ORIGINAL ARTICLE

Medical Costs of Secondhand-Smoke Exposure in North Carolina

Marcus Plescia, Daryl Wansink, Hugh R. Waters, Sally Herndon

BACKGROUND The health hazards of exposure to secondhand smoke (SHS) are well-defined. Less is known about the economic costs. We performed an analysis of the medical costs of SHS in North Carolina that was based on a similar study conducted in Minnesota.

METHODS We used 2006 Blue Cross and Blue Shield of North Carolina claims data and national and state surveillance data to calculate the treated prevalence of medical conditions that have been found to be related to exposure to SHS, as established by a 2006 report from the US surgeon general. We used the population attributable risk for these conditions to calculate the number of individuals whose episodes of illness could be attributed to exposure to SHS. We adjusted these treatment costs for other types of insurance provided in the state, using Medical Expenditure Panel Survey data.

RESULTS The total annual cost of treatment for conditions related to SHS exposure in North Carolina was estimated to be $293,304,430, in 2009 inflation-adjusted dollars. Sensitivity analysis showed a range of $208.2 million to $386.3 million. The majority of individuals affected were children, but the greatest costs were for cardiovascular conditions.

CONCLUSION These cost data provide additional rationale for regulating smoking in all work sites and public places.

During the 2009 North Carolina legislative session, a law was passed that banned smoking in all North Carolina restaurants and bars. Legislation in previous years had already banned smoking in state-employee work sites, including the North Carolina General Assembly building and offices. North Carolina now joins a growing majority of states with strong laws regulating tobacco use at work sites [1]. Because of North Carolina's status as a traditional tobacco state, many advocates see North Carolina's law as the tipping point in the national effort to eliminate the risks of exposure to secondhand smoke (SHS) in public places.

The health hazards of exposure to SHS are well-defined. A 2006 report from the US surgeon general clearly established that exposure to SHS is associated with poor health outcomes and that the ingredients of SHS are toxic and carcinogenic [2]. SHS is an important occupational risk factor for many workers. Regular exposure among nonsmokers increases their risk of lung cancer by 20%-30% and their risk of heart disease by 25%-30% [2]. Short-term exposure to SHS is associated with an increased risk of acute myocardial infarctions among individuals with preexisting medical risk factors for heart disease [3].

It is estimated that 1,690 adult nonsmokers in North Carolina will die each year as a direct consequence of exposure to SHS [4]. This is a compelling argument for work-site smoking regulations. Providing data on the treatment costs for medical conditions related to these risk exposures is an additional strategy in advocating adoption of new public health policy. Legislators and policymakers are concerned about containing costs, especially the costs of medical care. Recent state budget deficits and national discussions about health reform have heightened these concerns.

Data on the estimated proportion of individual medical conditions attributable to smoking and other uses of tobacco are available to determine the medical treatment costs of tobacco use. The most recent data were released by the Centers for Disease Control and Prevention in 2006, and the medical treatment cost of tobacco use in North Carolina was estimated to be $2.46 billion [5]. However, these data included smokers only and did not reflect the medical costs of exposure to SHS. The 2006 US surgeon general's report has made the analysis of medical treatment costs of SHS possible, by gathering, evaluating, and synthesizing the available epidemiologic evidence about the relationship between SHS exposure and a wide variety of medical conditions. Estimates of population attributable risk (PAR) for these conditions can be applied to medical care utilization rates and costs, to determine the medical treatment costs to payors that can be attributed to SHS exposure. Such an analysis, conducted in Minnesota, found that the medical cost of exposure to SHS was $228.7 million in 2006 [6].

The purpose of our study is to estimate the medical treatment costs, within a sensitivity range, of SHS exposure in North Carolina by means of an analysis similar to that used in the study from Minnesota. On the basis of these findings, we provide policy recommendations about the need for further regulation of exposure to SHS.

