatory coverage of comprehensive services for pregnant women and enhanced coverage of pharmacotherapy for smoking cessation. Moreover, Medicaid coverage is scheduled to expand to serve millions of additional low-income non-elderly adults in 2014 [26]. Thus, tobacco cessation services in Medicaid could soon be offered to a much larger share of the low-income smoking population.

Despite the budgetary problems faced by Medicaid program administrators and state and federal officials, efforts to implement comprehensive tobacco cessation programs for Medicaid enrollees (not just those who are pregnant) may be an element of evidence-based policy to both improve public health and reduce health care expenditures. Because Medicaid provides health insurance coverage, including coverage for preventive services, for a very large share of a high-risk, low-income population, public health objectives include recommendations for comprehensive smoking cessation coverage under Medicaid [4]. Research concerning the efficacy and cost-effectiveness of these initiatives to encourage smoking cessation may provide valuable information to policymakers and researchers alike. Additionally, cost-effectiveness studies that account for heterogeneity in populations of smokers are needed to provide important information to policymakers and other key stakeholders.

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Author Contributions

Analyzed the data: PR KW LK. Wrote the paper: PR LK.

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A Longitudinal Study of Medicaid Coverage for Tobacco Dependence Treatments in Massachusetts and Associated Decreases in Hospitalizations for Cardiovascular Disease

Thomas Land[1]*, Nancy A. Rigotti[2,3], Douglas E. Levy[2,3], Mark Paskowsky[1], Donna Warner[1], Jo-Ann Kwass[1], LeAnn Wetherell[4], Lois Keithly[1]

1 Massachusetts Tobacco Cessation and Prevention Program, Boston, Massachusetts, United States of America, **2** Tobacco Research and Treatment Center, General Medicine Division, Department of Medicine, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts, United States of America, **3** Mongan Institute for Health Policy, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts, United States of America, **4** Office of Medicaid Commonwealth of Massachusetts, Boston, Massachusetts, United States of America

Abstract

Background: Insurance coverage of tobacco cessation medications increases their use and reduces smoking prevalence in a population. However, uncertainty about the impact of this coverage on health care utilization and costs is a barrier to the broader adoption of this policy, especially by publicly funded state Medicaid insurance programs. Whether a publicly funded tobacco cessation benefit leads to decreased medical claims for tobacco-related diseases has not been studied. We examined the experience of Massachusetts, whose Medicaid program adopted comprehensive coverage of tobacco cessation medications in July 2006. Over 75,000 Medicaid subscribers used the benefit in the first 2.5 years. On the basis of earlier secondary survey work, it was estimated that smoking prevalence declined among subscribers by 10% during this period.

Methods and Findings: Using claims data, we compared the probability of hospitalization prior to use of the tobacco cessation pharmacotherapy benefit with the probability of hospitalization after benefit use among Massachusetts Medicaid beneficiaries, adjusting for demographics, comorbidities, seasonality, influenza cases, and the implementation of the statewide smoke-free air law using generalized estimating equations. Statistically significant annualized declines of 46% (95% confidence interval 2%–70%) and 49% (95% confidence interval 6%–72%) were observed in hospital admissions for acute myocardial infarction and other acute coronary heart disease diagnoses, respectively. There were no significant decreases in hospitalizations rates for respiratory diagnoses or seven other diagnostic groups evaluated.

Conclusions: Among Massachusetts Medicaid subscribers, use of a comprehensive tobacco cessation pharmacotherapy benefit was associated with a significant decrease in claims for hospitalizations for acute myocardial infarction and acute coronary heart disease, but no significant change in hospital claims for other diagnoses. For low-income smokers, removing the barriers to the use of smoking cessation pharmacotherapy has the potential to decrease short-term utilization of hospital services.

Please see later in the article for the Editors' Summary.

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Competing Interests: In the past 5 years, NAR's institution has received research grant funding from Pfizer and Nabi Biopharmaceuticals for the study of investigational and/or marketed smoking cessation products. She has consulted for Pfizer and Free & Clear. She does not accept payment for consultation and has not for the past two years.

