Prev Sci (2008) 9:38–46
DOI 10.1007/s11121-008-0082-0

Cost-Effectiveness Analysis of the Not On Tobacco Program for Adolescent Smoking Cessation

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Published online: 20 February 2008

Abstract Public health researchers and practitioners emphasize the need for effective, adoptable, and available youth smoking cessation interventions. Scarce resources demand that such interventions also be cost effective. This study describes a cost-effectiveness analysis (CEA) of the American Lung Association's Not On Tobacco (N-O-T) national and international teen smoking cessation program. N-O-T has been rigorously evaluated as an effective and adoptable program, and was recently found to be the most frequently-used teen smoking cessation program in the nation. N-O-T studies show intent-to-treat quit rates between 15% and 19%, among the highest reported in the literature. The current CEA resulted from a 2-year state-wide demonstration study in Florida, comparing the effectiveness of N-O-T with a 20-min brief intervention (BI). The CEA utilized a Markov transition model of decision analysis to explain stage progression of smoking cessation among participants from the age of 17 to 25 years. The Markov simulation predicted that out of a cohort of 100 N-O-T students, 10 will quit smoking and remain smoke-free at the age of 25 years and 14 will reduce smoking, resulting in 102.22 life years saved and a total of 20.11 years discounted life years (DLY) saved. Among BI youth, six will quit smoking and nine will reduce, indicating 64.31 life years saved and a total 12.65 DLY saved. The incremental DLY saved is 7.46 years. Results indicate that N-O-T is a very cost-effective option school-based smoking cessation, as cost effective as school-based primary tobacco prevention, and potentially more cost effective than adult tobacco use cessation.

Keywords Adolescent smoking cessation · School tobacco control · Cost effectiveness analysis

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Introduction

The figures are staggering and sobering—over half of the nation's high school students have tried smoking, nearly one quarter of youth between 12 and 17 years of age are current smokers (MMWR 2006), and one-third of all youth who smoke will eventually die of smoking-related diseases (Centers for Disease Control and Prevention 1996). With almost 4,000 youth initiating tobacco use every day (Substance Abuse and Mental Health Services Administration 2004), the need for concerted efforts to curb adolescent smoking cannot be overemphasized. Although there have been important successes in smoking prevention (Mermelstein 2003), these efforts do not address the needs of youth who smoke and want to quit. Consistently, there remains a critical need for effective and adoptable teen smoking cessation interventions (Houston et al. 1998; Lamkin et al. 1998; Sussman 2002).

A number of youth tobacco use prevention and cessation programs have been developed and implemented, each with its own methodology, effectiveness, and associated costs. However, concerns about limited public health resources require that decision makers at school, community, and state levels consider how to maximize impact with the most efficient expenditure of resources possible (Gold et al. 1996). To that end, it has been argued that the success of an intervention should be determined not only by effectiveness, but also by reach and adoption, factors that are influenced by the resources required for implementation (Glasgow et al. 2003).

When faced with selecting one intervention over another, decision makers, such as school administrators, often turn to a range of economic evaluation techniques, such as cost-utility analysis (benefits are expressed as quality-adjusted life years), cost-benefit analysis (benefits are expressed in monetary terms), and cost-effectiveness analysis (benefits are expressed as health-related benefits, such as life years gained). Each evaluation technique has its pros and cons. However, cost-effectiveness analysis (CEA) has been extensively utilized in the medical literature because of its focus on the links between costs, overall effectiveness, and health outcomes (Effective Clinical Practice 2000). Despite its relevance, CEA has been sparsely utilized in the public health literature, in general, and with behavioral interventions for youth, in particular (Wagner and Goldstein 2004). We are aware of only two studies that have assessed the cost-effectiveness of tobacco-use prevention programs implemented in US schools (Tengs et al. 2001; Wang et al. 2001).

The present study addresses this gap by describing a CEA of the American Lung Association's (ALA) Not On Tobacco (N-O-T) national teen smoking cessation program. N-O-T is a ten-session theory-based program delivered by trained facilitators, typically in school settings (Dino et al. 2001). N-O-T studies showed end-of-program intent-to-treat quit rates between 15% and 19% for the period 1998–2003 (Horn et al. 2005), among the highest rates reported in the literature (Sussman 2002). It has been rigorously evaluated as an effective, adoptable program (Horn et al. 2005). As a result, N-O-T is recognized as a Substance Abuse and Mental Health Services Administration evidence-based Model Program, a National Cancer Institute Research Tested Intervention Program, and an Office of Juvenile Justice and Delinquency Prevention Model Program. A recent survey of youth smoking cessation programs found N-O-T to be the most widely used intervention in the nation (Curry et al. 2007). Whereas N-O-T's effectiveness and adoptability have been examined, its cost-effectiveness has not. The present CEA compares N-O-T with a minimal-contact brief intervention (BI), using expert guidelines and recommendations (e.g., Gold et al. 1996; Haddix et al. 2003). We conducted the CEA from a school perspective because (1) all data resulted from school-based program delivery; (2) schools were (and are) the primary delivery site for N-O-T; and (3) at the time of the study, decisions to use N-O-T were made primarily by school personnel, using school-based considerations.

