Cost-effectiveness of the Clinical Practice Recommendations in the AHCPR Guideline for Smoking Cessation

Jerry Cromwell, PhD; William J. Bartosch, MPA; Michael C. Fiore, MD, MPH; Victor Hasselblad, PhD; Timothy Baker, PhD

NOTICE: This material may be protected By copyright law (Title 17 U.S. Code)

Context.—The Agency for Health Care Policy and Research (AHCPR) published the *Smoking Cessation: Clinical Practice Guideline* in 1996. Based on the results of meta-analyses and expert opinion, the guideline identifies efficacious interventions for primary care clinicians and smoking cessation specialty providers.

Objective.—To determine the cost-effectiveness of clinical recommendations in AHCPR's guideline.

Design.—The guideline's 15 recommended smoking cessation interventions were analyzed to determine their relative cost-effectiveness. Then, using decision probabilities, the interventions were combined into a global model of the guideline's overall cost-effectiveness.

Patients.—The analysis assumes that primary care clinicians screen all presenting adults for smoking status and advise and motivate all smokers to quit during the course of a routine office visit or hospitalization. Smoking cessation interventions are provided to 75% of US smokers 18 years and older who are assumed to be willing to make a quit attempt during a year's time.

Intervention.—Three counseling interventions for primary care clinicians and 2 counseling interventions for smoking cessation specialists were modeled with and without transdermal nicotine and nicotine gum.

Main Outcome Measure.—Cost (1995 dollars) per life-year or quality-adjusted life-year (QALY) saved, at a discount of 3%.

Results.—The guideline would cost $6.3 billion to implement in its first year. As a result, society could expect to gain 1.7 million new quitters at an average cost of $3779 per quitter, $2587 per life-year saved, and $1915 for every QALY saved. Costs per QALY saved ranged from $1108 to $4542, with more intensive interventions being more cost-effective. Group intensive cessation counseling exhibited the lowest cost per QALY saved, but only 5% of smokers appear willing to undertake this type of intervention.

Conclusions.—Compared with other preventive interventions, smoking cessation is extremely cost-effective. The more intensive the intervention, the lower the cost per QALY saved, which suggests that greater spending on interventions yields more net benefit. While all these clinically delivered interventions seem a reasonable societal investment, those involving more intensive counseling and the nicotine patch as adjuvant therapy are particularly meritorious.

JAMA. 1997;278:1759-1766

TOBACCO use has been cited as the chief avoidable cause of death in the United States, responsible for more than 420 000 deaths annually.[1] Despite this, physicians and other practitioners fail to assess and counsel smokers consistently and effectively.[2-4]

This study analyzes the cost-effectiveness of the Agency for Health Care Policy Resource's (AHCPR's) *Smoking Cessation: Clinical Practice Guideline*.[2] Released in April 1996, the guideline was developed over a 2-year period by a panel of smoking cessation specialists using extensive quantitative analysis of published effectiveness data. Recommendations include screening all presenting patients for tobacco use, advising patients who use tobacco to quit, and providing interventions that appear most efficacious. The recommendations were based on rigorous logistic regression meta-analyses of various cessation intervention outcomes, ranging from self-help materials to multisession group counseling lasting several hours or more. Recommendations were targeted specifically to 3 audiences: primary care clinicians; cessation specialists; and administrators, insurers, and purchasers of health care services.

Formulation of optimal health care policy requires an analysis of the costs of recommended interventions relative to their clinical effectiveness. This information is not readily available in the case of the AHCPR's guideline. Few claims data exist to quantify current practice. Most counseling services are an integral part of physician-patient contacts with no separate billing, while other services, such as nicotine replacement and intensive counseling, are generally not covered by insurance and, hence, do not produce a claims trail.

Finally, the benefits of stop-smoking treatments may be difficult to assess accurately. The immediate effect of efficacious treatment is smoking cessation, and this may or may not be related to immediate health benefits. Even when cessation leads to health benefits, these benefits are delayed many years, occurring

From Health Economics Research, Inc, Waltham, Mass (Dr Cromwell and Mr Bartosch); the Center for Tobacco Research and Intervention (Drs Fiore and Baker), Section of General Internal Medicine, Department of Medicine (Drs Fiore and Baker), Comprehensive Cancer Center (Dr Fiore), and Department of Psychology (Dr Baker), University of Wisconsin Medical School, Madison; and the Center for Health Policy Research and Education, Duke University, Durham, NC (Dr Hasselblad).

Since publication of the AHCPR Smoking Cessation Clinical Practice Guideline in April 1996, Dr Fiore has done consulting, received funding for clinical research studies, and/or spoken on behalf of GlaxoWellcome, SmithKline Beecham, and McNeil pharmaceutical companies. Dr Baker has done consulting, research, and/or speaking for SmithKline Beecham pharmaceutical company. Prior to 1994 (when work on the Guideline began), Drs Baker and Fiore had worked on clinical research studies funded in part by ALZA Corp, CIBA-Geigy Corp, Elan Pharmaceutical, Lederle Laboratories, Glaxo Wellcome, SmithKline Beecham, and Hoechst Marion Rousel Inc. Prior to 1994, Dr. Fiore had received honoraria for educational activities from CIBA-Geigy, Elan, Lederle, Marion Merrell Dow Inc, and Parke-Davis.

The statements contained in this article are solely those of the authors and do not necessarily reflect the views or opinions of the Agency for Health Care Policy and Research.

Reprints: Jerry Cromwell, PhD, Health Economics Research, Inc, 300 Fifth Ave, Sixth Floor, Waltham, MA 02154 (e-mail: jcromwell@her-cher.org).

through decreased morbidity or mortality across a wide range of illnesses. Many studies[5-7] have found single smoking cessation interventions to be cost-effective. However, these studies do not provide cost-effectiveness data on the range of effective interventions that are both in current use and recommended for clinical practice by the AHCPR.

METHODS

General Approach

The cost estimates developed in this study were not based on individual patients. Instead, they were based on recommended resource inputs found in the guideline report. Similarly, estimates of the marginal effectiveness of interventions were taken from the guideline and were based on prospective clinical trial results.