Abbreviations: AMI, acute myocardial infarction; BRFSS, Behavioral Risk Factor Surveillance System; CHD, coronary heart disease; CI, confidence interval; COPD, chronic obstructive pulmonary disease; FDA, US Food and Drug Administration; HCUP, Healthcare Cost and Utilization Project

* E-mail: Thomas.Land@state.ma.us

Introduction

Cigarette smoking is the leading preventable cause of death in the United States. It also contributes to health disparities, as tobacco use is highest in individuals with less education and lower incomes. In the short term, the only way to decrease tobacco use rates is to increase population-wide smoking cessation rates [1,2]. This decrease can be achieved by encouraging more smokers to try to quit and/or by increasing the success of those quit attempts with effective treatment, which includes counseling and/or pharmacotherapy with nicotine replacement products, bupropion, or varenicline [2,3].

At the population level, smoking cessation attempts and quit rates can be increased by reducing the cost of treatment to the smoker [3–5]. Smoking cessation treatment is not well covered in current health insurance programs, especially in state Medicaid programs that cover low-income individuals, who are more likely to be smokers. Currently, only 45% of state Medicaid programs offer tobacco cessation treatment that includes both pharmacotherapy and counseling, but only 12% cover behavioral counseling and all medications approved for tobacco cessation treatment by the US Food and Drug Administration (FDA) [6].

A barrier to the adoption of comprehensive tobacco treatment coverage, especially by publicly funded health insurance programs is the projected impact on health care costs. The health care costs of smokers who quit decline within 2 to 5 y after quitting [7–10], but the delay in cost recovery has been a barrier to governments considering adoption of smoking cessation benefits. Without better evidence of health improvements or cost containment, it is difficult for policy makers to mandate benefits that will incur significant expenses, especially in light of return-on-investment (ROI) models that show short term increases in health care costs following tobacco cessation. To date, to our knowledge, no US state has examined the impact of a publicly funded tobacco cessation benefit on medical claims for tobacco-related diagnoses.

In 2006, as part of a comprehensive health care reform law, Massachusetts mandated tobacco cessation treatment for all subscribers aged 18 y and older who were insured through MassHealth, the state's Medicaid program. Prior to this law, MassHealth did not provide tobacco cessation benefits to its subscribers. Starting July 1, 2006, the tobacco cessation benefit provided comprehensive coverage for both pharmacotherapy and counseling with minimal copay. On the basis of secondary surveys from the Behavioral Risk Factor Surveillance System (BRFSS), it was estimated that nearly 40% of smokers on MassHealth used the benefit to obtain either prescription or over-the-counter medications to help them quit [5]. In the first 2.5 y after this low-barrier insurance coverage was offered for tobacco cessation medications, a significant drop in smoking prevalence was observed among the Massachusetts Medicaid population [5]. Using BRFSS survey responses, smoking prevalence in the prebenefit period was estimated to be 38.3%. The rate dropped to 28.8% 2.5 y later. Moreover, a joinpoint analysis indicated that the drop in prevalence coincided with the implementation date of the MassHealth tobacco cessation benefit. BRFSS data for this period also showed no change in the percentage of smokers making quit attempts (1 d or longer). However, there was a significant increase in the percentage of former smokers reporting recent quit success. Specifically, the percentage of smokers reporting that they quit smoking in the previous 12 mo rose from 6.6% in the prebenefit period to 19.1% in the postbenefit period. Taken together, these findings suggest that a tobacco cessation benefit with low barriers can significantly reduce smoking prevalence in a Medicaid population.

The present study analyzes MassHealth claims data to explore the effect of comprehensive coverage of smoking cessation treatment on MassHealth subscribers' use of hospital care, which is a major contributor to overall health care costs [11,12]. Because these claims data do not include information about the smoking status of individuals using health services, we could not compare the claims experience of individuals by smoking status over time. Instead, we compared MassHealth subscribers' rates of hospitalization for specific diagnoses as a function of time before and after use of the tobacco cessation pharmacotherapy benefit, controlling for trends in hospital care utilization.

We hypothesized that a subscriber's probability of hospitalization for tobacco-related diagnoses would decrease as a function of time after use of the tobacco cessation benefit when compared to the same individual's probability of hospitalization prior to the benefit use. We further hypothesized that this postutilization reversal of risk would vary by diagnosis. Tobacco-related diagnoses with more rapid risk reductions would likely show significant reductions in probability of hospitalization, while those diagnoses with longer term risk reductions would not.