Methods

The methods are organized into five subsections. First, we describe N-O-T and the BI. Second, we outline the 2-year N-O-T vs. BI efficacy study (Dino et al. 2001) that provided the cost and effectiveness data used. Third, we detail the costs associated with N-O-T and the BI. Fourth, we discuss the evaluation of program effectiveness in terms of life years saved. Due to the lack of data on life expectancies of smokers and non-smokers below the age of 25, we describe the use of Markov transition models to estimate participants' smoking state at the age of 25 based on baseline and 7-month post-baseline data collected in the N-O-T efficacy study. Finally, we detail the processes involved in conducting the CEA.

Intervention Descriptions

The Not-On-Tobacco Program N-O-T takes a total health approach to teen smoking cessation and reduction (Dino et al. 2001). It incorporates motivational issues; smoking history; nicotine addiction; the physical, psychological, and social consequences of smoking; preparation for quitting; dealing with urges and cravings; relapse prevention; stress management; dealing with family/peer pressure; increasing healthy lifestyle behaviors; and volunteerism. In N-O-T effectiveness studies, participants received 10, 50-min sessions that occurred once a week for 10 consecutive weeks. Per formative research, N-O-T was delivered with small (<10) same-gender groups by trained same-gender facilitators, in private non-classroom settings during school hours (Dino et al. 2001).

The Brief Intervention Program The BI reflects what students might receive in a typical school setting. Mixed-gender groups gathered in a classroom where they received approximately 5–10 min of scripted quit smoking advice and widely available self-help brochures. An additional 10 min was used to describe the purpose of the gathering and to answer questions. School personnel assisted with BI recruitment and set up (Dino et al. 2001).

Utilization of Secondary Data: Two-Year Efficacy Study Overview

The data used in the current CEA resulted from a 2-year (1999–2000) state-wide demonstration study in Florida

(FL) that compared the effectiveness of N-O-T with that of the BI (Dino et al. 2001). Primary study partners included the academic research team and the ALA of Florida (FL). Each year, ten schools were selected to receive N-O-T; ten BI schools were then matched correspondingly to the ten N-O-T schools based on the community demographics of school locales, student population size, race and ethnic composition, student–teacher ratio, geographic location (urban, suburban, rural), and tobacco policy violations in the previous year. This resulted in 20 N-O-T and 20 BI schools over the 2 study years.

Enrolled youth had to volunteer to participate and report smoking at least five cigarettes per day on weekdays and/or weekends to be included in analysis. Across years, 627 youth enrolled in the study. Approximately 90% were study eligible (n=566, 313 N-O-T and 253 BI). Of these, 10% were excluded from analysis because they did not smoke at least five cigarettes a day or smoked cigars only. Participants were between 14 and 19 years old (M=16.19, SD=1.15) at baseline. Most were non-Hispanic white (81.3%), 1.8% were non-Hispanic African-American, 1.6% were American Indian, 1.1% were Asian-American or Asian, 8.8% were Hispanic, 1.1% were Pacific Islander/Native Hawaiian, and 4.2% were of other ethnic/racial origins or biracial. Participants smoked about half a pack a day on weekdays (M=11.66), and about one pack a day on weekends (M=18.18). The mean age of smoking onset was 11.45 years. N-O-T and BI facilitators were provided with specific recruitment guidelines and materials found effective in previous studies, such as posters and PA announcements.

Training of ALA staff and N-O-T facilitators Training included procedures consistent with standard ALA protocol, as well as guidance on the research process. Senior ALA of FL staff, one of whom served as an ALA-certified N-O-T Master Trainer, provided a 2-day training on N-O-T administration and implementation for the three local ALA coordinators involved in the project. The first author provided coordinators with approximately 3 hours of evaluation/study protocol training. Each regional coordinator then provided N-O-T facilitators with a 1-day experiential training workshop. Finally, the research team provided facilitators with 2 hours of study protocol training that included a manual on the study's evaluation protocol.