Two general methodological approaches were taken, both incorporating a societal perspective. Under one approach, three quarters of all smokers were assumed to undertake a particular intervention during a year's time. This represents the approximate percentage of current US smokers who have made a previous quit attempt.[8] This answers the question, "What would be the cost-effectiveness of the guideline if all willing smokers could be encouraged to undertake 1 of the 15 interventions recommended by the guideline panel?" When the resulting 15 cost-effectiveness ratios are compared across all cessation interventions, this informs policymakers as to which interventions appear to be the most cost-effective.

Under the second scenario, panel experts were queried regarding the likelihood of patients choosing 1 of the 5 counseling interventions with or without nicotine replacement. These probabilities were used to weight the costs and quit rates of the interventions. The result was a combined global cost-effectiveness ratio for the guideline as a whole, which answers the question, "How much would the guideline likely cost per life-year saved or quality-adjusted life-year (QALY) if adopted by practitioners, given the expected preferences of smokers for different interventions?"

Calculation of Cost-effectiveness Ratios

A cost-effectiveness ratio for a specific smoking cessation intervention can be decomposed into 4 components: (1) the cost of physicians screening the US patient population; (2) the cost of physicians advising smokers; (3) motivating unwilling smokers to try and quit; and, (4) the direct intervention costs incurred in helping smokers quit, expressed per quitter or per life-year saved.

Aggregating across interventions, the overall cost-effectiveness of the guideline can be expressed as the ratio of expected total guideline costs and expected benefits, eg, number of quitters or QALYs saved. Expected intervention costs include the total fixed screening, advice, and motivation costs, which are assumed to be independent of which intervention is chosen, plus a weighted sum of the direct costs per intervention for smokers selecting 1 of the 15 interventions. Expected benefits are a weighted sum of smokers' expected marginal quit rates across all interventions, multiplied by QALYs saved per quitter, using patient intervention preference proportions as weights. For example, if three quarters of adult Americans who smoke (25% of US adults are smokers) are willing to try to quit during a year, and 40% of them prefer particular intervention, then 15 million persons could be expected to incur the guideline's estimations for the direct costs associated with this intervention (ie, approximately 200 million adult Americans$\times$0.25$\times$0.75$\times$0.4). Similarly, if a particular intervention is found to raise the underlying natural quit rate by 0.1, then 1.5 million new quitters could be anticipated to justify the extra costs. When weighted and summed across all interventions, the result is an average cost-effectiveness ratio for the entire guideline. A lower cost-effectiveness ratio is better, implying less cost outlay per quitter or QALY saved. Holding everything else constant, a higher marginal quit rate would lower the overall cost-effectiveness, which would be lower, too, if smoker preferences shifted to more efficacious interventions.

Patient Intake

The guideline recognizes 2 loci of patient intake: the office and the hospital. Interventions in each of these sites were analyzed separately and then combined into a single cost-effectiveness ratio. Screening, advice, and motivation costs, which are incurred repetitively during several annual office visits, were added to similar screening costs of hospitalized patients. Direct intervention costs of hospitalized patients were debited from those incurred by ambulatory patients. This avoids double counting such costs, as only 1 quit attempt was assumed during a year's time regardless of whether a smoker was an inpatient.

Identification of Direct Interventions

The amount of counseling that smokers receive depends largely on patient and/or physician preferences. Based on the guideline, we modeled 5 possible counseling options that a patient may choose after receiving advice from a physician: (1) minimal, (2) brief, (3) full, (4) individual intensive, and (5) group intensive. The level of provider time and number of sessions vary widely among these 5 options. The first 3 interventions involve primary care clinicians, assumed to be physicians, while intensive counseling is performed by smoking cessation specialists. Each of the counseling options was analyzed both by itself and in conjunction with nicotine replacement (transdermal nicotine and nicotine gum).

Time Inputs

The assumptions that we made concerning the providers and length of time required for each intervention scenario are outlined in Table 1. The guideline recommends that health professionals screen all adult patients (aged 18 years or older) for smoking status during each office visit or hospitalization. We assumed that this task is performed by a registered nurse (RN) and that it requires 1 minute of provider time.

Following the identification of a smoker, initial smoking cessation advice is provided by physicians in either an office or a hospital setting. This task involves delivering a clear, strong, and personalized message urging every smoker to quit. We assumed that this would take 1 minute of physician time and that all smokers would be advised to quit at each of their office visits or sometime during the course of their hospitalization. Patients unwilling to quit after receiving initial advice are provided with a motivational intervention that involves an additional minute of physician time. We assumed all smokers would require a motivational intervention during at least 2 annual office visits or during the course of hospitalization.

Minimal, brief, and full counseling interventions are provided to smokers willing to make a quit attempt. These are delivered by primary care clinicians and involve increasing amounts of physician time. Among these 3 interventions, full counseling involves the greatest amount of physician time—15 minutes during an initial visit with two 10-minute follow-up visits. When nicotine replacement is used, an extra 3 minutes was allocated to the minimal, brief, and full counseling interventions to account for the time required to prescribe the pharmacotherapies and instruct patients in their use.

The individual intensive and group intensive counseling interventions begin with screening and advising tasks performed by primary care clinicians. Patients are then referred to a smoking cessation specialist. We assumed that smokers undergoing an individual intensive intervention receive 5 counseling ses-

sions that are each 30 minutes long. The first session involves 10 minutes of physician time for the purpose of assessing the patient and prescribing pharmacotherapy and an additional 20 minutes of time with an RN. The remaining time is divided between an RN with health education experience and a psychologist (three 30-minute visits for the former and two 30-minute visits for the latter). Across the 5 sessions, there is a total of 10 minutes of physician time, 80 minutes of RN time, and 60 minutes of psychologist time. We assumed that group intensive counseling is delivered to groups of 10 patients over 7 sessions that are each 1 hour long. Under this scenario, a physician is also available for a portion of the first session (in this case, 20 minutes). The remaining time for the first group session and sessions 2 through 7 involves an RN and a psychologist. These 2 professionals jointly provide services, and each contributes a total of 400 minutes of time across all sessions.

Input Costs

Physicians are the most costly provider group among primary care clinicians. Their costs include not only a return to their own time input but also any overhead costs associated with maintaining their practice. Other studies[5] have used physician charges, but very few patients or insurers pay full charges today. Medicare rates were used instead, under the assumption that they more accurately reflect the physician's true marginal cost of providing an office visit. To determine the per minute cost of physician time for the initial intervention, per patient 1994 Medicare allowed charges for 10-, 20-, 30-, 45-, and 60-minute visits were calculated based on Current Procedural Terminology (CPT) codes for new patients receiving services in an office or another outpatient setting. They were then adjusted for medical services inflation through 1995. Next, a per minute cost was calculated for each office visit code using the specified time intervals and a weighted average taken across visit types to account for differences in patients with respect to length of visit.