Method

Study Design

We conducted a longitudinal analysis comparing MassHealth subscribers' rates of hospitalization for specific diagnoses before and after their first use of the tobacco cessation pharmacotherapy benefit, controlling for trends in hospital care utilization. MassHealth and the Massachusetts Department of Public Health (MDPH) operate under the umbrella of the Massachusetts Executive Office of Health and Human Services (EOHHS). All EOHHS employees are required to be trained regarding ethics, confidentiality, and privacy issues related to the use and dissemination of health data. A data sharing agreement for this project was prepared by MassHealth and signed by representatives of MassHealth and MDPH. This agreement required that all claims records be stored on a secure password-protected server. Access to the claims records was limited to four of the authors on this paper (TL, MP, LW, and LK).

Tobacco Cessation Benefit

The tobacco cessation benefit, which began on July 1, 2006, provided coverage for both pharmacotherapy and counseling. With a doctor's prescription, MassHealth subscribers could obtain FDA-approved smoking cessation pharmacotherapies for US$1–US$3 for a 1-mo supply including over-the-counter medications. No preauthorization was required for the nicotine patch, gum, or lozenge, bupropion, or varenicline. Smokers could obtain a 90-d supply up to twice per year. In-person smoking cessation counseling services were also covered by the benefit. The state already provided up to five sessions of free telephone counseling through the state's quitline; this continued unchanged with the new cessation benefit. The counseling services were not required in order for subscribers to get pharmacotherapy.

Population

The population consisted of MassHealth subscribers who used the tobacco cessation pharmacotherapy benefit. The analysis was limited to use of the pharmacotherapy benefit, because use of the counseling benefit was very low compared to use of the pharmacotherapy benefit; 97% of all claims were pharmacotherapy claims. Since 2006, this percentage has varied less than 1%

year to year. Of all subscribers who used the tobacco benefit, 98% had at least one claim for a tobacco cessation medication.

Use of the benefit was defined as having a claim for a prescription of an FDA-approved tobacco cessation medication (any nicotine replacement product or varenicline). Subscribers who had a claim for a bupropion prescription were excluded from the analysis because the drug is not prescribed only for smoking cessation. To be included in the analysis, recipients were required to have a prescription for a tobacco cessation medication filled between July 1, 2006 and November 17, 2007. The end date was chosen to allow for a minimum of 6 mo of postutilization claims. In addition, recipients had to have at least 321 d of MassHealth eligibility in the 365 d both prior to and after the use of the benefit, excluding days where the recipient was dually eligible for Medicare and Medicaid, and had to be MassHealth eligible for at least 51 d in each 8-wk time segment, excluding days where the recipient was dually eligible for Medicare and Medicaid.

Data

MassHealth prepared raw eligibility and claims files for all subscribers who used the tobacco cessation benefit prior to November 17, 2007. Claims were included from all three types of MassHealth plans: fee for service (FFS), primary care clinician (PCC), and managed care organization (MCO). Full claims data were available for each plan, including the MCO that operates under a prospective payment scheme. The records included claims for inpatient hospitalizations (e.g., hospital specific charges), outpatient events (e.g., emergency department charges), physician services, medical services (e.g., hospice, physical therapy), and pharmacy prescriptions. All data records included a claim date or a specific date of service. All records except pharmacy claims included up to five International Classification of Diseases, 9th edition Clinical Modification (ICD 9) diagnosis codes.

Data for individual recipients were organized to produce a type of health history. Each history was broken into 33 consecutive 8-wk segments that were designed so that the implementation date of the tobacco cessation benefit (July 1, 2006) was the start of one of the 8-wk segments. The first segment began on August 2, 2003, and the implementation date of the MassHealth tobacco cessation benefit occurred at the start of the twentieth segment.

Outcomes

The outcomes of interest were claims for inpatient hospitalization with specific diagnoses during a given time segment. Only primary diagnoses were used. Diagnosis groups were defined according to the Healthcare Cost and Utilization Project (HCUP) clinical classification system [13]. With the exception of pregnancy or birth-related hospitalizations, all diagnosis groups with at least 200 hospitalizations were evaluated for changes in the likelihood of hospitalization comparing hospitalization rates prior to and following the first utilization date for tobacco cessation medication. Fifteen diagnosis groups had at least 200 hospitalizations in the time frame studied. Four of the 15 diagnostic groups were related to cardiovascular disease (CVD). Four were respiratory conditions. The remaining seven spanned a variety of conditions that were either known not to be related to tobacco use or were smoking-related but had a risk that would not go down in the short term following smoking cessation (Table 1). Hospitalizations for cancer diagnoses were rare and therefore not evaluated.