Study Outcomes Post-intervention data, including carbon monoxide-validated (CO<9 ppm) smoking status, were collected at 5.2 months post program. Approximately 50% of participants were available to provide quit and reduction outcome data (n=274, 127 N-O-T and 147 BI). At this time, the average age of the study participants was slightly less than 17 years. There are two methods for determining teen cessation quit and reduction rates—compliant sub sample analysis and the more conservative intent-to-treat analysis. Intent-to-treat (ITT) includes all participants who initially enrolled in treatment. ITT assumes that all youth lost to follow-up are program failures; i.e., they neither quit nor reduced smoking. Compliant sample analysis assumes that, with appropriate attrition analysis, the available sample of participants who provided follow-up data is representative of the total sample. Attrition analysis demonstrated no consistent differences between N-O-T and BI participants or between N-O-T and BI school groups that were related to program outcomes (Dino et al. 2001). Although these results could justify using outcome data from the compliant sub-sample, we chose the conservative ITT procedure to assess biochemically-validated quit rates. Reduction rates were also calculated using ITT. A participant was considered to have reduced smoking if s/he smoked less at follow up than at baseline. Quit analyses showed that 11.8% of the 289 N-O-T students quit smoking compared to 6.3% of 253 BI participants. Reduction analyses indicated that 26.0% of N-O-T youths and 18.2% of BI youths reduced smoking. Additional analyses (Dino et al. 2000) revealed a mean percent reduction for N-O-T youths of 56.0% (SD=22.3.%) and 53.1% (SD=25.7%) on weekdays and weekends, respectively; BI counterparts showed a mean percent reduction of 48.9% (SD=24.9%) and 51.2% (SD=26.8%) on weekdays and weekends, respectively.

Assessment of Intervention Costs

All costs included in the CEA are measured in terms of dollar costs in the year 2000. All intervention costs were incurred in a single year, so no adjustments for inflation were required. Medical cost savings were not incorporated in the analyses; therefore, discounting cost to adjust for preferential timing was not required. Intervention costs for a total of 40 schools were factored into the CEA. There were three primary sources of training costs for the two N-O-T facilitators at each school—(1) the N-O-T facilitator guide and miscellaneous expenses ($95 per facilitator, $190 per school); (2) the training facility and room, board, and service cost for an ALA-certified Master Trainer ($15 per school); and (3) N-O-T brochures and gifts for participants ($125 per school). Thus, the total estimated direct intervention cost for N-O-T was $526.25 per school. No funds or incentives were provided specifically for recruitment. In our study, the costs of N-O-T training and delivery were assumed by the research funding or funding provided to the ALA of FL by the state. In non-research applications, all N-O-T implementation costs (e.g., training of local ALA staff by an ALA Master trainer, facilitator training costs, and incentives for school and participants) would be incurred by stakeholders/implementers at school, a site, or at state levels. Thus, it is appropriate to include these costs in our CEA. The BI involved no significant resource utilization for facilitator training. The only costs for BI schools were for widely available educational brochures distributed to the students ($153); i.e., the National Cancer Institute's "Questions and Answers about Smoking and Health," "Facts about Cigarette Smoking," "Facts about Nicotine Addiction," and "I Quit." Although the cost of BI brochures, and gifts and incentives would not typically be assumed by schools implementing N-O-T, they are also included in the analyses to accurately reflect study costs. Finally, facilitators provided N-O-T or BI during school hours and received no monetary compensation in addition to their regular salaries. Thus, facilitator time was not included in the initial CEA. See Table 1 for a detailed breakdown of intervention costs.

Intervention Effects: Life Years Saved

One benefit of CEA is that it expresses benefits in terms of health effects, such as life years gained. In order to conduct the CEA, we had to first determine years of life gained by stopping smoking at the time of intervention. However, published estimates of life expectancies for different categories of smokers and ex-smokers were not available for age groups younger than 25 years, and the average age of our participants at the time of follow-up was 17 years old. Given that the progression from age 17 to age 25 may involve multiple transitions in and out of various states of smoking (e.g., non-smoking, "light" smoking, regular smoking), we extrapolated the probabilities that participants who stopped or reduced smoking at the age of 17 would remain in that state or transition to other smoking states by the age of 25 years. We used a Markov transition model of decision analysis to explain stage progression of smoking cessation among study participants from the age of 17 to 25 years. This modeling process was used successfully to estimate the cost-effectiveness of school-based tobacco education (Tengs et al. 2001), and has been used in the mathematical, medical, and psychological literature to estimate future states based on current data (Anderson et al. 2006; Bolt 2003; Macario et al. 2006). We selected the age of 25 as our endpoint for transition modeling because life expectancy data are available for smokers and ex-smokers from the age of 25 and above, allowing calculation of life years saved by N-O-T or BI interventions. Moreover, the probability of a former adolescent smoker relapsing after age 25, given 6 years or more of cessation is very slim (Krall et al. 2002). We utilized national smoking prevalence data from the cross-sectional Teenage Attitude and Practices Survey (TAPS). TAPS offered age-specific distributions to specify transition probabilities between the ages of 17 to 25 (Choi et al. 2001). These authors reported that the average probability of an adolescent smoker becoming an established smoker was 60.15%, and a probability of 74.7% that an established smoker will remain so at 4 years follow-up.

