RESEARCH PAPER

Examining the effects of tobacco treatment policies on smoking rates and smoking related deaths using the *SimSmoke* computer simulation model

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Tobacco Control 2002;**11**:47–54

Objectives: To develop a simulation model to predict the effects of different smoking treatment policies on quit rates, smoking rates, and smoking attributable deaths.
Methods: We first develop a decision theoretic model of quitting behaviour, which incorporates the decision to quit and the choice of treatment. A model of policies to cover the costs of different combinations of treatments and to require health care provider intervention is then incorporated into the quit model. The policy model allows for the smoker to substitute between treatments and for policies to reduce treatment effectiveness. The *SimSmoke* computer simulation model is then used to examine policy effects on smoking rates and smoking attributable deaths.
Results: The model of quit behaviour predicts a population quit rate of 4.3% in 1993, which subsequently falls and then increases in recent years to 4.5%. The policy model suggests a 25% increase in quit rates from a policy that mandates brief interventions and the coverage of all proven treatments. Smaller effects are predicted from policies that mandate more restricted coverage of treatments, especially those limited to behavioural treatment. These policies translate into small reductions in the smoking rate at first, but increase to as much as a 5% reduction in smoking rates. They also lead to substantial savings in lives.
Conclusions: Tobacco treatment policies, especially those with broad and flexible coverage, have the potential to increase smoking cessation substantially and decrease smoking rates in the short term, with fairly immediate reductions in deaths.

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Received
7 February 2001
and revision requested
26 July 2001.
Accepted
1 October 2001

Much of the focus of recent tobacco control policies has been on youth prevention,[1] through such policies as media campaigns, reducing tobacco sales to youth, and school education programmes. These policies take considerable time to reduce overall smoking rates and smoking related deaths.[2] Reducing the number of current smokers is necessary, however, to improve health in the immediate future. If current smokers quit, many of the health effects associated with smoking can be reversed.[3 4]

The recently released and updated Department of Health and Human Services guidelines[5] recommend that health care workers provide brief intervention and follow up, and that they advise the use of pharmacotherapy combined with behavioural treatment. Considerable research documents the effectiveness and cost effectiveness of treatment for tobacco use and dependence. Yet, access to treatment and involvement of health care workers is limited. Minimal interventions are not routinely provided by many health care providers.[6 7] Less than half of managed care operations fully cover cessation classes or telephone counselling, and pharmacotherapy is rarely covered.[8] Even government payers, such as Medicaid and Medicare, often provide limited or no coverage.[9]

Greater access to smoking cessation treatments and involvement of health care providers has the potential to increase treatment use.[5 10–13] In this paper, we present a simulation model of tobacco treatment policies. The model considers coverage for different combinations of treatments, and the provision of brief interventions by health care providers. The treatment model is part of a larger simulation model of tobacco control policies, known as *SimSmoke*, that is used to gauge the effect of treatment policies on smoking rates and on tobacco attributable deaths.

Because our knowledge of the empirical effects of public policies targeted at tobacco treatment is limited, the predictions of the model are quite tentative. The simulation model does, however, provide a heuristic tool to help understand how treatment policies may influence quit attempts, the specific treatments used, and the effectiveness of these treatments. The model highlights issues that need to be considered in developing treatment policies and the areas in which further evidence is needed to understand better the effects of tobacco treatment policies.

METHODS

First, a model of quit rates is described, which is used to predict cessation rates between 1993 and 2000. The effects of mandatory coverage are then addressed in the policy model, which predicts the effect of public policies on quit rates. Technical equations for the quit and policy model are presented and described at greater length elsewhere.[14] This paper focuses on policy implications. The *SimSmoke* model[15 16] is then described, which predicts the effect of treatment policies on smoking rates and on smoking attributable deaths from the year 2001 onward.

Quit model

In the quit model, the smoker first decides to quit, and then chooses among treatment options. The six treatment options are: (1) self-quit or minimal intervention; (2) prescription pharmacotherapy (Rx PT); (3) over-the-counter pharmacotherapy (OTC PT); (4) behavioural therapy; (5) Rx PT and behavioural therapy in combination; or (6) OTC PT and behavioural therapy in combination. Self-quit methods include the

Abbreviations: BIs, brief interventions; CDC, Centers for Disease Control and Prevention; OTC PT, over-the-counter pharmacotherapy; Rx PT, prescription pharmacotherapy