Inpatient hospitalization events were recorded in the following manner. For each individual, any 8-wk segment that included an inpatient hospital admission for a specific HCUP diagnosis group was given a value of 1. All time segments for an individual that did not include an inpatient hospital admission for a specific HCUP diagnosis group were assigned a value of 0. Multiple unique admissions in a single time segment were counted only once. For all analyses, the outcome measure was whether or not a hospitalization occurred in a given time segment. The vast majority of periods with recorded hospitalizations included only one inpatient admission per individual for a given period. For schizophrenia and other psychotic disorders, 19% of periods with admissions had more than one admission in that period; this was the maximum value for all diagnostic groups studied. The minimum level for multiple admissions was found for diagnoses of biliary tract disease with 3% multiple admissions. The remainder of diagnostic groups evaluated had approximately

Table 1. Diagnostic group codes evaluated.

Diagnostic Group Codes	Clinical Group Description Based on HCUP Classifications
Cardiovascular group codes	AMI (HCUP = 100)
	Coronary atherosclerosis and other heart disease (HCUP = 101)
	Nonspecific chest pain (HCUP = 102)
	Congestive heart failure (HCUP = 108)
Respiratory group codes	Pneumonia except by TB or STD (HCUP = 122)
	COPD and bronchiectasis (HCUP = 127)
	Asthma (HCUP = 128)
	Respiratory failure insufficiency arrest (HCUP = 131)
Other conditions	Diabetes mellitus with complications (HCUP = 50)
	Biliary tract disease (HCUP = 149)
	Pancreatic disorders not diabetes (HCUP = 152)
	Skin and subcutaneous skin infections (HCUP = 197)
	Abdominal pain (HCUP = 251)
	Mood disorders (HCUP = 657)
	Schizophrenia and other psychotic disorders (HCUP = 659)

STD, sexually transmitted disease; TB, tuberculosis.
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10% multiple hospitalizations for periods with recorded inpatient admissions.

The 8-wk time segment that included the first use of tobacco cessation medications was excluded from all analyses because smoking cessation attempts are often associated in time with adverse health events. Developing new symptoms or receiving treatment for tobacco-related disease can stimulate a smoker to attempt to quit. Standards for hospital quality developed by the Joint Commission assess provision of smoking cessation advice for smokers hospitalized for acute myocardial infarction (AMI), heart failure, and pneumonia [14]. Including the time segment when treatment began in the model would have overestimated the impact of tobacco cessation treatment.

Independent Variables

Basic demographic data were ascertained from the eligibility file, including gender, age, race/ethnicity, and English-speaking. We also accounted for comorbid medical diagnoses using two methods. First, each segment was scored for health risk during the previous 336 d (six segments) using the Chronic Illness Disability Payment System (CDPS) [15]. CDPS was developed using diagnoses recorded on Medicaid claims records. It has been used to assess health status and to estimate future payments for individual Medicaid subscribers. Also, the HCUP clinical classification system was used to score health risk. All primary and secondary diagnoses were included. The earliest diagnosis date was recorded for nine HCUP categories: AMI, asthma, congestive heart failure, chronic obstructive pulmonary disease (COPD), diabetes, gastritis and duodenitis, hypertension, lupus or other connective tissue disease, and cerebrovascular disease. Those time segments in the patient health history that predated the diagnosis were assigned a value of 0. Those time segments after and including the diagnosis date were assigned a value of 1. Similar coding was undertaken for previous use of medications for treating hypertension and/or hyperlipidemia.

Given the relationship between influenza cases and coronary heart disease (CHD) [16], we also included weekly counts of "influenza-like cases" as recorded by the Massachusetts Department of Public Health. Finally, since research has shown that smoke-free air laws reduce smoking-related health events especially cardiovascular events, we included an indicator for time segments after the implementation of the Massachusetts Smoke-Free Workplace Law (effective date July 5, 2004).

Analytic Model

Data were analyzed using generalized estimating equations (GEEs) using a logistic link with hospitalization in each time segment as the dependent variable. Generally, we estimated a trend in hospitalization rates prior to benefit utilization and a change in that trend following use of the tobacco cessation benefit. Our primary goal was estimating the magnitude of this change in trend. The general trend was characterized as time in years since August 2, 2003. The change in trend was recorded as the time in years since a recipient's first use of the tobacco cessation benefit. Our primary goal is estimating the magnitude of this change in trend. Start of tobacco cessation treatment was recorded as the earliest time segment in which an FDA-approved tobacco cessation medication prescription was filled. Because many cardiovascular and respiratory conditions have a seasonal quality, annual and semi-annual sine and cosine terms were also included in the model [17]. We adjusted for correlation within individuals across time, assuming a first-order autoregressive structure. All analyses were conducted using SAS 9.1, PROC GENMOD (SAS Corporation).