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Methods

The methods in the present study largely replicated those used in the study conducted in Minnesota [6]. Our unit of analysis was the treated prevalence, defined as the number of individuals living in North Carolina who have sought treatment for medical conditions that have been found to be related to exposure to SHS, as established by the 2006 surgeon general's report. Blue Cross and Blue Shield of North Carolina (BCBSNC) administrative claims data were used to estimate both the treated prevalence and the cost of conditions associated with SHS. Public data sources were used to help extrapolate the BCBSNC results to other public and private health insurance payors in North Carolina. We adjusted the treated prevalence for the age and sex compositions of these different groups, where appropriate.

As in the Minnesota study, 5 steps were used to estimate the costs of SHS in North Carolina.

(1) Determine the health conditions attributable to SHS. We used the risk categories established by the 2006 surgeon general's report, including all the conditions for which the evidence of a link with SHS was considered sufficient. We did not include the conditions for which the evidence was considered suggestive. Sufficient conditions include delivery of a newborn who has a low birth weight; acute lower-respiratory illnesses, for people aged 0-4 years; otitis media, middle-ear effusion, and asthma, for people aged 0-17 years; and lung cancer and coronary heart disease, for people in 2 age ranges, 18-64 years and 65 years or older.

(2) Derive the treated prevalence among BCBSNC members. For each sufficient condition, we calculated the treated prevalence for the BCBSNC membership, broken down by age range and sex. BCBSNC analyzed administrative claims data for services incurred in 2006, to identify members with episodes of care for the diseases identified in step 1. This corresponds to the percentage of the BCBSNC population who not only had the medical conditions in question during the calendar year but who also received treatment for these conditions.

An episode of care was derived from Episode Treatment Group (ETG) software, version 6 (Symmetry). The software uses clinical rules to group together claims and costs of care related to the treatment of more than 600 discrete conditions. ETG codes provide a useful measure of treated prevalence because they group all claims related to a single clinical episode of illness. ETG uses diagnosis information submitted by physicians and other health care professionals on insurance claims, to identify the start of treatment for a given condition, and it then aggregates subsequent treatment events and costs that pertain to the index condition. ETGs aggregate all related care provided to a patient, including professional services; inpatient and outpatient hospital services; laboratory, radiology, and pathology services; and prescribed pharmaceuticals [7].

(3) Estimate the treated prevalence in the North Carolina population. The number of North Carolina residents with a disease attributable to SHS was derived by taking the treated prevalence calculated within the age and sex brackets for BCBSNC members and then multiplying the total number of North Carolina residents in that age and sex bracket by the same value. Numbers of North Carolina residents in each age and sex bracket were obtained from the 2006 US Census Bureau Current Population Survey [8]. Because BCBSNC did not have a large population of members aged 65 years or older, more-reliable estimates of North Carolina's disease prevalence for this age group were obtained from the National Cancer Institute's SEER (Surveillance, Epidemiology and End Results) program, for the prevalence of lung cancer, and from the Agency for Healthcare Research and Quality, for the prevalence of coronary artery disease [9, 10]. Separately, North Carolina state data were used to estimate the prevalence of low birth weight [11].

(4) Apply the contribution of SHS to disease prevalence. We used the PAR proportions to determine the number of individuals whose episodes of illness could be attributed to exposure to SHS. The total number of North Carolinians who were treated for each disease (ie, the treated prevalence) was then multiplied by the appropriate PAR, to obtain the prevalence of each disease that was the result of exposure to SHS. We also performed sensitivity analysis for the PAR estimates, varying the baseline values across a range of ±25%.

The PAR was defined as the proportion of cases and associated mortality of a disease in a given population that can be considered to be causally related to exposure to a risk factor. The PAR is calculated as follows: [(incidence in total population) − (incidence in unexposed group)]/(incidence in total population). For example, if the treated prevalence of hospitalization for lung cancer for an entire population is 20.0% and the incidence among those not exposed to SHS is 19.0%, the risk attributable to exposure to SHS would be as follows: [0.2 − 0.19]/0.2 = 0.05 = 5%.

We used the PARs from the Minnesota report [6]. These were identified from the most-recent valid estimates in the published literature [6, 12, 13], with the exception of asthma, for which state prevalence data and risk estimates reported in the surgeon general's report were used because there no sound estimates were available [2, 6].