Table 1 Treatment prevalence and attempted quit rates for 1993-2000

	Treatment prevalence						Attempted quits per smoker	Predicted average quit rate
	Self	Rx PT	OTC PT	BT	BT and Rx PT	BT and OTC PT		
1993	0.77	0.13	0.00	0.07	0.03	0.00	0.46	0.043
1994	0.83	0.08	0.00	0.06	0.03	0.00	0.44	0.040
1995	0.87	0.06	0.00	0.05	0.02	0.00	0.44	0.039
1996	0.82	0.05	0.05	0.04	0.02	0.02	0.44	0.040
1997	0.75	0.03	0.13	0.03	0.03	0.03	0.46	0.045
1998	0.75	0.04	0.12	0.03	0.03	0.03	0.46	0.044
1999	0.77	0.04	0.11	0.02	0.03	0.03	0.46	0.044
2000	0.78	0.04	0.10	0.02	0.03	0.03	0.46	0.044
Treatment effectiveness	0.08	0.13	0.13	0.13	0.20	0.20		

Rx PT, prescription pharmacotherapy; OTC PT, over-the-counter pharmacotherapy; BT, behavioural therapy.

distribution of pamphlets and reductions in the numbers of cigarettes smoked, and is differentiated from behavioural therapy by excluding health care provider involvement. The categories were chosen based on similarities in effectiveness,[5 17] policy relevance (for example, payers must decide whether to require behavioural therapy use with PT and whether to cover OTC as well as Rx PT), and the need for simplicity.

The average quit rate of smokers in the population is obtained by multiplying the percentage of the smoking population that attempts to quit by the average quit rate per attempt. The average quit rate per quit attempt is estimated by multiplying the percentage of smokers making quit attempts using each of the six options by the effectiveness of that option, and then summing over options.

Since empirical studies usually examine follow up periods of one year or less, the model focuses on the one year quit rate of current smokers. Estimates of treatment effectiveness[5 18–20] indicate that use of PT or of behavioural therapy alone about doubles quit rates compared to no intervention or unassisted quitting, and combined PT and behavioural therapy use about doubles quit rates of either behavioural therapy or PT alone. Recent studies[21 22] have generally not found differences among the effects of using Rx and OTC PTs in clinical settings. Using a base quit rate of 5% for self-quits,[10 23] the success of behavioural therapy or PT alone would be 10%, and of behavioural therapy and PT combined would be 20%, for those who make a single quit attempt during a single year. Since smokers generally make multiple quit attempts[24] however, these rates were adjusted upward, based on the 1993 and 1996 Tobacco Use Supplement data,[25 26] Fiore and colleagues,[27] and our team of expert advisers. The final rates were estimated to be 8% for unassisted attempts, 13% for Rx PT, OTC PT, and behavioural therapy, and 20% for combined RX or OTC PT and behavioural therapy, reflecting that those using more assisted methods are more likely to remain quit and thus less likely to make a repeat attempt.

The quit model is used to examine trends in the 1993-2000 period. The effectiveness of treatments is assumed to be constant, but use patterns and the rate of quit attempts change. Table 1 presents estimated treatment rates for the years 1993 through 2000. As shown, 16% of attempted quits in 1993 were estimated to involve Rx PT use (13% without and 3% with behavioural therapy), and 10% behavioural therapy use (7% alone and 3% with Rx PT), leaving 79% of smokers using unassisted quit attempts. Because 1992-93 were peak years for Rx PT use because of the introduction of the patch,[28] Rx PT use declines in 1994 and 1995. In 1997, the first full year of OTC PT availability, it is estimated that Rx PT use declines further as quitters substitute OTC PT. As estimated by Shiffman and colleagues,[29] the ratio of OTC PT to Rx PT use is 2.5. By 2000, it is estimated that 8% of attempted quits involve Rx PTs (6% without and 2% with behavioural therapy), 15% involve OTC PTs (12% alone and 3% with behavioural therapy), and 8% use behavioural therapy (2% alone, 3% with Rx PTs, and 3% with OTC PTs). The relative use of OTC PTs is expected to have fallen in recent years because of introductions of new Rx PTs (bupropion in particular) and a decline in OTC PT use from when it was first introduced. Table 1 also presents attempted quit rates. Beginning at 46% in 1993, quit attempts drop slightly between 1993 and 1994 (because of the decrease in Rx PT use) and increase in 1996 with the introduction of OTC PT. When OTC PT falls, new Rx PTs are introduced in 1998, leaving the attempted quit rate constant.

Fiore *et al*,[27] Hazeldon,[30] Cummings *et al*,[31] Oster *et al*,[32] Pierce *et al*,[33] and Zhu *et al*[34] were the primary sources used to estimate the initial levels of treatment use, while Shiffman *et al*[29] and Burton *et al*[28] served as the major sources of information for trends in PT use. Estimated attempted quit rates were based primarily on National Health Interview Survey data from the Centers for Disease Control and Prevention (CDC).[35–40] The estimates were also reviewed by our team of expert advisers.