Results

Between July 1, 2006, and May 9, 2009, 74,454 MassHealth individual subscribers used the pharmacotherapy benefit. After applying the exclusion criteria described above, 21,656 were eligible for analysis. 35,765 of the original 74,454 individuals were excluded because they first used the benefit after November, 16, 2007, and completeness of claims data for the postutilization time period for these individuals could not be assured. 18,389 individuals were excluded because these subscribers had insufficient eligibility in the year before first utilizing tobacco cessation medications, insufficient eligibility in the year after first use of tobacco cessation medications, or were dually eligible for Medicare. The average case included in the analysis had claims covering 27.5 8-wk segments with an average of 8.7 segments in the postutilization time period.

Table 2 shows demographic and other comparisons for those individuals included in the analysis and those excluded. In general, individuals included were slightly older and more likely to be female, white, and non-English speaking.

Among the 21,656 benefit users in the sample, 8,194 (37.8%) had at least one inpatient hospitalization during the study period. In total, there were 17,084 uniquely dated inpatient hospitaliza-

Table 2. Comparison of benefit users included in analysis to those excluded from analysis.

Benefit User Characteristics	Included (n = 21,656)	Excluded (n = 52,798)
First use of tobacco cessation medications between	7/1/2006–11/16/2007	7/1/2006–5/9/2009
Average age (y)	42.1	41.1
Percent male	30.9	43.9
Percent race/ethnicity = white non-Hispanic	71.8	55.9
Percent race/ethnicity = Black non-Hispanic	7.0	5.4
Percent race/ethnicity = Hispanic	5.2	6.0
Percent race/ethnicity = not listed	15.5	31.5
Percent English spoken	73.2	86.4
Percent days eligible for MassHealth (no dual eligible days included)	90.2	46.9
Percent days not eligible for MassHealth	8.4	34.8
Percent days dually eligible for MassHealth and Medicare	1.4	18.3

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tions in the period studied; 71.1% of these hospitalizations occurred in the prebenefit period. The most common primary diagnosis group was asthma, followed by COPD and pneumonia.

Unadjusted rates of hospitalization were calculated prior to accounting for seasonality, influenza, demographics, previous health risks, and smoke-free air laws. Overall, there was a 7% (95% confidence interval [CI] 3%–10%) annualized increase in the unadjusted rate of hospital admissions from the pre-utilization period to the postutilization period (Table 3). There were also increases in the annualized unadjusted rates of hospital admissions for all primary diagnoses of respiratory conditions, congestive heart failure, abdominal pain, and mood disorders. There was a significant decrease in the annualized unadjusted rate of hospital admissions for a primary diagnosis of coronary atherosclerosis (see Table 3).

Following adjustments for demographics, prior health risks, seasonality, statewide influenza rates, and the implementation date of the Massachusetts Smoke-Free Workplace Law, trend changes in likelihood of hospitalization during the postutilization period were found for AMI and atherosclerosis. Because hospitalizations are relatively rare in our population (19% annual risk of hospitalization), we interpret our odds ratios as changes in the likelihood of hospitalization. For AMI, there was a 46% annualized decrease (95% CI 2%–70%). For coronary atherosclerosis, the annualized decreased was 49% (95% CI 6%–72%). Likelihood of hospitalization for nonspecific chest pain was lower but this change did not reach significance. No other diagnosis group showed a significant increase or decrease in likelihood of hospitalization in the postutilization period.

Quadratic terms were added to all models to test for nonlinearity in the postutilization period. No diagnosis group showed any significant nonlinearity.

Discussion

Here we extended previous research in smoking prevalence among MassHealth beneficiaries by examining claims data to explore whether the utilization of a low-barrier benefit for tobacco

Table 3. Number of admissions by group, unadjusted change in hospital admissions in pre-utilization period compared to postutilization period with *p*-value and 95% CI, annualized change in inpatient hospital admissions postutilization with *p*-value and 95% CI.