(5) Assign costs to treatment of attributable disease. BCBSNC administrative claims data were used to compute the total cost for an episode of care for each of the diseases attributable to SHS. The only exception was for low birth weight, which was estimated from per-episode costs reported in the literature [14]. In addition, because of the small population of BCBSNC members aged 65 years or older, the costs for lung cancer and coronary heart disease for members 18-64 years old were used as a proxy for the older members.

Because BCBSNC provides private insurance coverage to only a portion of North Carolinians, it was necessary to adjust the BCBSNC costs for different types of insurance

coverage, to estimate total costs for the state. BCBSNC costs were used as a proxy for all private insurance. For other types of insurance, we adjusted the per-episode treatment costs, using data from the Medical Expenditure Panel Survey (MEPS). The MEPS is a nationally representative sample of noninstitutionalized Americans that is collected by the Agency for Healthcare Research and Quality and includes a household-survey component and an insurance component providing details for employer-provided insurance plans. The ratios of medical expenses for several types of coverage (ie, Medicare, Medicaid, TRICARE [for military personnel and their families], and none) to that for private coverage in North Carolina was computed using MEPS data from the southeast region of the United States (Table 1) [15]. The ratios were then applied to the private-insurance costs for episodes of care, to estimate costs for treating each disease, depending on the type of insurance. The cost per episode of care was then adjusted for the prevalence of conditions by type of insurance. Finally, the costs based on 2006 data were adjusted to reflect 2009 dollars, using the Consumer Price Index [16].

Results

Table 2 shows the health conditions identified in the surgeon general's report and the overall prevalence of these conditions, projected using the prevalence among BCBSNC members, in North Carolina. The PAR for each condition is applied to each group, to determine the prevalence of each condition that can be attributed to SHS in North Carolina.

Table 3 provides the results of the medical cost analysis that was based on our analysis of the cost per episode of care among BCBSNC members. These costs are adjusted for insurance type, to provide the overall medical cost to the state for each condition. Table 1 specifies the distribution of insurance coverage in North Carolina and the ratios of medical expenses for other insurance sources to that for private insurance.

SHS was attributed with causing health problems for more than 100,000 North Carolinians in 2006. The vast majority of affected individuals were children. The findings show that the health care costs associated with SHS exposure in 2006 amounted to $293,304,430 in 2009 dollars. Cardiovascular disease represented the greatest cost and was almost half of all costs related to SHS. The next highest was for infants of low birth weight and represented nearly one-quarter of all costs.

TABLE 1.
Medical Expenses Attributable to Secondhand-Smoke (SHS) Exposure, by Primary Health Insurance (HI) Type, 2006

HI type	North Carolina residents, %	Expenses reported by MEPS respondents[a] Total,[b] mean, $	Ratio
Private	65	3,508	1.0
TRICARE[c]	2	4,867	1.39
Medicare	7	9,122	2.60
Medicaid	9	2,013	0.57
None	18	970	0.28

Note. See Methods for discussions of data collection and calculations.
[a]Medical Expenditure Panel Survey (MEPS) data were collected from individuals in the southeastern United States [15].
[b]Data indicate expenses per episode of care for diseases in which SHS exposure is considered a sufficient cause.
[c]For military personnel and their families.

As in the Minnesota study, sensitivity analyses were calculated for the PAR estimates and the MEPS insurance cost-adjustment ratios. We varied the PAR by 25% and the cost estimates by 15% in either direction. The results provide a range in the final cost-estimate value of $208.2 million to $386.3 million.

Discussion

We successfully replicated a detailed and methodologically rigorous analysis that had been completed in the state of Minnesota, to determine the total medical cost of treatment for conditions causally linked to SHS exposure in the 2006 surgeon general's report. In North Carolina, health care costs attributable to SHS in 2006 equaled $293,304,430 in 2009 inflation-adjusted dollars. The methods used in the Minnesota study were applied by us to determine the costs of SHS in North Carolina, using data from the state's dominant commercial insurer, BCBSNC.