Based on this approach, we estimated that the Medicare effective physician allowable charge per minute for an initial visit was $1.97 in 1995. Using the same method, we estimated that the average per minute cost of physician time for follow-up office visits was $2.20. We used the CPT codes for subsequent hospital care to estimate initial physician advice and counseling costs in a hospital setting, ie, $1.92 per minute. We assumed that hospitalized patients would receive follow-up after discharge in an office or outpatient setting at the same $2.20 cost per minute.

Table 1.—Resource Utilization Assumptions*

Interventions for Primary Care Clinicians	Intervention Time, min: Minimal Counseling	Brief Counseling	Full Counseling
Screening for tobacco use			
Registered nurse	1	1	1
Advice to quit			
Physician alone	1	1	1
Initial cessation counseling			
Physician alone	3	7	15
Physician with patch or gum	6	10	18
Follow-up counseling			
First follow-up physician visit	3-6	10	10
Second follow-up physician visit	...	...	10

Intensive Interventions for Smoking Cessation Specialists	Intervention Time, min†: Individual‡ Intensive	Group§ Intensive
Screening for tobacco use		
Registered nurse	1	1
Advice to quit		
Physician	1	1
Cessation counseling sessions		
Physician	10	20
Registered nurse	80	400
Psychologist	60	400

*Data from Fiore et al.[2]
†Patients referred to a smoking cessation specialist are first screened in an office or hospital setting and advised to quit by a primary care clinician.
‡Counseling time for "individual intensive" patients are distributed over five 30-minute sessions.
§Counseling time for "group intensive" patients are distributed over seven 1-hour sessions.

We used estimates from the US Bureau of Labor Statistics for mean weekly earnings to calculate the per minute cost of RN and psychologist time. In 1995, the average weekly earnings of RNs and psychologists were $729 and $698, respectively. Assuming that these professionals work an average of 40 hours each week, the per minute labor cost of RNs is $0.30, and for psychologists, the per minute labor cost is $0.29. To account for additional fringe and overhead costs, we doubled their salaries. Medicare physician claims already include a practice cost allowance and were not adjusted further.

The guideline recommends that patients receive educational materials during the course of their smoking cessation intervention. While physicians and hospitals often receive self-help pamphlets from government agencies or antismoking groups free of charge, there is a cost associated with these materials that is incurred by society at large. For each intervention scenario, we assumed that patients would receive 2 educational pamphlets during their counseling session at a total societal cost of $2.00 per patient per intervention.

The guideline recommends that providers offer nicotine replacement therapy to all smokers except in special circumstances, eg, pregnant women. Guideline recommendations were followed on the amount and dosages that each patient should receive.[9] A complete smoking cessation intervention using the patch requires that patients use different dosages over a period of 8 weeks. We used the 1995 average wholesale price as an estimate of the cost of nicotine replacement.[10] The average cost of an 8-week supply of the patch is $219.23. Nicotine gum is available under 1 brand name in 2-mg or 4-mg doses. Both doses come in boxes of 96, and the average wholesale price per box is $38.85 and $63.29, respectively. We assumed that patients use nicotine gum for the first 3 months of their quit attempt and chew an average of 10 pieces per day. This requires a single patient to purchase 10 boxes of gum. Therefore, complete treatments with 2-mg gum and 4-mg gum cost $388.50 and $632.90, respectively.

Only a portion of patients willing to undergo an intervention quit successfully. We assumed unsuccessful quitters would purchase only a 4-week supply of the patch or gum. For transdermal nicotine, the average cost for the first month of patches is $114.38. A 4-week supply of nicotine gum requires approximately 3 boxes of gum at a cost of $116.55 for 2-mg gum or $189.87 for 4-mg gum.

Resource Costs by Intervention Activity

Table 2 displays our cost estimates of the guideline's recommended smoking cessation interventions. These estimates assume that patients first encounter a physician during the course of a routine office visit. All the interventions have the same cost per participant for preintervention screening ($0.60), advice ($1.97), and motivation ($1.97). Per participant direct

Table 2.—Smoking Cessation Costs per Participant*

Cessation Intervention	Total Cost per Participant	
	Successful	Failed
Without nicotine replacement		
Minimal counseling	14.51	14.51
Brief counseling	37.79	37.79
Full counseling	75.55	75.55
Individual intensive counseling	104.50	104.50
Group intensive counseling	53.14	53.14
With transdermal nicotine		
Minimal counseling	246.25	141.40
Brief counseling	262.93	158.08
Full counseling	300.69	195.84
Individual intensive counseling	323.73	218.88
Group intensive counseling	272.37	167.52
With nicotine gum		
Minimal counseling	415.52	143.57
Brief counseling	432.20	160.25
Full counseling	469.96	198.01
Individual intensive counseling	493.00	221.05
Group intensive counseling	441.64	169.69

*All costs reported in 1995 dollars. Data from Fiore et al[2]; *1996 Physician's GenRX*[10]; Medicare allowed changes; the *Current Population Survey: 1995 Estimates of Weekly Earnings*, published in 1996 by the US Bureau of Labor Statistics; and 1994 Medicare Part B data.

intervention costs naturally increase with the intensity of counseling provided. The estimated cost of a single minimal counseling intervention without pharmacotherapy is $14.51. The initial intervention takes 3 minutes and costs $5.91 of physician time. A 3-minute follow-up (provided via telephone) by a physician costs $6.60. Finally, education materials cost $2.00. The brief intervention assumes a longer initial physician visit and follow-up time, with a per participant cost of $37.79. The full counseling intervention, requiring 15 minutes of physician time during the initial visit plus two 10-minute follow-up visits, costs $75.55.

Adding pharmacotherapy greatly increases intervention costs. For brief counseling, the per participant cost rises to $262.93 with the addition of transdermal nicotine and to $432.20 with nicotine gum. Full counseling with complete transdermal nicotine treatment costs $300.69 vs $469.96 with nicotine gum. These costs, however, are much lower for patients who fail to quit because they do not require complete treatment with nicotine replacement.