Clinical Group Description	*n* Admissions (Pre and Post)	Unadjusted Change Pre-utilization Versus Postutilization			Adjusted Annualized Change Postutilization		
		Annualized Percent Change in Admissions Pre Versus Post (Unadjusted)	*p*-Value Pre Versus Post (Unadjusted)	95% CI Pre Versus Post (Unadjusted)	Annualized Change in Admissions[a] (Postutilization)	*p*-Value Annualized Change in Admissions	95% CI Annualized Change in Admissions
Cardiovascular group codes							
AMI	239	−8%	$P=0.54$	0.70–1.21	−46%	$P=0.049$	0.30–0.98
Coronary atherosclerosis and other heart disease	337	−28%	$P<0.01$	0.56–0.92	−49%	$P=0.04205$	0.28–0.94
Nonspecific chest pain	559	14%	$P=0.13$	0.96–1.36	−32%	$P=0.07$	0.45–1.03
Congestive heart failure	279	103%	$p<0.001$	1.61–2.57	14%	$P=0.74$	0.54–2.37
Respiratory group codes							
Pneumonia except by TB or STD	832	16%	$p<0.05$	1.01–1.34	14%	$P=0.40$	0.82–1.62
COPD and bronchiectasis	912	91%	$p<0.001$	1.68–2.18	21%	$P=0.39$	0.79–1.84
Asthma	938	29%	$p<0.001$	1.13–1.48	−1%	$P=0.95$	0.67–1.46
Respiratory failure insufficiency arrest	260	64%	$p<0.001$	1.29–2.10	−6%	$P=0.84$	0.55–1.64
Other conditions							
Diabetes mellitus with complications	462	10%	$P=0.33$	0.90–1.33	−3%	$P=0.93$	0.51–1.92
Biliary tract disease	225	−14%	$P=0.32$	0.65–1.15	−13%	$P=0.67$	0.45–1.68
Pancreatic disorders not diabetes	525	4%	$P=0.68$	0.87–1.25	42%	$P=0.30$	0.73–2.79
Skin and subcutaneous skin infections	655	<1%	$P=0.96$	0.84–1.17	−26%	$P=0.24$	0.45–1.22
Abdominal pain	282	15%	$p<0.05$	1.04–1.69	−18%	$P=0.46$	0.48–1.39
Mood disorders	419	23%	$p<0.05$	0.62–0.96	37%	$P=0.18$	0.77–2.43
Schizophrenia and other psychotic disorders	350	−11%	$P=0.33$	0.71–1.12	42%	$P=0.31$	0.67–3.44
All hospitalizations	17,724	7%	$p<0.001$	1.03–1.10	−2%	$P=0.74$	0.90–1.08

[a]Adjusted for trend, seasonality, influenza like cases, individual demographics, prior diagnoses of specific diseases, prior use of hypertension or cholesterol medication, CDPS health risk score, and the implementation date of the Massachusetts Smoke-Free Workplace Law.

STD, sexually transmitted disease; TB, tuberculosis.

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cessation medications is also associated with a significant reduction in hospital care utilization, specifically inpatient hospital admissions for acute coronary heart disease, a tobacco-related diagnosis that is particularly sensitive to decrease in response to smoking cessation [18,19]. Our analysis of medical claims for MassHealth subscribers who used tobacco cessation medications paid for by MassHealth showed a significant reduction in inpatient hospital claims for two acute CHD diagnoses (AMI and coronary atherosclerosis) in the postutilization period, compared to the pre-utilization period. The findings were robust and persisted after adjustment for potential confounding factors that included demographics, medical comorbidities, seasonality, statewide influenza rates, and the implementation date of the Massachusetts Smoke-Free Workplace Law. We found a 46% annualized decrease in inpatient claims for AMI and a 49% annualized decreased in hospital claims for coronary atherosclerosis claims in the postutilization period. No significant changes occurred in rates of hospital admissions for other diagnoses, including four respiratory conditions (pneumonia, asthma, COPD, and respiratory failure) and in seven additional diagnostic groups not previously associated with smoking or with short-term health improvements following smoking cessation.

Because return-on-investment (ROI) analyses have often shown short-term increases followed by long-term decreases in health care costs for recent quitters, nonlinear trends were evaluated for all 15 diagnostic groups. No diagnosis group showed any significant nonlinearity.

To date, to our knowledge, no study has linked use of the tobacco cessation benefit with a reduction in claims for tobacco-related diagnoses. However, several recent studies have shown reductions in tobacco-related diagnoses following implementation of smoke-free air laws [20–22]. Moreover, the impact of smoke-free air laws appears to increase as a function of time in much the same way that the risk of tobacco-related diagnoses decreases after a smoker quits smoking [18,19]. Therefore, the longitudinal model we used to study the health impact of the MassHealth tobacco cessation benefit mirrors the models used to evaluate the health effects of smoke-free air laws.