Minnesota and North Carolina are similar in that Blue Cross and Blue Shield is the largest insurance provider in both states, with 26% of the market share (1.3 million members) in Minnesota [6] and 33% of the market share (3.7 million members) in North Carolina [17]. Therefore, Blue Cross and Blue Shield claims data represent a significant portion of costs in both states. In addition, the age and sex distributions of the 2 covered populations are very similar. When appropriate, external sources were used to expand or supplement Blue Cross and Blue Shield data. In both states, estimates of treated prevalence for the elderly population had to be drawn from other sources, as BCBSNC and Minnesota Blue Cross Blue Shield (MBCBS) did not serve large enough numbers of individuals in this age range. In addition, Blue Cross and Blue Shield data on cost -per episode of care for lung cancer and heart disease were not available for the population 65 years or older, because this population was predominantly covered by Medicare. Therefore, the cost data for the population aged 18-64 years were also applied to this group. While these cost estimates are similar to those found in the literature [18], compared with younger people, older people may have much higher costs, because they have more-chronic conditions, or they may have lower costs, if they do not choose aggressive treatment.

The cost estimates calculated here are likely to be underestimates because only medical conditions that were found to be sufficiently causally linked to SHS in the 2006 surgeon general's report were analyzed; conditions with evidence suggestive of a causal link were not included in our analysis. Costs for long-term care were not included because they

could not be as definitively attributed to SHS. Indirect costs related to the health care conditions of interest, such as lost productivity, are likewise not included. For this reason, we do not address the controversies related to SHS costs and shorter life expectancy.

One major limitation of the North Carolina analysis relates to our determination of costs for the Medicaid and uninsured populations. The methods used to estimate disease prevalence assume that the disease prevalence in the entire state population is comparable to the prevalence in the BCBSNC-insured population, with the exception of residents 65 years and older or low-birth-weight infants. However, the Medicaid and uninsured populations have higher rates of most adverse health conditions and are more likely to be exposed to SHS in the occupational setting. Therefore, it is likely that our method underreports the burden and costs of SHS exposure in these populations. The Minnesota study differs from this study because MBCBS includes special plans that cover portions of both the uninsured and the Medicaid populations and because the Minnesota study was able to use treated prevalence data for these groups, to better determine the specific prevalence estimates for these populations. In addition, the Medicaid and uninsured populations together composed a smaller proportion of the Minnesota population (18.9 % [9.2% and 9.7%, respectively]), compared with the proportion in North Carolina (25% [7% and 18%, respectively]) [15].

The implications of this study are important given the current fiscal crisis in many states and discussions of the significant costs of providing coverage to the uninsured through health reform. In addition, a significant portion of these savings could probably be realized over a relatively short period. Recent data have shown that regulations restricting exposure to SHS in multiple communities were associated with significant decreases in hospitalizations for myocardial infarction over a 1-2–year period [3]. Similar short-term reductions in health care utilization may be possible for asthma and ear infections in children.

In the 2009 session, the North Carolina General Assembly became the first major tobacco-producing state to make all bars and restaurants smoke free. This built on incremental successes of previous years, which made all schools and prisons 100% tobacco free and government buildings and motor fleets smoke free. The 2006 surgeon general's report had been introduced in legislative debates in the 2 years before passage of the law that banned smoking in restaurant and bars, making the science of the serious health consequence of SHS more widely understood. Results of this study were released on March 16, 2009, in time for the facts to be entered into the discussion of the bill in House and Senate committee and floor debates.