Intensive interventions are divided into 5 sessions for individual counseling and 7 sessions for group counseling. The cost of educational materials and pharmacotherapy is assumed to be the same under these scenarios. While the group counseling sessions are longer than individual counseling sessions (1 hour as opposed to 30 minutes), their per participant costs ($53.14 per patient) are much lower because the cost for each group session is distributed across 10 patients. Adding a complete treatment of transdermal nicotine increases intensive counseling costs to $323.73 for individual counseling and $272.37 for group counseling, respectively. A complete, successful intensive intervention with nicotine gum costs $493 when provided through individual counseling and $441.64 when provided in a group context. Again, among the scenarios that use pharmacotherapy, costs would be substantially less for patients who fail.

Effectiveness of Smoking Cessation Interventions

The guideline uses long-term quit rates as its effectiveness indicator. Primarily using a modified intent-to-treat analysis technique, the researchers who support the guideline panel drew from peer-reviewed, published clinical trial literature based on at least 5 months of follow-up data to calculate percentages of individuals who successfully quit smoking using different interventions. Meta-analyses evaluated basic treatment characteristics such as counseling format (eg, individual vs group), duration of treatment, and use of pharmacotherapy. Studies that included the same intervention were grouped together, screened to ensure methodological rigor, and analyzed using either fixed or random effects logistic models. The guideline odds ratios (ORs), which indicate an intervention's marginal effectiveness, are generated by exponentiating the logistic regression coefficients obtained from 56 studies in the meta-analyses.

From the meta-analyses, the average baseline "no intervention" quit rate was 8.8% vs 10.7% for minimal counseling, 12.1% for brief counseling, and 18.7% for full counseling lasting more than 10 minutes, all excluding pharmacotherapy. The baseline and intervention quit rates for intensive counseling (4-7 sessions) were 10.4% and 22.6%, respectively. Baseline quit rates vary by intervention owing to different samples and "self-help" activities among the various control groups in the clinical trials. Odds ratios for the patch and gum over and above counseling alone were found to range between 2.1 to 2.6 and 1.4 to 1.6, respectively. Intervention-specific marginal quit rates were derived by subtracting the underlying baseline quit rate.

Despite statistically controlling for "all-comers" vs "want-to-quit" subjects, the logistic coefficients estimated from the meta-analyses generated unreasonably high baseline quit rates (eg, 8.8%) for 2 reasons: many studies include only want-to-quit subjects, and some control subjects receive very low-intensity cessation interventions (eg, self-help materials). To apply the results of the meta-analyses to the entire US smoking population, the ORs derived from the analyses were applied to the underlying 3-month-or-more quit rate of all smokers (ie, all-comers) in the United States. We assumed this rate was 5% (vs 5.7% for smokers quitting for at least 1 month).[11]

To illustrate our method, the estimated OR for brief counseling was 1.4, implying roughly a 40% gain in quitters. Using the most conservative ORs for the patch (2.1), the combined OR for brief counseling with the patch is 2.94 (ie, 1.4×2.1). Multiplying the underlying 5% quit rate by 2.94, after converting it into an OR (0.05/0.95=0.0526), results in an estimated OR of 0.155. Converting this OR back into a percentage quit rate equals 0.134 (ie, 0.155/[1+0.155]). Finally, subtracting the underlying 5% quit rate gives 8.4% as the marginal quit rate of brief counseling using the patch as adjuvant therapy. This is a more conservative estimate than one based on the average quit rate of the control groups in the clinical trials. Using the 8.8% baseline would have produced almost 60% more quitters.

Sensitivity analysis (discussed below) was also applied to the percentage of smokers willing to make a quit attempt during the year. To recognize that not all quitters stay abstinent, a 45% relapse rate is applied as well to the marginal quit rates.[12] The 45% figure is based on considerable relapse data showing that most relapses typically occur within the first 6 months.[13] Therefore, this figure estimates the relapse rate for subjects who have already passed the time of maximal relapse risk. Long-term follow-up data show that, of subjects who have been abstinent for 1 year, only some 30% or so will relapse over the subsequent 5 years.[8] After 5 years relapse occurs, but the rate is extremely low.[8,12] Also, after prolonged abstinence, the rate of relapse is approximately balanced by cessation occurring through subsequent quit attempts.[8]

Quality-Adjusted Life-Years Saved

The guideline does not differentiate interventions by patient age. All smokers, regardless of age, are deemed candidates to try to quit. Moreover, the clinical trial results do not differentiate quit rates by intervention by age group. Quit rates were applied uniformly to the age- and sex-specific distribution of smokers and then were converted into years of life saved using published and unpublished estimates developed by Fiscella and Franks.[6] The authors calculated sex- and age-specific years of life saved using life expectancy data for smokers and never smokers taken from Rogers and Powell-Griners.[14] Fiscella and Franks[6] extrapolated mortality rates for smokers vs never smokers using a 20-year phase-in period

based on mortality ratios of long-term quitters to never smokers derived from the American Cancer Society's Cancer Prevention Study II.[8] They also made a quality-of-life adjustment to the raw years-of-life-saved figures using an index of years of healthy life constructed from questions on the National Health Interview Survey (NHIS).[3,15]

Assuming that marginal quit rates apply uniformly to all age groups, an overall estimate of life-years saved was derived by weighting expected years saved within age group by the actual distribution of smokers by age group and by the uniform quit rate. Men aged 25 to 29 years are expected to gain 1.31 years of life, discounted at 3%, which is equivalent to 2.34 QALYs. Older men, aged 65 to 69 years, only save 0.47 years of life (0.69 QALYs). Women gain more years of life from quitting than men. Female quitters aged 25 to 29 years save 1.43 life-years (1.94 QALYs), while those aged 65 to 69 years save 1.41 life-years (1.08 QALYs). Given the current distribution of smokers, we calculated a weighted average of 1.46 life-years saved per quitter (1.97 QALYs). Our analysis (and the analysis of Fiscella and Franks[6]) assumes a 3% discount rate for life-years saved. Sensitivity analyses were performed at 0% and 5%.

Table 3 shows the intervention's marginal quit rates, expected number of quitters, and life-years and QALYs saved for each of the guideline interventions. If intensive counseling with transdermal nicotine were provided to three quarters of smokers in the United States willing to try to quit during a year's time, it would generate the largest number of quitters, 3 346 000 (6 602 000 QALYs). Minimal counseling without pharmacotherapy results in the fewest quitters, 189 000 (373 000 QALYs). Based on patient preferences for the various interventions (discussed next), adoption of the guideline could be expected to generate 1.67 million additional quitters and nearly 3.3 million QALYs, discounted at 3% (Table 3).