This study has several limitations. First, claims records were used as proxies for health events. Review of clinical charts would have yielded a more sensitive accounting of diagnoses but were impractical given the large volume of individual subscribers. Second, unmeasured confounding is a threat to the study's internal validity. Because subscribers were not randomly assigned to the benefit and there was no concurrent control condition, it is possible that subscribers who chose to use the tobacco benefit were also more likely to adhere to treatment for other CHD risk factors such as hypertension or hyperlipidemia. This behavior could independently reduce their likelihood of hospitalization for CHD. To partially address this issue, our model adjusted for simultaneous use of medications for hypertension and hyperlipidemia. However, claims data alone cannot fully address the issue of adherence to prescription schedules. Third, use of the tobacco benefit is used as a proxy for stopping smoking, because smoking status is not available in claims data; this might lead to misclassification of benefit users who did not quit as quitters, and would have the effect of biasing the results toward the null. Finally, Table 2 shows differences between included and excluded subscribers on the basis of eligibility criteria. These differences could limit the generalizability of results to the entire population of MassHealth subscribers.

Because of these limitations, additional studies in other states are warranted. The authors note that initial studies showing reductions in smoking-related diagnoses following implementation of smoke-free laws were met with skepticism. However, subsequent research has greatly increased confidence in the relationship between smoke-free workplace laws and reductions in smoking-related diagnoses, especially myocardial infarction [23]. Those studies used a similar longitudinal model, but only research from other states will determine whether these new results from Massachusetts reflect a replicable pattern of hospital utilization following the implementation of a comprehensive tobacco treatment benefit.

It is unlikely that our findings would have reached significance without the high utilization rate of the Massachusetts Medicaid tobacco cessation benefit. Nearly 40% of subscribers used the benefit in the first 2.5 y after implementation [5]. This rate was achieved, in part, by heavy promotion of the benefit in Massachusetts during the first 18 mo after implementation. The Massachusetts Medicaid Program and the Massachusetts Tobacco Cessation and Prevention Program (MTCP) formed a close working relationship to promote the benefit. In addition, the FDA approved varenicline as a tobacco cessation medication in May 2006. A media campaign by varenicline's manufacturer promoting the product began in December 2006 and may have increased smokers' interest in obtaining smoking cessation treatment.

As noted previously, this study is the second in a series of studies regarding use the MassHealth tobacco cessation benefit. The first study used secondary survey data from the BRFSS to show a significant reduction in smoking prevalence for the Massachusetts Medicaid population. This reduction coincided with the implementation of the tobacco cessation benefit [5]. The current study has focused on reduced inpatient hospitalization claims for tobacco-related diagnoses. Two more papers are planned for this series. The first will focus on evaluating changes in claims for ambulatory visits for Medicaid subscribers who used the MassHealth tobacco cessation benefit. The second will focus on costs and estimated cost savings. The analytic models required for these latter studies are so substantially different from the one presented here that it is necessary to present the material in separate papers.

In preparing this paper, we sought to find other comparable datasets from Medicaid agencies in other states. Little information, if any, was readily available. While demographics may vary from state to state, there was nothing in our results to indicate that the health benefits from quitting smoking would be significantly different in Massachusetts than from any other state's Medicaid population. However, it is still important to note that our study was conducted in a low socioeconomic status (SES) population. Individuals of low SES are at greater risk of a wide range of health conditions through complex and sometimes poorly understood interactions between physical, social, and behavioral mechanisms [24–26]. Though we control for preexisting and comorbid health conditions, we cannot know for sure whether unmeasured factors or complex interactions may limit the generalizability of our findings to other populations. Nonetheless, the results reported here are promising. If replicated across state Medicaid programs, these findings have important implications for reducing costly hospitalizations and improving the health of our nation's poorest residents.

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Author Contributions

ICMJE criteria for authorship read and met: TL NAR DEL MP DW JAK LW LK. Agree with the manuscript's results and conclusions: TL NAR DEL MP DW JAK LW LK. Designed the experiments/the study: TL DEL DW JAK LK. Analyzed the data: TL DEL MP LW. Collected data/did experiments for the study: TL MP LW. Wrote the first draft of the paper: TL. Contributed to the writing of the paper: NAR DEL DW JAK LW LK. Advised on design and analysis plan: NAR. Oversaw study design, contributed to implementation, and oversaw evaluation of MassHealth benefit: LK.