Table 1 Costs for Not On Tobacco (N-O-T) and the Brief Intervention (BI)

Intervention Component	N-O-T		BI	
	Cost for 20 Schools	Cost Per School	Cost for 20 Schools	Cost Per School
Master Trainer	$305.00	$15.25	–	–
Costs incurred for facilitators	$3,800.00	$190.00	–	–
Manuals/brochures	$3,920.00	$196.00	$153.00	$7.65
Gifts and incentives	$2,500.00	$125.00	–	–
Total costs	$10,525.00	$526.25	$153.00	$7.65

Since everyone enrolled in either N-O-T or the BI was an established smoker, a state called "smoker" was used to define all participants at baseline. Consistent with Markov procedures, we then assigned participants into one of three subsequent states: (1) "quit," (2) "reduce," or (3) "stay smoker," based on our 6-month follow-up data. The state probabilities at follow up (age 17) and at age 25, corresponding to the end of the Markov simulation, are shown in Table 2. A participant was in the "quit" state if self-reported quitting was indicated and validated by expired air carbon monoxide readings <9 ppm (Dino et al. 2001). A participant was in the "reduce" state if his/her percent reduction in cigarette consumption from baseline was greater than zero. All remaining participants were assumed to be active smokers and classified in the "stay smoker" state. We dropped these "stay smoker" participants from future iterations of our simulation and permanently categorized them as smokers throughout the model. Although some of these individuals may eventually quit smoking in the future, that outcome may not be attributed to the interventions with confidence. This is consistent with intent to treat assumptions that all participants lost to follow up continue to smoke. As a result, estimations utilized in the CEA may be conservative.

In the next step, N-O-T and BI participants categorized in the "quit" and "reduce" states were modeled to pass through two 4-year cycles from age 17 to 21 and then from age 21 to 25 (see Fig. 1). Participants who were modeled as maintaining quit status at the end of the first 4-year cycle were classified to be in the "quit" state for entry into the second 4-year cycle. Participants initially classified in the "quit" state were subsequently categorized in the "reduce" state for the second 4-year model cycle if the model identified them as relapsing to smoking at a rate lower than at baseline. Participants classified in the "reduce" state at the start of the first 4-year cycle could progress to the "quit"

Table 2 Smoking states, life expectancy and life years saved at age 17 and 25 years for Not On Tobacco (NOT) and the Brief Intervention (BI)

Smoking State	N-O-T Program		BI Program		Average life expectancy	Life years saved
	Age 17[a]	Age 25[b]	Age 17[a]	Age 25[b]		
Quit	11.8%	9.7%	6.3%	6.2%	54.9	5.1
Reduce	26%	14.5%	18.2%	9.0%	53.5	3.7
Stay smoker	62.3%	75.8%	75.5%	84.8%	49.9	–

Life years saved and life expectancies are based on estimates of being in each smoking state at age 25; average life expectancies are weighted averages using the proportion of female and male students as weights.

[a] Based on data collected from participants at 7-month post-baseline follow-up (14).

[b] Based on the results of the Markov transition models

state at the end of the cycle if the model identified them as a nonsmoker. If the model suggested the participant maintained his/her reduce status, he/she remained in the "reduce" state. Participants modeled as smoking at the same or higher rate than at baseline, were classified in the "stay smoker" state and remained there through the second 4-year model cycle.

At the beginning of the second 4-year cycle, participants were again categorized into the three states of "quit," "reduce" or "stay smoker." Modeling for the second cycle utilized the same procedures as those for the first. The simulation was designed to terminate at the end of the second cycle at which time the average age of the participant would be 25 years. At age 25, the percentage of the cohort belonging to each of the three states provided an estimate for the probability that an individual student would belong to a certain smoking state at that age.

Based on participant's classification in one of the three smoking states at the end of the second 4-year model cycle, we then estimated the number of life years saved. To do