Table 3.—Expected Annual Number of Quitters and Life-Years Saved by Smoking Cessation Intervention, Assuming 75% of Smokers Attempt to Quit Once During the Year*

	Overall Guideline			
Interventions	Marginal Quit Rate, %	Quitters,† No. in Thousands	Life-Years Saved,‡ No. in Thousands	Quality Life-Years Saved,§ No. in Thousands
Minimal counseling alone	0.94	189	276	373
With patch	6.70	1347	1968	2658
With gum	3.68	734	1072	1448
Brief counseling alone	1.86	374	546	738
With patch	8.40	1689	2467	3333
With gum	4.95	995	1454	1964
Full counseling alone	6.20	1247	1821	2460
With patch	16.00	3217	4700	6348
With gum	10.90	2192	3202	4325
Intensive counseling alone‖	6.62	1331	1945	2627
With patch	16.64	3346	4888	6602
With gum	11.50	2312	3378	4563
Combined intervention¶	...	1669	2439	3294

*Data from Fiore et al[2] and Fiscella and Franks.[6] Ellipses indicate not applicable.
†The number of quitters was discounted by 45% to account for post–follow-up relapse.
‡Life-years (discounted 3%) were derived using a 1.46 adjustment factor. The adjustment factor represents the average life-years saved per quitter given the current distribution of smokers and expected life-years saved for each sex-specific age group.
§Quality-adjusted life-years (discounted 3%) were derived using a 1.97 adjustment factor. The adjustment factor represents the average life-years saved per quitter given the current distribution of smokers and expected quality-adjusted life-years saved for each sex-specific age group.
‖Different quit rates were not available for "individual counseling" vs "group intensive counseling". Therefore, the same quit rate (6.62%) was used for both interventions.
¶The variable was derived by weighting the individual interventions by the likelihood of smokers choosing each intervention.

Intervention Decision Probabilities

In actual practice, patients and providers vary in their intervention preferences, and it is highly unlikely that all smokers would choose the same intervention. While group intensive counseling costs less per quitter than any of the other interventions, very few patients would actually choose this treatment option. Conditional probabilities incorporating willingness to quit and preferences concerning format and use of pharmacotherapy were calculated for the 15 interventions. Our baseline assumes that 25% of the US adult population smokes[16] and that 75% of smokers would be willing to make a quit attempt in a year's time. The 75% estimate reflects the total percentage of smokers who will try to make a quit attempt in a given year and reflects the increase in cessation attempts caused by introduction of the guideline interventions (eg, brief interventions offered across diverse health care settings). Based on the expert opinion of the guideline panel, we assumed that 40% of smokers would choose brief counseling, 30% would choose full counseling, 25% would choose minimal counseling, and 5% would choose intensive counseling (2.5% individual intensive counseling and 2.5% group intensive counseling). We further assumed that 75% of all smokers who are willing to try to quit, regardless of the length of counseling they choose, would use pharmacotherapy. Among those willing to use pharmacotherapy, 83% would choose the patch and 17%, nicotine gum. In our model, for example, 1.875% ($0.25\times0.75\times0.40\times0.25\times100$) of the entire US population would undergo brief counseling alone, 4.67% ($0.25\times0.75\times0.40\times0.75\times0.83\times100$) would likely receive brief counseling and transdermal nicotine, and 0.96% ($0.25\times0.75\times0.40\times0.75\times0.17\times100$) would undergo brief counseling using nicotine gum as adjuvant therapy. When summed across the 15 interventions, the percentages add to the 18.75% of the entire US population who would be expected to undergo a quit attempt.

Sensitivity analysis of the decision probabilities involved testing the 75% rate of those who are willing to try and quit at 50% and 100%. The 45% relapse rate (after 5 months of abstinence) was also tested at 35% and 55% in some simulations.

Basic Parameters

Each of the smoking cessation scenarios that we modeled is based on a common set of basic parameters. As of January 1, 1996, the US resident population older than 18 years was estimated by the US Bureau of the Census at 195 million. The probability of smoking is based on the NHIS, which found that, in 1993, 25% of the US adult population smoked cigarettes.[16] We assumed that the proportion of the population who smoked remained constant between 1993 and 1996, producing approximately 48 745 000 adult smokers in 1996.

Our estimate of the number of physician office visits per year is based on the National Ambulatory Medical Care Survey.[14] This study found that there was a total of 606 877 000 office visits in the United States in 1992 among the population aged 15 years and older, resulting in 3.11 physician office visits per year per adult.

Smokers have higher physician office and hospital utilization rates than people who have never smoked. Rice et al[17] found that, on average, smokers experienced about 6% more physician office visits and spent 27% more days in the hospital than never smokers. If the ratio of the average number of physician visits among smokers vs nonsmokers is 1.06, and the average number of visits

Table 4.—Cost-effectiveness of Smoking Cessation by Intervention*

Intervention	Cost per Quitter	Cost per Life-Year Saved, (3% Discount)	Cost per Quality-Adjusted Life-Year (3% Discount)
Without nicotine replacement			
Minimal counseling	7922	5423	4015
Brief counseling	6276	4296	3181
Full counseling	2989	2046	1515
Individual intensive counseling	3595	2461	1822
Group intensive counseling	2186	1496	1108
With transdermal nicotine			
Minimal counseling	4745	3248	2405
Brief counseling	4184	2864	2120
Full counseling	2715	1859	1376
Individual intensive counseling	2871	1969	1455
Group intensive counseling	2310	1581	1171
With nicotine gum			
Minimal counseling	8962	6135	4542
Brief counseling	7350	5031	3725
Full counseling	4237	2900	2147
Individual intensive counseling	4407	3016	2233
Group intensive counseling	3596	2461	1822

*Data from Fiore et al[2] and Fiscella and Franks.[6] This table assumes that 75% of patients who smoke attempt to quit at least once during the year. Quitters were discounted by 45% to account for relapse. All costs are in 1995 dollars.

per capita is 3.11, then the average smoker would experience 3.25 visits while nonsmokers would average 3.06 visits. We estimated that 158 580 925 physician office visits were made by smokers (3.25×48 475 000) in 1992.