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Editors' Summary

Background. Smoking is the leading preventable cause of death in the world. Globally, it is responsible for one in ten deaths among adults. In developed countries, the death toll is even higher—in the USA and the UK, for example, one in five deaths are caused by cigarette smoking. In the USA alone, where a fifth of adults smoke, smoking accounts for more than 400,000 deaths every year; globally, smoking causes 5 million deaths per year. On average, smokers die 14 years earlier than nonsmokers, and half of all long-term smokers will die prematurely because of a smoking-related disease. These diseases include lung cancer, other types of cancer, heart disease, stroke, and lung diseases such as chronic airway obstruction, bronchitis, and emphysema. And, for every smoker who dies from one of these smoking-related diseases, another 20 will develop at least one serious disease because of their addiction to tobacco.

Why Was This Study Done? About half of US smokers try to quit each year but most of these attempts fail. Many experts believe that counseling and/or treatment with tobacco cessation medications such as nicotine replacement products help smokers to quit. In the USA, where health care is paid for through private or state health insurance, there is some evidence that insurance coverage of tobacco cessation medications increases their use and reduces smoking prevalence. However, smoking cessation treatment is poorly covered by US health insurance programs, largely because of uncertainty about the impact of such coverage on health care costs. It is unknown, for example, whether the introduction of publicly funded tobacco cessation benefits decreases claims for treatment for tobacco-related diseases. In this longitudinal study (a study that follows a group of individuals over a period of time), the researchers ask whether the adoption of comprehensive coverage of tobacco cessation medications by the Massachusetts Medicaid program (MassHealth) in July 2006 has affected claims for treatment for tobacco-related diseases. During its first two and half years, more than 75,000 MassHealth subscribers used the tobacco cessation medication benefit and smoking prevalence among subscribers declined by approximately 10% (38.3% to 28.8%).

What Did the Researchers Do and Find? The researchers used MassHealth claims data and a statistical method called generalized estimating equations to compare the probability of hospitalization prior to the use of tobacco cessation medication benefit with the probability of hospitalization after benefit use among MassHealth subscribers. After adjusting for other factors that might have affected hospitalization such as influenza outbreaks and the implementation of the Massachusetts Smoke-Free Workplace Law in July 2004, there was a statistically significant annualized decline in hospital admissions for heart attack of 46% after use of the tobacco cessation medication benefit. That is, the calculated annual rate of admissions for heart attacks was 46% lower after use of the benefit than before among MassHealth beneficiaries. There was also a 49% annualized decline in admissions for coronary atherosclerosis, another smoking-related heart disease. There were no significant changes in hospitalization rates for lung diseases (including asthma, pneumonia, and chronic airway obstruction) or for seven other diagnostic groups.

What Do These Findings Mean? These findings show that, among MassHealth subscribers, the use of a tobacco cessation medication benefit was followed by a significant decrease in claims for hospitalization for heart attack and for coronary atherosclerosis but not for other diseases. It does not, however, show that the reduced claims for hospitalization were associated with a reduction in smoking because smoking cessation was not recorded by MassHealth. Furthermore, it is possible that the people who used the tobacco cessation medication benefit shared other characteristics that reduced their chances of hospitalization for heart disease. For example, people using tobacco cessation medication might have been more likely to adhere to prescription schedules for medications such as statins that would also reduce their risk of heart disease. Finally, these findings might be unique to Massachusetts, so similar studies need to be undertaken in other states. Nevertheless, the results of this study suggest that, for low-income smokers, removing financial barriers to the use of smoking cessation medications has the potential to produce short-term decreases in the use of hospital services that will, hopefully, outweigh the costs of comprehensive tobacco cessation medication benefits.

Additional Information. Please access these Web sites via the online version of this summary at http://dx.doi.org/10.1371/journal.pmed.1000375.

- The US Centers for Disease Control and Prevention Office on Smoking and Health has information on all aspects of smoking and health, including advice on how to quit
- The UK National Health Service Choices Web site provides advice about quitting smoking; more advice on quitting is provided by Smokefree
- The American Heart Association provides information on heart disease, including advice on how to quit smoking (in several languages)
- Information about MassHealth is available, including information on smoking and tobacco use prevention