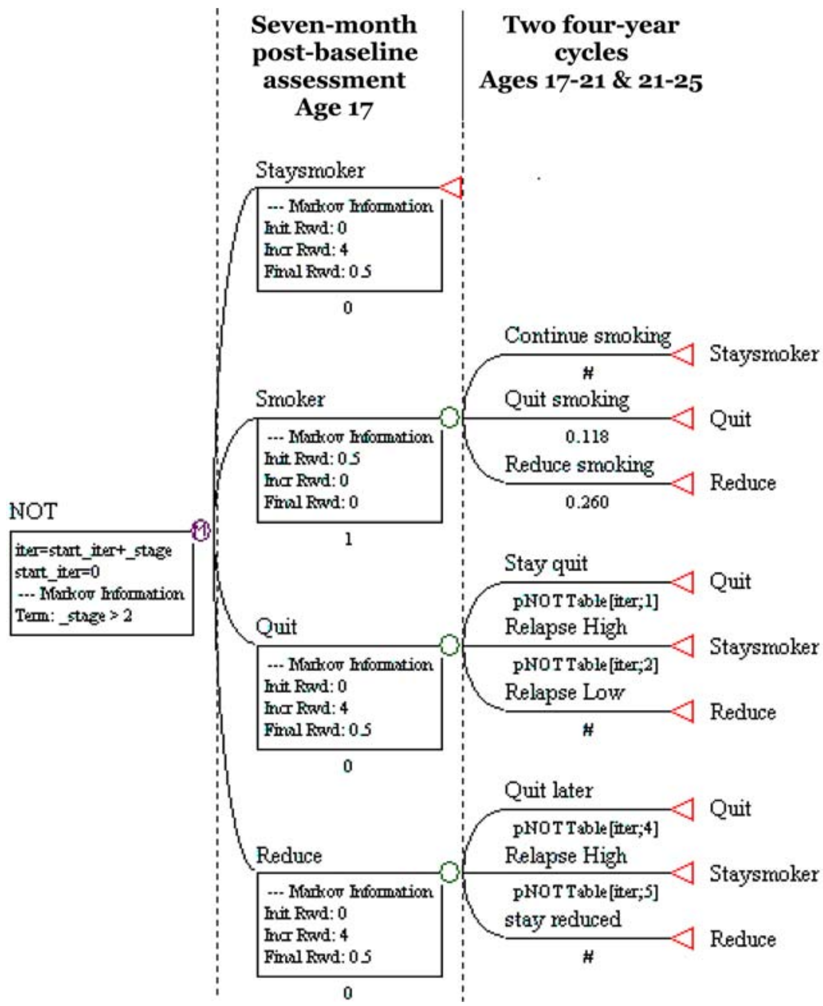

Fig. 1 Sample Markov Decision Tree (the Markov information at the N-O-T node instructs termination after two iterations). *Init Rwd* Initial reward, the number of years attained before entering a particular state; *Incr Rwd* incremental reward, the number of years spent in a particular state; *Final Rwd* final reward; the number of years attained after a particular state. Initial and final rewards have 0.5 values because the modeling exercise was done using a mid-year index

this, we utilized Rogers and Powell-Griner (1991) data for estimated life expectancies for never, former, and current smokers in the age group 25–29 years for both sexes. Based on these estimates, we calculated the life years saved (weighted by gender) by a quitter at age 25 to be the difference between the life expectancy of a current smoker and that of a former smoker. For a reducer at age 25, we calculated the life years saved as the difference between the life expectancies for a current smoker and a light smoker. Because of the difference in the proportions of males and females receiving N-O-T and BI, the resulting average life years saved by a quitter or reducer is slightly different for both interventions. This procedure resulted in an estimated life years saved of approximately 5.1 years for quitters and about 3.7 years for reducers, as shown on Table 2.

Sensitivity Analyses

Assumptions about transition probabilities and cost estimates significantly affect final CEA results. Therefore, we performed multivariate sensitivity analyses by varying assumptions about the rate with which the probability of moving from one state to another changes from the preceding year. Consistent with the school perspective, we varied the cost estimates by including indirect costs of facilitators' time. Facilitators were regular teachers, so time spent implementing N-O-T or the BI may have meant time not spent on other school-related activities. Thus, one might argue that there is an opportunity cost associated with provision of the intervention. We estimated that each N-O-T facilitator spent an average of 16.5 hours for preparing and delivering N-O-T (10-hour program and 6.5 hours preparation time). This time commitment was valued at an hourly wage of $18, corresponding to an annual salary of $35,000. Thus, the costs for 40 N-O-T facilitators in 20 schools would amount to $11,880. Since the BI was not delivered in a gender-sensitive manner, only one facilitator was required for each school. We estimated that each facilitator spent an hour delivering the BI (15 min for program delivery and 45 min for preparation) and calculated the imputed value of facilitator's time as $360 for the 20 BI schools using the same hourly rate of $18.

Our nationwide experience with N-O-T shows that schools often lack resources to distribute participant incentives and, thus, may use incentives provided by others (e.g., movie theatres, food and beverage retailers). Since incentive costs are not constant, we recalculated total costs by eliminating incentives, thus reflecting a total cost estimate for schools not incurring such costs. Different combinations of alternative estimates for transition probabilities and intervention costs enabled us to calculate a range of program cost and effectiveness values from which the "best-case" and "worst-case" scenario values for the incremental cost-effectiveness ratio were derived (see Table 3). The "best-case" scenario result is derived from combining the best quit rates and the least cost situations while the "worst-case" scenario result corresponds to the conditions of the highest cost and worst quit rates.

Results and Discussion

The results of the Markov transition models are summarized in Table 3. As indicated, the Markov simulation predicted that out of a cohort of 100 students who participated in N-O-T at an average age of 16.2 years, 10 will quit smoking and remain smoke-free at the age of 25 years; 14 will reduce the number of cigarettes smoked. This would result in a total of 102.22 life years saved, equivalent to a total discounted life years (DLY[1]) saved of 20.11 years. Of a cohort of 100 BI students, 6 will quit smoking and remain smoke-free of 25 years of age and 9 will reduce smoking. This would result in a total of 64.31 life years saved, equivalent to a total DLY saved of 12.65 years. The difference between the discounted life years saved for N-O-T and BI represents the incremental discounted life years saved and is equal to 7.46 years.