Using NHIS estimates of the distribution of short-term hospital episodes by age and sex,[18] we calculated that there were 29 051 900 admissions among the adult population aged 18 years or older of a total of 32 315 795 admissions, excluding newborn and psychiatric, reported by the American Hospital Association (AHA) in its 1993 survey of hospitals.[19] Therefore, there were approximately 0.149 admissions per adult resident (29 051 900/194 980 000). We assumed that because smokers experience 27% more hospital days per year than nonsmokers,[17] they would also be 27% more likely to be admitted to the hospital. We calculated that 17.8% of smokers would experience an inpatient stay during the year, while only 13.9% of nonsmokers would be admitted, using the formula: $(0.149 = 0.25 \times 1.27 \times \mathrm{ARNS} + (0.75 \times \mathrm{ARNS})$, where ARNS indicates the estimated admission rate of nonsmokers. These estimates generated 8 653 757 smoker admissions (0.178×48.7 million smokers). However, among the general population, only 80.5% of admissions are unique hospital admissions, according to NHIS estimates; the remaining 19.5% are readmissions. We calculated that the total number of unique smoker admissions eligible for an intervention would be 6 966 275, assuming each patient would undergo a smoking intervention only once on an inpatient basis during a year's time.

RESULTS

Cost-effectiveness of Individual Interventions

Table 4 shows cost-effectiveness ratios for 15 smoking cessation interventions that are described in the guideline. These results were derived by assuming that 75% of smokers would make 1 quit attempt during the year with all using a particular intervention. Hence, the figures answer the question, "What would be the guideline's cost-effectiveness if all willing-to-quit smokers undertook a single intervention?" Cost per quitter among the counseling interventions without pharmacotherapy ranged from a low of $2186 for group intensive counseling to a high of $7922 for minimal counseling. Cost per QALY (discounted at 3%) was lower and therefore better, ranging from $1108 for group intensive counseling to $4015 for minimal counseling.

As the amount of clinician time increases, intervention costs and the number of quitters both increase while the cost per quitter decreases (except for individual intensive counseling). Group intensive counseling is a particularly low-cost intervention, excluding patient time costs, even though it involves the greatest amount of patient-clinician time (seven, 1-hour sessions). This is because it generates a large number of new quitters because of its intensity of contact and because intervention costs are shared across groups of 10 patients, which lowers the cost per quitter even further.

Adding pharmacotherapy increases the cost of each intervention, but it also increases their marginal effectiveness substantially. When using transdermal nicotine (the patch) as adjunct therapy to each of the counseling interventions, the cost per quitter ranged from $2310 for group intensive counseling, which is slightly less cost-effective, to $4745 for minimal counseling, which is far more cost-effective than it would have been without nicotine replacement. This translated to $1171 and $2405 per QALY, respectively. The cost per quitter for counseling with nicotine gum ranged from $3596 for group intensive counseling to $8962 for minimal counseling. The cost per QALY ranged from $1822 to $4542, respectively.

Cost-effectiveness of Combined Interventions

Table 5 shows total costs, number of quitters, life-years saved, and the ultimate cost-effectiveness of the combined smoking cessation guideline, derived by weighting each of the individual intervention's costs and benefits by the likelihood of a smoker choosing it. For example, the total cost of minimal counseling without nicotine replacement is $93 578 727. This was derived by assuming that only 6.25% of smokers (0.25×0.25) would receive this intervention. Direct intervention costs would be $33 105 235 vs $60 473 492 in total preintervention costs (screening, advice, and motivation). Minimal counseling without pharmacotherapy would generate 12 000 quitters under the combined guideline, 17 000 life-years saved, and 23 000 QALYs saved.

Overall, the average cost per quitter was $3779; the average cost per life-year saved, $2587; and the average cost per QALY saved, $1915.

Brief and full counseling with pharmacotherapy are expected to generate the preponderance of both costs and benefits, in part because they are more costly and efficacious; but it is also because they are among the most popular choices for trying to quit, ie, 24.9% opt for brief counseling with the patch and 18.7% for full counseling with the patch.

Based on the guideline and the likely cessation intervention preferences of patients, it would cost $6.3 billion annually to screen, motivate, and provide 75% of ambulatory and hospitalized smokers with the intervention of their (expected) choice. Screening, advice, and motivation account for $968 million, or 15.4%, of the total cost. Implementation of the guideline would result in 1.67 million new quitters during the first year, with more than 60% resulting from brief and full counseling using the patch. The figure of 1.67 million new quitters is derived from the 48.7 million smokers in the United States figure. We assumed that 36.6 mil-

lion of those smokers would make a new quit attempt during the year, generating 3.03 million new quitters based on a combined intervention marginal quit rate of 8.3%. The guideline would cost an average of $3779 per quitter. The cost per life-year saved (discounted at 3%) would be $2587. Adjusting for improved quality of life further lowers the cost per life-year saved to $1915.

Sensitivity Analysis

We performed a series of 1-way sensitivity analyses on several of our major assumptions. Our baseline analysis assumes that 75% of smokers are willing to make a quit attempt. When we assumed that only 50% of patients would be willing to try the intervention of their choice, the cost per QALY saved (discounted at 3%) increased from $1915 to $2073, or by 8.25%. If we assumed that all smokers would be willing to undergo an intervention, the cost per QALY decreased further to $1836, or by 4.12% more. Altering the assumption about the number of smokers willing to try to quit has a slight impact on the cost-effectiveness ratios because preintervention costs are unchanged, while the number of quitters varies at the various willing-to-quit rates.

The cost-effectiveness ratios proved quite sensitive to the discount rate used to adjust life-years saved. When QALYs were discounted by 5%, the cost for the guideline was $3205 per QALY saved—or two thirds more; without any discounting, the guideline would cost only $745 per QALY saved—61% less.

At press time, a new analysis by CDC estimated that the baseline, 3-month quit rate for smokers is 4.6% (C. Husten, MD, MPH, unpublished data, November 1997). We tested the sensitivity of our combined model to the new baseline and found that the cost per QALY increased to $2048, or 6.9%.

The sensitivity of the relapse rate was tested at 35% and 55%. The lower relapse rate decreased the guideline cost per QALY to $1620 (a 15.4% decline). Increasing the relapse rate to 55% raised costs per QALY by 22% to $2340, which is still a low figure.