The policy model

The policy model considers the effect of mandating access to treatment through financial coverage and requiring brief interventions by health care providers. Since the simulation model examines policy effects at a national level, it is assumed that the policies are mandated by the federal government. For insured smokers, they are assumed to be carried out through coverage by government and private insurers. For uninsured smokers, the provision of treatment is subsidised through rebates. For simplicity and because of lack of information, we do not consider sociodemographic variations in policy effects. However, the effect of a policy depends on current cessation rates, which are adjusted for demographic differences in the *SimSmoke* model.

Access policies directly affect the use of treatments by reducing treatment costs to the user. Access policies may also reduce barriers, such as travel, time or inconvenience, or lack of information, through the type of treatments covered and restrictions on use. For example, the Agency for Health Care Policy and Research[41] advocates fairly intensive counselling with pharmacotherapy usage. This "comprehensive" approach requires physician involvement, thereby providing more information and guidance to the smoker but involving more time and possibly inconvenience than options not requiring physician involvement. A more flexible approach would give the patient treatment options. Under this approach, convenience may increase, but smokers may not receive the support and guidance provided by a physician or other health care worker.

We consider access policies that may provide PT or behavioural therapy alone or in combination. Policies affecting OTC PTs are further distinguished from those affecting Rx PTs because of the implications for physician involvement. Specifically, the reimbursement plans considered in the model

Table 2 Treatments affected by each policy

Policy reimbursement	Treatments affected
Rx PTs	Rx PT, combined BT and Rx PT
All PTs	Rx PT, OTC PT, combined BT and Rx PT or OTC PT
BT alone	BT, combined BT and Rx or OTC PT
BT and PTs (Rx or OTC) combined (comprehensive)	BT, combined BT and Rx or OTC PT
All PTs (Rx or OTC) and BT (flexible)	Rx PT, OTC PT, BT, combined BT and Rx PT or OTC PT

Rx PT, prescription pharmacotherapy; OTC PT, over-the-counter pharmacotherapy; BT, behavioural therapy.

are: (1) Rx PTs alone; (2) Rx or OTC PT alone; (3) behavioural therapy alone; (4) the "comprehensive approach," with PTs only provided when used with behavioural therapies (for example, enrolment in formal cessation programme) or behavioural therapy alone; and (5) "flexible approach," with any PTs and behavioural therapy, alone or in combination. For parsimony, restrictions on specific types of pharmacologic agents (for example, use of clonidine), or specific types of behavioural therapy (for example, hypnosis or acupuncture), or to certain providers (for example, physicians or psychologists), and on the duration, frequency, and intensity of use are not explicitly considered in the model. However, payers are expected to adopt such restrictions to encourage proper use and reduce costs. We assume that treatments are fully covered.

In the policy model, access policies increase the use of particular types of treatment by current smokers through their treatment use rates. The use of treatment as a result of a particular policy depends on the initial treatment use multiplied by the percent change in treatment use as a result of the policy, then adjusted by the percent of smokers already covered for treatments.

Few studies have examined the effect of access policies on treatment use and quit rates. Based on Curry *et al*[11] and Hughes *et al*,[10] Rx PT coverage is estimated to increase use by 140%. Based on Schauffler *et al*,[12] coverage of all PTs increases use by 90%. The smaller percentage effect of broader coverage was also set at a lower level than for Rx PT coverage. The higher base rate suggests for OTC PT use that access barriers, in the absence of policy, are lower because a physician's prescription is not required. Based on Curry *et al*,[11] and because of the implicit cost of time and travel expense required, behavioural therapy coverage is estimated to increase behavioural therapy use by 70%. Coverage of combined Rx PT and behavioural therapy is estimated to increase use by 180%. This estimate is relatively high, because initial combined behavioural therapy and Rx PT use is initially low and smokers are expected to be more motivated to try medications that will help alleviate withdrawal symptoms than when only behavioural therapy is covered. Based primarily on Schauffler *et al*,[12] the flexible option increases treatment use by 120% from its higher base rate. The policy effectiveness parameters were also reviewed by our team of expert advisers for reasonableness and consistency.

A policy option may affect more than one treatment type, as shown in table 2. For example, Rx PT coverage alone increases combined behavioural therapy and Rx PT use, because the medication portion is less expensive. Similarly, behavioural therapy coverage reduces the cost of combined PT and behavioural therapy use. The flexible option increases access to all treatments. The coverage elasticity is assumed to be the same for each of the treatments affected by a policy.

Current levels of coverage are based on McPhillips-Tangum[8] and Barker *et al*,[9] adjusted downward to reflect that many smokers are uninsured. We estimate that 3% of insurers cover Rx PTs and 2% also cover OTC PTs, 11% cover behavioural therapies only, 13% cover Rx PTs with behavioural therapies, and 2% cover any PT or behavioural therapy, for a total of 31% coverage.