Based on the cohort of 100 students, the estimated total costs of N-O-T would be approximately $3,362.61 whereas that of the BI would be $60.47. The incremental cost (i.e., the difference between the two cost estimates) is approximately $3,302.15. Hence, the incremental cost-effectiveness ratio is equal to about $442.65 per DLY saved. This value implies that every additional life year saved as a result of N-O-T, that otherwise would have been unobtainable due to the BI, will be at an additional expense of $442.65.

The results of the sensitivity analyses gave us a range of possible values for the incremental cost-effectiveness ratio. The results of the best- and the worst-case scenarios are presented also in Table 3. The results are sensitive to the assumption about the yearly growth or decline in the transition probabilities as well as the cost of gifts given to students receiving N-O-T. As we would expect, the higher the cost of implementing N-O-T relative to BI, without any improvement in the outcome measures, the higher will be the incremental cost-effectiveness ratio, implying a decline in the cost-effectiveness of N-O-T. Similarly, the more stringent the assumption about a participant transiting between the "reduce" to the "quit" states, assuming no change in program costs, the higher will be the incremental cost-effectiveness ratio. The best-case scenario indicates an incremental cost-effectiveness ratio of about $273.60 per DLY saved. This represents what is obtainable under the

[1] Despite the controversies associated with discounting life years, we believe that failure to do so results in bias results in favor of non-discounted cost-effectiveness ratios.

Table 3 Results of base model, best- and worst-case scenarios

	Base model		Best case scenario		Worst case scenario	
	N-O-T	BI	N-O-T	BI	N-O-T	BI
Number of quitters	9.7	6.2	11.50	7.10	8.20	5.40
Number of reducers	14.5	9.0	16.00	9.40	14.30	8.80
Total life years (LY) saved	102.22	64.31	116.83	70.32	93.90	59.53
Total discounted LY saved	20.11	12.65	22.99	13.84	18.48	11.71
Total cost of intervention ($)	3362.61	60.47	2563.90	60.47	7158.15	202.77
Incremental cost ($)	3302.15		2503.43		6955.38	
Incremental effectiveness (year)	7.46		9.15		6.76	
Incremental cost-effectiveness ratio ($/DLY saved)	442.65		273.60		1028.90	

N-O-T Not On Tobacco; *BI* Brief Intervention

most optimistic assumptions about transition probabilities and at the minimum possible costs for implementing N-O-T. In contrast, the worst-case scenario indicates an incremental cost-effectiveness ratio of about $1,028.90 per DLY saved. This represents what we might expect under overly pessimistic assumptions about transition probabilities and with a generous budget.

Our base estimate of $442.65 per DLY saved for the incremental cost-effectiveness ratio compares favorably with estimates from previous cost-effectiveness studies of adolescent prevention and adult smoking cessation programs (Wang et al. 2001). For example, Wang and colleagues found a base cost-effectiveness ratio of $703 (in 1990 dollars) per DLY saved for a classroom-based tobacco prevention program when medical costs were excluded. Since they did not have a comparison intervention, we converted our base estimate to an ordinary cost-effectiveness ratio (as opposed to an incremental ratio) in order to aid comparison with their estimate. This translates to a cost-effectiveness ratio of $167.21 for N-O-T, a much lower figure even in 2000 dollars. Whereas no standard exists that specify what is a "good value" with regard to monetary costs associated with CEA, it has been suggested that amounts less than $10,000 per life year are "cost effective" and highly desirable (Wang et al., 2001).

Several study limitations result our choices for conducting the CEA. First, CEA experts encourage researchers to use the societal perspective in studies that impact population health (e.g., Gold et al., 1996; Haddix et al., 2003). We concur fully that the societal perspective is a critical one in spite of our rationale for using the school perspective. Because of our school rather than societal based perspective, we excluded medical care costs that could potentially be saved by ex-smokers in estimating the total costs of N-O-T and the BI. It could be argued that whereas ex-smokers save medical costs on smoking-related diseases, they also live longer than do non-smokers. Consequently, they may, in fact, incur higher medical care costs over their lifetimes. Hence, special attention should be paid when comparing our results with those from studies that report cost-savings (by including medical care costs saved) for smoking cessation programs. Second, we excluded student time out of the classroom. Although it could be argued that time outside of the classroom is a cost, participants in previous studies of N-O-T consistently report enhanced knowledge about health, feeling better about themselves, and managing stress better; and facilitators report participants' showing a greater commitment to school, receiving better grades, and overall improvement in confidence (e.g., Horn et al. 1999). These secondary outcomes may be conceptualized not as costs, but as benefits. Additionally, our CEA did not include a "no intervention" condition. Without this condition, we were unable to ascertain the cost-effectiveness of N-O-T with that of "doing nothing" or to assess if the BI, in itself, is better than "doing nothing."