Treatments that involve more direct intervention time and 1 or more follow-up visits can have substantial patient costs. For each intervention, we estimated the costs associated with patient travel and cessation counseling time. Travel time for initial physician visits was excluded because patients would have incurred these costs in the absence of the smoking cessation intervention. Patient-specific time costs associated with each smoking cessation intervention (including travel to follow-up or intensive counseling sessions) were calculated assuming that patients would travel an average of 1 hour (round-trip) for each visit. Patient time per intervention ranged from 3 minutes for minimal counseling to 840 minutes for group intensive counseling, ie, seven 1-hour sessions plus 7 additional travel hours. According to the Bureau of Labor Statistics, in 1995, the median weekly salary of full-time wage and salary workers was $479. We assumed an average workweek was 40 hours long and calculated an average per minute patient opportunity cost of $0.20 ($479/2400 minutes). Group intensive counseling involved the greatest amount of travel and direct intervention time (seven 1-hour visits), costing each participant $168 in lost time for other activities.

As the intensity of the interventions increases, they become more sensitive to patient opportunity costs. Group intensive counseling without pharmacotherapy experienced the greatest change in cost per QALY, rising from $1108 when patient costs were ignored to $3446 when they were included in the analysis, more than tripling the estimate. Still, minimal counseling and brief counseling without pharmacotherapy remained less cost-effective at $4132 and $3944 per QALY saved, respectively. However, when patient costs were incorporated into the analysis of interventions without pharmacotherapy, group intensive counseling with 7 sessions became less cost-effective than full counseling with 2 follow-up sessions, eg, $3446 per QALY vs $1975 per QALY. Adding patient costs to the combined interventions increased overall cost per QALY from $1915 to 2167 (13%).

Table 5.—Cost-effectiveness of the Combined Agency for Health Care Policy and Research Resource Guideline*

Interventions	Costs, $ in Thousands	Quitters,† No. in Thousands	Life-Years Saved,‡ No. in Thousands	Quality-Adjusted Life-Years Saved,§ No. in Thousands
Without nicotine replacement				
Minimal counseling	93 579	12	17	23
Brief counseling	234 730	37	55	74
Full counseling	279 425	93	137	184
Intensive counseling	29 908	8	12	16
Group counseling	18 186	8	12	16
With transdermal nicotine				
Minimal counseling	998 787	210	308	415
Brief counseling	1 766 540	422	617	833
Full counseling	1 637 972	603	881	1190
Intensive counseling	150 075	52	76	103
Group counseling	120 769	52	76	103
With *nicotine gum*				
Minimal counseling	205 551	23	34	45
Brief counseling	335 782	50	73	98
Full counseling	348 209	82	120	162
Intensive counseling	31 843	7	11	14
Group counseling	25 981	7	11	14
Combined interventions‖	6 307 337	1669	2439	3294

*Data from Fiore et al[2] and Fiscella and Franks.[6]
†The number of quitters was discounted by 45% to account for post–follow-up relapse.
‡Life-years (discounted 3%) were derived using a 1.46 adjustment factor. The adjustment factor represents the average life-years saved per quitter given the current distribution of smokers and expected life-years saved for each sex-specific age group.
§Quality-adjusted life-years (discounted 3%) were derived using a 1.97 adjustment factor. The adjustment factor represents the average life-years saved per quitter given the current distribution of smokers and expected quality-adjusted life-years saved for each sex-specific age group.
‖This variable was derived by weighting the individual interventions by the likelihood of smokers choosing each intervention.

COMMENT

These analyses demonstrate that full implementation of the guideline throughout 1 year could cost $6.3 billion annually, or $32.31 per capita. For this investment, society could expect to gain approximately 1.67 million new quitters over and above the current baseline 5% quit rate after allowing for a 45% relapse rate among those abstinent for 5 months from the day of cessation. These quitters could expect to enjoy 2.4 million extra life-years (3.3 million extra QALYs), even after discounting by 3%. Given that smokers at all ages experience reduced life expectancy and survival rates,[20] certainly many younger quitters would enjoy more productive years of employment.

For $2587, society could expect to save another life-year by implementing the guideline. Given the negative health associated with smoking, the cost-effectiveness of the guideline is even better on a QALY basis, ie, $1915. The more intensive the cessation intervention, the lower the cost per year of life saved. While all interventions seem a reasonable societal investment, those involv-

ing more intensive counseling and the nicotine patch are particularly meritorious. Nicotine gum with counseling is also more effective than counseling alone, although it does not generate as many new quitters as the patch.

A study like ours naturally has several limitations. Results reflect only the first year of guideline implementation. It is not at all clear how the success rates of the various interventions would change, if at all, with repeated years of the guideline. Clinical trials data were unavailable to build a dynamic, recurring intervention model.

Differences in marginal quit rates by intervention with respect to age, sex, severity of illness, and motivational level could not be determined through meta-analysis because of small samples. However, our model uses a sex- and age-specific distribution of smokers when constructing average life-years and QALYs saved per quitter.

Further, it is probably unrealistic to assume the same permanent marginal quit rate for all willing smokers who are triaged through a single intervention. Nevertheless, we believe the quit rates give a reasonable guide to the relative advantages of the various interventions.

Following previous cost-effectiveness studies of smoking cessation interventions,[5,7] we excluded lifetime medical expenditures from our analysis. Whether lifetime medical expenditures should be included in cost-effectiveness analyses has been debated in the literature.[21-25] Warner and Luce[22] argue that offsetting the lower medical costs of nonsmokers in their working lifetimes by higher medical costs because of their longer lives ignores the consumption (and productivity) gains from living longer.

In any event, recent analysis[25] has shown that net medical costs over a person's lifetime are $6239 higher for US smokers (in discounted 1990 dollars). during his or her remaining lifetime than people who never smoked. Simply counting the excess medical costs of smokers to age 65 years averages $9000 to $11 000.[26] Subtracting excess medical costs from the guideline's average cost per life-year saved would turn the ratio negative, implying that smoking cessation interventions actually save more in lifetime medical expenditures than they cost, initially. By excluding all excess lifetime medical expenditures from our analysis, we believe the guideline could be considered even more cost-effective than reported above.

Moreover, our analysis does not attempt to compare the psychosocial costs of smoking treatment, such as the pain and suffering of nicotine withdrawal, with the pain and suffering produced by other preventive interventions. Such issues are certainly important in evaluating the net benefits of preventive interventions.