While access may affect a broad array of treatments, use of those treatments may result from smokers switching from another treatment. This group of potential quitters would have attempted to stop smoking even in the absence of the new policy, but the policy leads them to *substitute* the treatment or combination of treatments that they use. For example, when OTC PT is covered, some smokers switch from behavioural and Rx PT to OTC PT alone, which is less effective. When Rx PT, with or without behavioural therapy, is covered, some switch from OTC PT alone to Rx PT and behavioural therapy, which is more effective. In the model, we distinguish the effect of an access policy on those who would not otherwise have tried to quit from those who substitute from other treatments.

No empirical literature specifically addressed the extent to which increased access would yield new quitters and substitution between treatment methods. Estimates of substitution from each of the sources were developed based on observed practices in previous studies[27] and consultation with our advisers. For all but behavioural therapy alone and behavioural therapy with Rx PT, we assume that approximately 50% of new use is assumed to involve new quitters, and the other 50% involves substitution of quitters previously using other types of treatment. For behavioural therapy coverage, we estimate 60% substitution. No substitution occurs from the treatments affected by a policy. All of the substitution is from self-quitters for the flexible policy since all treatments are options. For the other policies, most substitution is from self-quitters.[14]

While greater access may increase the intensity or duration of use, the effects of access policies may be lessened if smokers less well suited or committed or with less information about proper use are induced to try a treatment. In the absence of access policies, paying a price, in effect, serves the role of screening out smokers less committed to or appropriate for quitting. As those less motivated or appropriate for treatment are treated, the average effectiveness of a treatment across the entire population of attempted quitters declines.

Schauffler[12] provided evidence that average effectiveness declined with increased numbers of users. Hays *et al*[22] found higher rates of quit success for those who paid for treatment than those who did not. In the absence of direct evidence of the effects on new users, limited tendencies to diminishing returns were estimated. Treatment effectiveness falls 10% as treatment use doubles for all treatment categories, except the combined PT and behavioural therapy, for which a 20% reduction is estimated. A greater tendency to diminishing returns is expected for the combined PT/behavioural therapy policy because some of the behavioural therapy new users are expected to have switched in order to receive PT coverage.

Brief interventions (BIs) are modelled as involving physician screening and offering minimal advice, and generally lasting less than six minutes. More extensive interventions would involve more time and more extensive counselling and follow up, and may be considered in the model as policies that include behavioural therapy.

BIs are assumed to increase quit attempts, which in turn leads to the same proportional increase in all methods of quitting. Since evidence is lacking that minimal BIs steer patients towards the use of any particular treatment,[5] it is conservatively assumed that patients' proportional choice of treatments will be the same as that of current treatment users and that treatment effectiveness is unchanged. Similar to the access model, the effect of mandating BIs depends on the percentage increase in attempted quit rates as a result of the policy and the percentage of the population newly receiving BIs as a result of a policy change. Those newly receiving BI, in turn, depend on the percent of smokers that already receive BIs and the percent of smokers that visit physicians each year.

The percentage of physicians currently providing BIs is estimated as 60%, based on CDC[7] and Shiffman *et al*.[29] The CDC[7,42] estimated that 70% of smokers see a physician each year. A review of the literature conservatively indicates a 30% increase in the quit rate as a result of BIs.[5,13]

Most studies examine the effectiveness of BIs in controlled experimental settings. Less is known about how to implement BIs effectively in the population. In particular, the effect of BIs for new populations may differ from the effects on those already exposed before the policy change. Health care providers newly providing the intervention as a result of a mandate may be less inclined or able to follow the recommended procedures faithfully, either because they are not properly trained or are sceptical about the effectiveness of BIs. Some may not even follow the mandate at all. In addition, before mandated BIs, health care providers may have also limited their advice and counsel to those smokers more likely to be amenable to quitting. Thus, as physicians are required to intervene, average effectiveness is expected to fall. It is assumed that the average effectiveness of those newly providing BIs decreases 20% as a result of a policy mandate.

Because parameter estimates in the policy model are tentative, sensitivity analyses were conducted. Changes in policy effectiveness, the percentage of new quit attempt versus substitute parameters, and the extent of diminished effectiveness are considered.

Projecting smoking rates and smoking attributable deaths

The effects of treatment policy are considered relative to a "business as usual" scenario, in which other tobacco control policies are held constant at their current levels. Smoking rates are tracked using the *SimSmoke* model of tobacco policies.

Discussed elsewhere,[14 15 43] the *SimSmoke* model begins with the number of smokers, never smokers, and ex-smokers by age, sex, and racial/ethnic group in the baseline year 1993. As each demographic cohort evolves, the model allows for births and deaths and for initiation, cessation, and relapse in tracking smoking behaviour using a discrete first order Markov process.