Another way to informally examine the cost savings of N-O-T is to compare the amount the average participant spent on cigarettes for a year with the study's cost-effectiveness ratio. At the time of study enrollment, participants smoked about half a pack of cigarettes per day on weekdays and about a pack per day on weekends or 4.5 packs per week. Assuming a 52-week year, a teen smoker would have consumed 234 packs of cigarettes in a year. If a pack cost $3, the teen would have spent about $702 a year. His or her total spending on cigarettes will amount to about $1,346 per year if cigarettes cost $5.75 a pack. The lower cost of $702 per year is higher than the incremental cost-effectiveness ratio of $442.65 per DLY saved for the base model and the higher cost of $1346 per year is higher than our worst-case estimate of $1,028.90 per DLY saved. Thus, the money that the teen would have used to purchase cigarettes over a year would be enough to pay for N-O-T, and at the same time save the teen an additional year of life that could have been lost to smoking.[2]

[2] We are grateful to a workshop participant at the 16th National Chronic Disease Conference in Atlanta, GA, for making this illustration.

Conclusion

In recent years, public and school health practitioners have joined researchers and national health organizations to emphasize the importance of disseminating effective, adoptable school-based youth smoking cessation initiatives. Although studies of program effectiveness are available, scarce resources demand that programming choices go beyond efficacy considerations, and reflect the extent to which an intervention is cost effective; i.e., provides “a good value for the cost” (Gold et al. 1996; Tengs et al. 2001; Wang et al. 2001).

CEA results indicate that N-O-T is a cost-effective option for school-based tobacco control. In fact, our CEA suggests that a group-based teen smoking cessation intervention, such as N-O-T, can be as cost effective as a school-based tobacco prevention program and potentially more cost effective than adult smoking cessation (Wang et al. 2001). These findings are especially noteworthy in light of the conservative choices used in our CEA procedures; e.g., intent-to-treat procedure and 6-month follow up. Moreover, the BI quit rates, in contrast to the N-O-T quit rates, reported here are among the highest we have ever obtained in N-O-T effectiveness studies (Horn et al. 2005). Based on the present findings, we recommend strongly that policy makers and school health decision makers consider including adolescent smoking cessation as a critical component of comprehensive, cost-effective tobacco control efforts.

This recommendation is consistent with the efforts of the Youth Tobacco Cessation Collaborative (YTCC) (Orleans et al. 2003). One of the goals identified in YTCC’s National Blueprint is to ensure that every youth tobacco user “has access to appropriate and effective cessation interventions by the year 2010” (YTCC, pp. 5). The Blueprint offers guidance for implementing cessation options for youth that includes using science- and theory-based cessation strategies that are flexible and easily implemented in a variety of settings, advocating for financial support via the Master Settlement Agreement with the Tobacco industry, and developing best practice dissemination methods and criteria. We maintain that consideration of an intervention’s cost effectiveness is an important addition to this guidance.

Findings should be interpreted keeping study limitations in mind. Our results were based on a simulation exercise and relied on previously published data. The lack of follow-up data beyond 6 months post program limited our ability to better estimate the cost-effectiveness of N-O-T. However, to the extent that these secondary data are reliable, and our assumptions about probability and cost estimates are reasonable and representative, the present CEA provides a good approximation of the cost-effectiveness of N-O-T from a school perspective. Future CEA investigations of N-O-T should be prospective, include a no-intervention condition, and utilize the societal perspective. We encourage other youth smoking cessation researchers to include cost data as part of their evaluations, so that economic analysis can become an integral part of the adolescent tobacco control literature. Such analyses will allow for enhanced school-based resource allocation directed at improving the health of our nation’s youth.

Acknowledgments Funding for the Not On Tobacco efficacy studies described in this manuscript was provided by The Florida Department of Health, Office of Tobacco Control. Funding for this cost-effectiveness analysis was provided by the Centers for Disease Control and Prevention’s Cooperative Agreement with the WV Prevention Research Center (U48/CCU310821). The contents of the paper are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

References

Anderson, K., Jacobson, J. S., Heitjan, D. F., Zivin, J. G., Hershman, D., Neugut, A. I., et al. (2006). Cost-effectiveness of preventive strategies for women with a BRCA1 or a BRCA2 mutation. *Annals of Internal Medicine*, *21*, 397–406.

Bolt, D. M. (2003). Estimation of compensatory and noncompensatory multidimensional item response models using Markov chain Monte Carlo. *Applied Psychological Measurement*, *27*, 395–414.

Centers for Disease Control and Prevention (1996). Projected smoking-related deaths among youth—United States. *Morbidity and Mortality Weekly Report*, *45*, 971–974.