Relative to other medical interventions, all the smoking cessation interventions recommended in the guideline appear cost-effective and should be promoted. Tengs et al[27] reviewed 500 life-saving interventions and adjusted them for inflation (all costs are expressed in 1993 dollars), discount rate (all findings converted to 5% discount rate), exclusion of indirect costs, and consistent effectiveness measures (years of life saved).

The costs of the AHCPR's guideline are $3539 per life-year saved when discounted at a comparable 5% rate. Several well-targeted prevention strategies listed in the study by Tengs et al[26] show very low cost-effectiveness ratios as well, including a 1-time screening for cervical cancer for women older than 64 years ($2053) and pneumonia vaccination for people older than 64 years ($1769). Other screening strategies targeted at younger age groups cost considerably more, including an annual mammography for women aged 40 to 49 years ($61 744) and hypertension screening for men aged 40 years ($23 335). The smoking cessation interventions are all the more remarkable in that the guideline is not targeted to any one population group.

The guideline's cost-effectiveness ratio is favorable relative to most other medical interventions, confirming Eddy's[28] treatment of smoking cessation as the "gold standard" by which all other screening tests can be compared. Of course, the guideline does not address public health strategies aimed at stopping smoking that may be even more cost-effective relative to clinical smoking cessation treatments.

In summary, our findings reinforce the guideline's central challenge to clinicians, insurers, purchasers, and administrators to identify and intervene universally with all smokers presenting in a health care setting.

This article was prepared under contract No. 282-95-2002 from the Agency for Health Care Policy and Research, US Department of Health and Human Services; Kathleen A. Weis, DrPH, NP, was the project officer.

References

1. Centers for Disease Control and Prevention. Cigarette smoking–attributable mortality and years of potential life lost: United States, 1990. *MMWR Morb Mortal Wkly Rep.* 1993;42:645-649.
2. Fiore MC, Bailey WC, Cohen SC, et al. *Smoking Cessation: Clinical Practice Guideline No. 18.* Rockville, Md: Agency for Health Care Policy and Research; April 1996. Publication No. 96-0692.
3. Centers for Disease Control and Prevention. Physician and other health care professional counseling of smokers to quit: United States, 1991. *MMWR Morb Mortal Wkly Rep.* 1993;43:925-930.
4. Robinson MD, Laurent SL, Little JM Jr. Including smoking status as a new vital sign: it works. *J Fam Pract.* 1995;40:556-563.
5. Cummings SR, Rubin SM, Oster G. The cost-effectiveness of counseling smokers to quit. *JAMA.* 1989;261:75-79.
6. Fiscella K, Franks P. Cost-effectiveness of the transdermal nicotine patch as an adjunct to physicians' smoking cessation counseling. *JAMA.* 1996; 275:1247-1251.
7. Oster G, Huse DM, Delea TE, Coldize GA. Cost-effectiveness of nicotine gum as an adjunct to physicians' advice against cigarette smoking. *JAMA.* 1986;256:1315-1318.
8. US Dept of Health and Human Services. *The Health Benefits of Smoking Cessation: A Report From the Surgeon General.* Atlanta, Ga: US Dept of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1990. DHHS publication No. (CDC) 90-8416.
9. The Smoking Cessation Clinical Practice Guideline Panel and Staff. The Agency for Health Care Policy and Research smoking cessation clinical practice guideline. *JAMA.* 1996;275:1270-1280.
10. *1996 Physician's GenRX: The Complete Drug Reference.* St Louis, Mo: Mosby–Year Book Inc; 1996.
11. Centers for Disease Control and Prevention. Smoking cessation during previous year among adults—United States, 1990 and 1991. *MMWR Morb Mortal Wkly Rep.* 1993;42:504-507.
12. Gilpin EA, Pierce JP, Farkas AJ. Duration of smoking abstinence and success in quitting. *J Natl Cancer Inst.* 1997;89:572-576.
13. Cohen S, Lichtenstein E, Prochaska J, et al. Debunking myths about self-quitting: evidence from ten prospective studies of persons quitting smoking by themselves. *Am Psychol.* 1989;44:1355-1365.
14. Rogers RG, Powell-Griner E. Life expectancies of cigarette smokers and non-smokers in the United States. *Soc Sci Med.* 1991;32:1151-1159.
15. Adams PF, Benson V. Current estimates from the National Health Interview Survey, 1991. *Vital Health Stat 10.* 1992;181:1-212.
16. National Center for Health Statistics. *Health United States, 1994.* Hyattsville, Md: US Public Health Service; 1995. Publication PHS 95-1232.
17. Rice DP, Hodgson TA, Sincheimer P, et al. The economic costs of the health effects of smoking, 1984. *Milbank Q.* 1986;64:489-547.
18. National Center for Health Statistics. *Current Estimates From the National Health Interview Survey, 1992.* Hyattsville, Md: US Public Health Service; 1993. Publication PHS 93-1509.
19. American Hospital Association. *Hospital Statistics.* 1994-1995 ed. Chicago, Ill: AHA Services Inc; 1994.
20. US Dept of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress: A Report of the Surgeon General.* Washington, DC: US Dept of Health and Human Services; 1989. DHHS publication 89-8411.
21. Weinstein MC, Stason WB. Foundation of cost-effectiveness analysis for health and medical practices. *N Engl J Med.* 1977;296:716-721.
22. Warner K, Luce B. *Cost-Benefit and Cost-effectiveness Analysis in Health Care: Principals, Practice, and Potential.* Ann Arbor, Mich: Health Administration Press; 1982.
23. Russell L. *Is Prevention Better Than Cure?* Washington, DC: Brookings Institution; 1986.
24. Drummond MR, Stoddart GL, Torrance GW. *Methods for the Economic Evaluation of Health Care Programmes.* Oxford, England: Oxford University Press; 1987.
25. Gold MR, Siegel JE, Russel LB, Weinstein MC. *Cost-effectiveness in Health and Medicine.* New York, NY: Oxford University Press; 1996.
26. Hodgson TA. Cigarette smoking and lifetime medical expenditures. *Milbank Q.* 1992;70:81-125.
27. Tengs T, Adams M, Pliskin J, et al. *Five-Hundred Life-Saving Interventions and Their Cost-effectiveness.* Cambridge, Mass: Harvard Center for Risk Analysis; 1995.
28. Eddy DM. David Eddy ranks the tests. *Harvard Health Letter.* July 1992:10-11.