Smokers are defined as individuals who have smoked more than 100 cigarettes in their lifetime and are currently smoking. Ex-smokers are defined as those who have smoked more than 100 cigarettes, and are not currently smoking. Individuals are classified as never smokers from birth until they initiate smoking or die. Initiation occurs until age 25.[44] Because of difficulties in measuring initiation and quitting, initiation rates at a particular age are measured as the change in prevalence rate between those smoking at that age and those smoking at the previous age. This measure of initiation net of quitting ensures that the number of smokers at age 24 years equals the number of actual smokers at that age. Using separate measures of initiation and cessation for those under age 24 would require relying on two unstable numbers.

Quit rates have been modified from our earlier models.[43] The first year quit rate (net of relapse) is measured as the average population quit rate calculated by the quit rate model. To account for differences in quit rates by age, sex, and racial/ethnic groups, the one year quit rates are multiplied by a demographic adjuster variable. The adjusters are calculated by first estimating the one year quit rate, in which "quits" are defined as those who stopped smoking in the last year, but not the last three months. Logistic regression analysis was employed to determine quit rates for each of the age, sex, and racial/ethnic groups. The demographic group's predicted quit rate was divided by the average quit rate for sample to obtain the demographic adjuster.

The quit rate for those below age 25 was only used to calculate the policy effects on those in that age group. In addition to difficulties in measuring cessation before age 25, cessation before age 25 is relatively less important because smokers who quit before then are not expected to have any permanent health effects as ex-smokers. Relapse rates after the first year are used for those after age 25 to determine the percentage of ex-smokers who again become smokers. Treatment policies affect the first year cessation rate, but do not affect relapse after the first year.

Population data are from the 1993 Census of Population, fertility rates are from the US Census Vital Rate Inputs Tables, and mortality rates are from the 1993 Multiple Cause-of-Death File. The source of data on smoking, initiation, and cessation rates by demographic group for those age 15 and above is the Tobacco Use Supplement of the Census Population Survey (1992-93),[25 26 45] and on smoking and initiation rates for those below age 15, the 1993 Teenage Attitudes and Practices Survey.[46] Relapse rates after the first year are based on COMMIT (community intervention trial for smoking cessation) data,[47] Gilpin *et al*,[48] McWhorter *et al*,[49] and the US Department of Health and Human Services.[50]

Smoking attributable deaths are predicted using standard attribution measures, which use the prevalence rates and the risks of smokers and ex-smokers relative to non-smokers.[51 52] Deaths rates differ by age, sex, and smoking groups (never, current, and quit < 1 year, 1–2 years, 3–5 years, 6–10 years, 11–15 years, and > 15 years) based on the Cancer Prevention Study II.[50 53]

RESULTS

Predicted quit rates from 1993-2000

As shown in table 1, quit rates were predicted to be 4.3% in 1993. Because the patch was introduced in 1992, the quit rate falls to 3.9% by 1995. Population quit rates are predicted to rise in 1996 with the introduction of OTC PTs in May of that year. Quit rates peak at 4.5% in 1997, the first full year after OTC PT is introduced, about 15% above the 1995 level.

Average treatment effectiveness increases between 1995 and 1997, mostly because of the increased use of treatments and consequent reduction in self-quits. This improvement primarily reflects the increase in OTC PT usage and in attempted quits. Quit rates fall slightly, to 4.4% in 1998 through 2000, as the use of OTC PT falls but new Rx PTs come onto the market.

Effects of tobacco treatment policies on quit rates

The effect of each policy is presented in terms of the percentage increase in the population quit rate from its 2000 level of 4.5% in table 3. As shown in column 1, when behavioural therapy coverage alone is mandated, the model predicts only a 4.4% relative increase in the quit rate. The relatively small effect is due to the low percentage of smokers that use the method and the relatively small policy elasticity, both of which

Table 3 Policy effects in terms of per cent increase in quit rates*

Access policy	(1) Full coverage with BI	(2) Full coverage without BI	(3) Policies increase use by 100%	(4) Policies increase use by 200%	(5) No diminished returns in effectiveness	(6) No substitution from other treatments	(7) Cases 4, 5, and 6
Rx PT only	9.0	16.3	14.9	23.1	20.3	25.8	37.0
All PTs	13.5	21.1	26.8	46.9	28.9	37.6	84.5
Behavioural only	4.4	11.4	15.8	24.8	14.6	16.4	38.8
Behavioural and Rx PT	13.6	21.2	17.3	27.9	29.9	31.5	38.8
Flexible policy	19.8	27.8	32.2	57.7	43.1	50.0	90.6
No access policy	–	6.7					

*Per cent change is measured relative the absence of any policy. Rx PT, prescription pharmacotherapy; BI, brief interventions.