While the impact on decision making by legislators is difficult to quantify, these data were used consistently in the arguments presented by legislative champions in committee and floor debates. Analyses of news reports following the passage of the law have indicated that data on financial cost played a significant influence in the success of this legislation [19]. Cost data were considered useful, given the significant historic legacy of tobacco growing and manufacturing in the state's economy. The data were useful in helping to shift the attitudes of some decision makers from tobacco as an economic benefit in North Carolina to

TABLE 2.
Treated Prevalence of Conditions Attributable to Secondhand-Smoke (SHS) Exposure, North Carolina (NC), 2006

Age, condition	Susceptible NC population[a]	For BCBSNC members[b]	Projected to NC residents	Attributable to SHS in MN[c]	Treated prevalence in NC
<18 y					
Low birth weight	127,646	0.09084[d]	11,595	0.18	2,087
Acute lower respiratory illnesses (for ages <5 y)	473,306	0.11965	56,633	0.25	14,158
Otitis media and middle-ear effusion	2,151,548	0.16630	357,801	0.14	50,092
Asthma, wheeze illness	2,151,548	0.04022	86,539	0.35	30,289
18-64 y					
Lung cancer	5,660,468	0.00077	4,370	0.049	214
Coronary heart disease	5,660,468	0.01877	106,258	0.069	7,332
≥65 y					
Lung cancer	1,057,639	0.00664[e]	7,028	0.049	344
Coronary heart disease	1,057,639	0.03496[f]	36,973	0.069	2,551

Note. See Methods for definition of "treated prevalence" and discussions of data collection and calculations.
[a]Data are from [8].
[b]Data are from Blue Cross and Blue Shield of North Carolina (BCBSNC) administrative claims.
[c]Minnesota (MN) data are from [6].
[d]Data are from [11].
[e]Data are from [9].
[f]Data are from [6].

TABLE 3.
Medical Costs of Health Conditions Attributable to Secondhand-Smoke (SHS) Exposure, North Carolina (NC)

Age, condition	Treated prevalence in NC	Cost per episode of care, $		Overall costs for NC residents, $	
		For BCBSNC members[a]	Adjusted for NC residents[b]	Unadjusted	Inflation adjusted
<18 y					
Low birth weight	2,087	41,790[c]	34,548	72,104,178	77,151,470
Acute lower respiratory illnesses (for ages <5 y)	14,158	621	515	7,287,382	7,797,499
Otitis media and middle-ear effusion	50,092	333	276	13,818,975	14,786,303
Asthma, wheeze illness	30,289	981	814	24,648,459	26,373,851
18-64 y					
Lung cancer	214	42,409	36,613	7,840,023	8,388,246
Coronary heart disease	7,332	11,971	10,337	75,789,730	81,095,011
≥65 y					
Lung cancer	344	42,409[d]	66,164	22,784,811	24,379,747
Coronary heart disease	2,551	11,971[d]	19,537	49,842,620	53,341,603
Total	...	...	...	274,116,177	293,304,430

Note. See Methods for definition of "treated prevalence" and discussions of data collection and calculations.
[a]Data are from Blue Cross and Blue Shield of North Carolina (BCBSNC) administrative claims.
[b]Data are adjusted for types of insurance coverage in North Carolina.
[c]Data are from [14].
[d]Imputed from costs for people aged 18-64 years, because of a small number of observations.

tobacco use as a health care and human cost liability. This was strategic, as the economic and human costs of SHS exposure helped to sway legislators who had voted against tobacco-control legislation in previous years. Use of cost data, derived directly from insurance claims, was felt to be more compelling than use of data from analyses based on statistical modeling.

The passage of a smoke-free law for restaurants and bars is significant in North Carolina, given the state's historic role in both growing and manufacturing tobacco products. In addition, the vast majority of restaurants and bars are complying with the new law. In the first 6 weeks after enactment, the state had received complaints against only 370 of more than 24,000 businesses that are subject to the law [20]. However, a comprehensive SHS law would ban tobacco use in all work sites. While the recent law probably covers a large proportion of North Carolina workers in the service industry, our previous analyses have found that only 56% of blue-collar workers and 73% of white-collar workers reported working in a smoke-free environment [21]. These workers receive no protection from the current law. For these reasons, the North Carolina Institute of Medicine Task Force on Prevention recommended in 2009 that the North Carolina General Assembly should amend current smoke-free laws to mandate that all workplaces and public places are smoke free [22]. Such action would protect all workers from the chemical hazards of SHS. NCMJ

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