Choi, W. S., Gilpin, E. A., Farkas, A. J., & Pierce, J. P. (2001). Determining the probability of future smoking among adolescents. *Addiction*, *96*, 313–323.

Curry, S. J., Emery, S., Sporer, A. K., Mermelstein, R., Flay, B. R., & Berbaum, M. (2007). A national survey of teen smoking cessation programs. *American Journal of Public Health*, *97*, 171–177.

Dino, G., Horn, K. A., Goldcamp, J., Fernandes, A., Kalsekar, I., & Massey, C. (2001). A 2-year efficacy study of Not on Tobacco in Florida: An overview of program successes in changing teen smoking behavior. *Preventive Medicine*, *33*, 600–605.

Dino, G., Horn, K., & Goldcamp, J. (2000). *The statewide diffusion and evaluation of N-O-T in Florida Year 9 1999–2000 study: Final summary report*. Morgantown: West Virginia University Prevention Research Center, Office of Drug Abuse Intervention Studies.

Effective Clinical Practice (2000). Primer on cost-effectiveness analysis. *Effective Clinical Practice*, *3*, 253–255.

Glasgow, R. E., Lichtenstein, E., & Marcus, A. C. (2003). Why don’t we see more translation of health promotion research to practice? Rethinking the efficacy-effectiveness transition. *American Journal of Public Health*, *93*, 1261–1267.

Gold, M. R., Siegel, J. E., Russell, L. B., & Weinstein, M. C. (1996) (Eds.). *Cost-effectiveness in health and medicine*. New York: Oxford University Press.

Haddix, A. C., Teutsch, S. M., & Corso, P. S. (2003) (Eds.). *Prevention effectiveness: A guide to decision analysis and economic evaluation.* New York: Oxford University Press.

Horn, K., Dino, G., Gao, X., & Momani, A. (1999). Feasibility evaluation of Not On Tobacco: The American Lung Association's New Stop Smoking Program for Adolescents. *Health Education*, *99*, 192–207.

Horn, K., Dino, G., Kalsekar, I., & Mody, R. (2005). The impact of Not On Tobacco on teen smoking cessation: End-of-program evaluation results, 1998–2003. *Journal of Adolescent Research*, *20*, 640–661.

Houston, T., Kolbe, L. J., & Eriksen, M. P. (1998). Tobacco-use cessation in the 90s—not "adults only" anymore. *Preventive Medicine*, *27*, A1–A2.

Krall, E. A., Garvey, A. J., & Garcia, R. I. (2002). Smoking relapse after 2 years of abstinence: Findings from the VA Normative Aging Study. *Nicotine & Tobacco Research*, *4*, 95–100.

Lamkin, L., Davis, B., & Kamen, A. (1998). Rationale for tobacco cessation interventions for youth. *Preventive Medicine*, *27*, A3–A8.

Macario, A., Chow, J. L., & Dexter, F. (2006). A Markov computer simulation model of the economics of neuromuscular blockade in patients with acute respiratory distress syndrome. *BMC Medical Informatics and Decision Making*, *15*, 15.

Mermelstein, R. (2003). Teen smoking cessation. *Tobacco Control*, *12*, i25–i34.

MMWR (2006). *Cigarette use among high school students—United States, 1991–2005*. Retrieved January 4, 2007 from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5526a2.htm.

Orleans, T. C., Bratic-Arkin, E., Backinger, C. L., Best, A., Crossett, L., Grossman, D., et al. (2003). Youth tobacco cessation collaborative and national blueprint for action. *American Journal of Health Behavior*, *27*, S103–S119.

Rogers, R. G., & Powell-Griner, E. (1991). Life expectancies of cigarette smokers and nonsmokers in the United States. *Social Science Medicine*, *32*, 1151–1159.

Substance Abuse and Mental Health Services Administration (2004). *Results from the 2004 Survey on Drug Use and Health*. NSDUH: Detailed Tables. Retrieved January 4, 2007 from http://www.oas.samhsa.gov/NSDUH/2k4tabs/2k4tabs.pdf.

Sussman, S. (2002). Effects of sixty six adolescent tobacco use cessation trials and seventeen prospective studies of self-initiating quitting. *Tobacco Induced Diseases*, *1*, 35–81.

Tengs, T. O., Osgood, N. D., & Chen, L. L. (2001). The cost-effectiveness of intensive national school-based anti-tobacco education: Results from the Tobacco Policy Model. *Preventive Medicine*, *33*, 558–570.

Wagner, T. H., & Goldstein, M. K. (2004). Behavioral interventions and cost-effectiveness analysis. *Preventive Medicine*, *39*, 1208–1214.

Wang, L. Y., Crossett, L. S., Lowry, R., Sussman, S., & Dent, C. W. (2001). Cost-effectiveness of a school-based tobacco-use prevention program. *Archives of Pediatrics and Adolescent Medicine*, *155*, 1043–1050.