Table 4 Smoking rates as a per cent of the all age population predicted by *SimSmoke*

Year	BAU (%)	BI alone (%)	% change	BI and RxPT (%)	% change	BI and OTC PT (%)	% change	BI and behav (%)	% change	BI and comp (%)	% change	BI and flex (%)	% change
2000	18.4							18.4					
2001	18.3	18.3	−0.0	18.3	−0.0	18.3	−0.0	18.3	−0.0	18.3	−0.0	18.3	−0.0
2002	18.2	18.1	−0.3	18.1	−0.5	18.0	−0.8	18.1	−0.4	18.0	−0.6	18.0	−0.9
2003	18.1	18.0	−0.4	17.9	−0.7	17.8	−1.2	17.9	−0.6	17.9	−1.0	17.8	−1.4
2004	18.0	17.9	−0.5	17.8	−0.9	17.7	−1.5	17.8	−0.8	17.7	−1.2	17.6	−1.8
2005	17.8	17.7	−0.6	17.7	−1.1	17.5	−1.8	17.7	−1.0	17.6	−1.5	17.5	−2.1
2010	17.4	17.2	−1.0	17.1	−1.8	16.9	−2.9	17.1	−1.6	17.0	−2.4	16.8	−3.4
2015	17.0	16.8	−1.3	16.6	−2.3	16.4	−3.7	16.6	−2.1	16.5	−3.0	16.3	−4.4
2020	16.5	16.3	−1.5	16.1	−2.7	15.8	−4.2	16.1	−2.4	15.9	−3.5	15.7	−5.0
2025	16.0	15.8	−1.7	15.6	−2.9	15.3	−4.6	15.6	−2.6	15.4	−3.8	15.2	−5.5
2030	15.6	15.4	−1.7	15.1	−3.1	14.9	−4.8	15.2	−2.8	15.0	−4.0	14.7	−5.7
2035	15.4	15.1	−1.8	14.9	−3.1	14.6	−4.9	15.0	−2.8	14.8	−4.1	14.5	−5.8
2040	15.3	15.0	−1.8	14.8	−3.1	14.6	−4.9	14.9	−2.8	14.7	−4.1	14.4	−5.8

Per cent change is measured relative to business as usual (that is, the absence of the intervention) for the same year.
BAU, business as usual; BI, brief intervention; Rx PT, prescription pharmacotherapy; OTC PT, over-the-counter pharmacotherapy, behav, behavioral therapy; comp, comprehensive with pharmacotherapy and behavioural required; flex, flexible with all treatments covered.

reflect the higher implicit costs associated with the time costs. The quit rate increases by 9.0% with a policy covering Rx PT alone. When accompanied by required behavioural therapy coverage, the "comprehensive approach", the quit rate increases by 13.6%. The quit rate increases by 13.5% when all PTs, but not behavioural therapy, are covered, and the quit rate increases by 19.8% when all treatments including behavioural therapy are covered. The relatively large effect of these policies reflects the flexibility that it affords those attempting cessation and the relative desirability of PT use.

As shown in column 2, a policy mandating BIs by all health care providers is predicted to increase the quit rate by 6.7% in the absence of access policies. The effect of each access policy is increased by a slightly greater percentage because BIs enhance the effect of access policies.

Sensitivity analysis on key parameters of the policy model is also presented in table 3. When coverage increases use for all treatments by 100% (column 3), the increase in the quit rate falls, except for all PT coverage and behavioural therapy coverage. If coverage increases all treatment use by 200% (column 4), the quit rate almost doubles for all PT coverage, behavioural therapy coverage, and the flexible policy. When the diminishing return parameter is reduced to 0 (formerly 10% for all except the flexible option which was 20%), the effects increase between 10% and 20%. When it is assumed that all new use is from new quitters (that is, no substitution from other treatments), increases are near 50% for the flexible policy and a smaller percentage for other policies. When policies increase use by 200% and diminishing returns and substitution is absent (column 7), the quit rate increases by 90% for the flexible option, compared to about 40% for the Rx PT only, behavioural therapy only, and comprehensive option.

Sensitivity analysis was also conducted on the brief intervention parameters. If the effectiveness parameter is changed from 30% to 50%, the quit rate increases by 11.2% instead of 6.7%. Increasing only the diminishing returns parameter from 0.2 (the reduction in effectiveness) to 0.5 decreases the effect of mandating brief interventions from a 6.7% to a 4.2% increase in the quit rate. Reducing the diminishing returns parameter to 0 increases the quit rate by 8%.

Effects of tobacco treatment policies on smoking rates and deaths

Smoking rates as a percent of the population of all ages are presented in table 4 with and without treatment policies. In the absence of any policy, the model predicts that smoking rates fall gradually, from 18.4% in 2000 to 15.3% in 2040. Because of the large pool of current smokers with only a small percentage quitting each year, the initial effects are small, but grow over time as more current smokers successfully quit. For example, with mandated brief interventions and coverage of Rx PT, it takes two years before the smoking rate is reduced by 1%, this rate changing slowly over time. The smoking rate is reduced 2.7% after 20 years, and 3% after 40 years. With behavioural therapy covered in addition to mandated BI and Rx PT coverage, the effects increase to 4%. With all treatments covered, an almost 6% reduction is predicted. Part of the effect is offset with the addition of new youth initiating smoking each year.

As shown in table 5, effects on smoking attributable deaths are further delayed. With mandated BI and Rx PT coverage, it is only after 15 years that deaths are reduced by 1%. After 40 years, deaths are reduced by 3.3%, which amounts to about 15 000 deaths per year. The flexible policy leads to more than a 6% reduction in death rates. The effect on death rates is delayed, because smoking deaths generally occur at later ages and it takes time for cessation to reverse the effects of smoking. The long run effect on death rates is larger in relative terms than on smoking rates, because smokers at later ages, particularly between the ages of 45 and 60, have higher quit rates. Not by coincidence, smoking attributable deaths also become more imminent at those ages.

DISCUSSION

The quit model predicts that the quit rate declined from 4.3% to 3.9% between 1993 and 1995. The predictions for 1993 are close to those estimated by Gilpin *et al*[48] and Burns *et al*,[54] and the trend is in the same direction as predicted by Burns *et al*.[54] We predict that quit rates have increased between 1995 and 2000 because of the availability of new treatments.

The model highlights the need for better information on the quitting process. In particular, data are needed on the number of and reasons for quit attempts (especially multiple attempts within a year), treatment effectiveness in non-clinical settings, and treatment use (especially for OTC market nicotine replacement therapies and combined behavioural/pharamacotherapy treatments).

The policy model predicts a 25% relative increase in quit rates from a policy that combines mandated brief interventions with coverage of all proven cessation treatments. Smaller effects are predicted from policies that provide more restricted coverage of treatments, especially those limited to behavioural treatment. A policy with flexible coverage, but which attempts to steer smokers to behavioural therapies, might improve success rates beyond those predicted here.

The policy model assumed that mandatory coverage would lead to diminished effectiveness of treatments in non-clinical settings and some substitution from treatments used before the policy was implemented. In the absence of these effects,

Table 5 Deaths attributable to smoking predicted by *SimSmoke* under different policy scenarios

Year	BAU	BI Alone	% change	BI and RxPT	% change	BI and OTC PT	% change	BI and behav	% change	BI and comp	% change	BI and flex	% change
2000	418317	418317	−0.0	418317	−0.0	418317	−0.0	418317	−0.0	418317	−0.0	418317	−0.0
2005	429912	429806	−0.0	429723	−0.0	429608	−0.1	429742	−0.0	429661	−0.1	429548	−0.1
2010	443672	442484	−0.3	441564	−0.5	440310	−0.8	441778	−0.4	440888	−0.6	439659	−0.9
2015	456150	453442	−0.6	451359	−1.1	448543	−1.7	451843	−0.9	449837	−1.4	447090	−2.0
2020	468909	464511	−0.9	461148	−1.7	456631	−2.6	461929	−1.5	458703	−2.2	454311	−3.1
2025	482833	476765	−1.3	472152	−2.2	465986	−3.5	473220	−2.0	468809	−2.9	462836	−4.1
2030	486476	479058	−1.5	473443	−2.7	465977	−4.2	474742	−2.4	469391	−3.5	462176	−5.0
2035	474942	466680	−1.7	460452	−3.1	452202	−4.8	461890	−2.7	455969	−4.0	448018	−5.7
2040	449120	440591	−1.9	434181	−3.3	425718	−5.2	435659	−3.0	429578	−4.4	421437	−6.2

Per cent change is measured relative to business as usual (that is, the absence of the intervention) for the same year.
BAU, business as usual; BI, brief intervention; Rx PT, prescription pharmacotherapy; OTC PT, over-the-counter pharmacotherapy, behav, behavioral therapy; comp, comprehensive with pharmacotherapy and behavioural required; flex, flexible with all treatments covered.

quit rates increase by as much as 50% for some policies. However, policies may have smaller effects if these effects were underestimated in the model. The policy model was also based on tentative estimates of policy effectiveness. With more optimistic estimates of policy effects (for example, if access policies tripled use) and the absence of diminishing returns in treatment use, quit rates could almost double under a flexible coverage policy with mandated brief interventions. Differences in treatment effectiveness among specific types of behavioural treatment; the effects of restricting treatment duration, frequency, and intensity; and the effects of partial treatment coverage merit further exploration. In addition, information dissemination policies may be directed at the entire community, such as Community Intervention Trial for Smoking Cessation, or through telephone quit lines as part of media campaigns. Advertising or other promotions by cessation treatment producers in response to policy changes may also affect treatment usage and effectiveness.

The analysis assumed that the effects of treatment policy on quit rates are maintained over time. If the policy is maintained, its effects may change over time, leading to higher or lower quit rates. The effects might diminish if those likely to react to policy (for example, less addicted smokers) take immediate action and are successful. However, smokers typically attempt to quit several times before they are successful.[24] The effects of policies may increase during the first several years as the smoker goes through the stages necessary to quit smoking. Use of the nicotine patch and other therapies may lead to reductions in the quantity smoked, which only later reduces smoking rates through complete cessation.[55] Similarly, repeat advice by physicians may be needed, but the effect of additional interventions may diminish because repeat advice has little additional effect and the percentage of smokers previously advised to quit increases. Repeated advice with follow up may, however, be necessary to impact more addicted smokers who have more difficulty stopping smoking. In general, little is known about the effect of treatment policies beyond the first year.[5 13]

The policy model assumes that cessation policies are mandated by the federal government. The form of the policy, however, is likely to affect the extent and quality of physician involvement, and restrictions on treatment accessibility. Cessation policies may be implemented by local, state, or federal governments; directly through private insurers; or by employers via worksite programs.[56] Access policies may need to be mandated at a federal level to cover self-insured companies, and special provisions will need to be made for the uninsured. Access policies may take the form of direct payments to smokers through rebates or coupons, or subsidies to providers or insurance companies. Instead of simply mandating brief interventions, health care workers may receive insurance reimbursement through a special diagnostic code for providing cessation counselling.

Treatment policies may also play a greater role if they influence populations that are little affected by other policies. Access to treatment may be directed at specific populations, such as the uninsured and those covered by Medicaid, who are more likely to smoke and are more sensitive to costs.[31] While not considered in the model, those groups may be particularly sensitive to access policies that lower the costs of provision. However, in the USA, these groups, especially the uninsured, are currently under-served by the health care system, and it may be difficult to reach those groups. In addition, policies may be directed to pregnant or more addicted smokers. Those groups can be tracked in the health care system and provided greater attention through stepped care approaches and interventions tailored to smokers with comorbid addictions or to pregnant smokers.[5] Policies directed specifically at reducing smoking rates among youth also merit exploration.[57] Treatment policies may play an important role in a comprehensive tobacco policy by reaching particular populations.

The model suggests that the long term effects of cessation treatment policies compare favourably with other tobacco control policies. For example, the long term effects of a flexible access policy with brief interventions are similar to those of a tax increase of $0.30[16] or an intensive media policy directed at smokers of all ages.[58] However, the effects of the treatment policy on smoking take longer to realise in terms of reductions in smoking rates and smoking attributable deaths. The policy's effects on the smoking population, however, are more immediate than a fairly intensive youth access policy.[59] The effects are more immediate, because those who tend to quit are closer to the age when quitting affects their current health status.[60 61]

Most previous effectiveness and cost effectiveness studies of treatment policies have examined limited sets of interventions, and have not adequately considered limitations in implementing policies.[13] The policy model provides a basis to develop more realistic estimates of the effectiveness and cost effectiveness of the different policies. There are many areas in which more information is needed about tobacco treatments and policies. In addition, it is important to consider the costs of the different interventions.[14] Nevertheless, the results presented here suggest considerable scope for policies to increase quit rates and thereby reduce the medical costs, productivity loss, and pain and suffering from smoking attributable disease and illness.

ACKNOWLEDGMENTS

We would like to thank our team of expert advisers—F Chaloupka, M Cummings, S Curry, J DiFranza, W Evans, and J Forster—for their guidance during the development of the model. We would also like to thank M Carmona, J Gitchell, and H Holder for their comments at the various stages of the research. This paper was presented at the Addressing Tobacco in Managed Care conference in 2000 sponsored by the Robert Wood Johnson Foundation. Development of this simulation model was partially funded by the Substance Abuse and Mental

What this paper adds

Prior studies find that the use of tobacco cessation treatments and the involvement of health care workers in cessation both improve quit success. Some studies also find that insurance coverage of cessation treatments increases the use of treatments and the number of quit attempts. Little is known about how greater coverage of treatments would affect quit attempts and cessation rates of the smoking population.

This paper presents a simulation model that predicts the effects of cessation treatment policies on prevalence rates and smoker deaths caused by smoking. We consider the effects of interventions by health care workers and policies that cover the cost of behavioural and pharmacologic treatments. Different coverage policies are considered. We consider the effect on overall smoking rates and the number of deaths attributable to smoking. In addition, the model is used to trace the effect of changes in the use of treatments between 1993 and 2000.

Health Services Administration, United States Department of Health and Human Services. The authors would also like to thank the Substance Abuse Prevention Research Program (grant 037856) of the Robert Wood Johnson Foundation for their support to write this paper.

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