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Cost-Effectiveness Analysis of Face-to-face Smoking Cessation Interventions by Professionals

Cost-effectiveness analysis of face-to-face smoking cessation interventions by professionals.

A Modeling study

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Terminology and definitions

Bupr Bupropion

Comparator The intervention used as an alternative to the investigated intervention

Cost effective An intervention or program is called more cost effective if it leads to lower costs per effect than the alternative intervention, ie the comparator. This is reflected in the cost-effectiveness ratio (expressed as the costs of the intervention minus the costs of the alternative divided by the effects of the intervention minus the effects of the alternative). Cost effectiveness is a relative measure and it is impossible to call a program 'cost effective' without refering to a comparator.

Cost-effectiveness analysis An analytic tool in which costs and effects of a program or intervention and at least one alternative are calculated and presented in a ratio of incremental costs to incremental effects. Effects are health outcomes, measured in natural effects or physical units, such as new patients prevented or life years gained. If health outcomes are measured in *quality adjusted life years (QALYs)*, the method is also called *cost-utility analysis*.

DDD Defined Daily Dose, used to measure medication use in a common unit. One DDD is the standard amount prescribed per day for the medications main indication.

Direct costs Value of resources diverted from other use due to illness. Divided into direct medical costs (value of health care resources, e.g. drugs), and direct nonmedical costs, for instance transportation.

Discounting The process of converting future costs or effects to their *present value* with the help of a discount rate.

Dominant/dominated intervention Intervention A dominates intervention B (intervention A is dominant, intervention B is dominated) if A is more effective and less costly than B.

Efficiency Resource input in relation to outcome, for instance health outcomes. One measure of efficiency in health care is *cost effectiveness*.

H-MIS Short, low intensity counseling in a primary care setting, by the general practitioner, and/or his assistant.

IC Intensive counseling

Incremental costs/effects The difference in costs (effects) between the intervention and its alternative.

Indirect costs Value of lost resources due to illness or death. Most important example is *productivity costs*, that is the costs of production lost due to absence from work.

LYG Life years gained. A measure of health outcome which counts the difference in life expectancy with and without the intervention. This measure only takes account of reductions in mortality.

Net costs/net savings Outcome if all costs and savings included in the evaluation are added together. Positive net costs imply negative net savings and vice versa.

NRT Nicotine replacement therapy.

Present value The value to the decision maker now of outcomes (effects or costs) occurring in the future.

Productivity costs Value of resources lost due to lost or impaired ability to work (both paid and unpaid) as a result of illness or death.

Purchasing Power Parity Exchange rate used to compute results to different currencies, based on the price of a given, fixed, basket of goods.

Quality adjusted life year (QALY) A measure of health outcome which assigns to each period of time a weight, corresponding to health-related quality of life during that period, where a weight of 1 corresponds to optimal health and a weight of 0 corresponds to a health state judged equivalent to death; these are then aggregated across periods. This measure combines reductions in mortality and morbidity.

TC Telephone counseling

Transferability Degree to which (cost-effectiveness) results can be transferred from one setting, e.g. one country, to the other.

Abstract

Objectives: To estimate the cost-effectiveness of five face-to-face smoking cessation interventions: 1) Telephone Counseling (TC), 2) Minimal counseling by a general practitioner (H-MIS), 3) Minimal counseling by a general practitioner combined with Nicotine Replacement Therapy (H-MIS+NRT), 4) Intensive Counseling combined with Nicotine Replacement Therapy (IC+NRT) and 5) Intensive Counseling combined with Bupropion (IC+Bupr), in terms of costs per quitter, costs per life-year gained and costs per quality-adjusted life-year (QALY) gained.

Methods: Scenarios on increased implementation of smoking cessation interventions were compared to current practice. Base-case scenarios assumed that one of the five interventions was implemented for a period of either 1 year, 10 years or 75 years and reached 25% of the smokers. A computer simulation model, the RIVM Chronic Disease Model, was used to project future gains in life-years and Quality Adjusted Life Years (QALYs), and savings of health care costs from a decrease in the incidence of smoking-related diseases. Regardless of the duration for which the intervention was implemented, our time horizon was 75 years, i.e. costs and effects were studied over a period of 75 years. Intervention costs were computed based on bottom up estimates of resource use and costs per unit of resource use. Cost calculations of smoking cessation interventions were carried out from a health care perspective, i.e. total direct medical costs were calculated based on estimates of real resource use. Effectiveness in terms of cessation rates was obtained from Cochrane meta-analyses. For the base-case scenarios, future costs and effects were discounted at an annual percentage of 4%. Incremental cost-effectiveness ratios were calculated as: (additional intervention costs minus the savings from a reduced incidence of smoking related diseases) / (gain in health outcomes). A series of one-way sensitivity analyses were performed to assess the robustness of the cost-effectiveness ratios with regard to variations in cessation rates, intervention costs, discount rates, time horizon, and the percentage of smokers reached by the intervention.

Results: Base-case estimates for costs per quitter ranged from €443 for H-MIS to €2800 for IC+NRT. Compared to current practice H-MIS is a dominant intervention regardless of the duration of implementation. This means that H-MIS not only generates gains in life years and

QALYs but its saving are higher than its intervention costs. The four other interventions had relatively low cost-effectiveness ratios when compared to many other preventive interventions. When implementing each of the interventions for a period of 75 years, their ratios varied from about €1400 per life year gained for TC to €6200 per life year gained for IC+NRT. Incremental costs per QALY gained were €1100 for TC, €1400 for H-MIS+NRT, €3400 for IC+Bupr, and €4,900 for IC+NRT. Results were most sensitive to the rate of discounting.

Conclusions: All five smoking-cessation interventions are very cost-effective, with ratios far below €20000. H-MIS is even cost saving.

Introduction.

Smoking is a leading cause of preventable morbidity and mortality in terms of increased risks of many diseases, loss of quality of life and loss of life-years. In 2001, 30% of the Dutch population of 15 years and older was a current smoker and 16% of the total mortality in that same year was attributable to smoking.[1] Smoking incurs high costs to society. The World Bank estimated that 6% to 15% of the health care costs were attributable to smoking in developed countries.[2]

For many smokers, it is hard to quit smoking on will power alone. Only 3-7% of the smokers who attempts to stop smoking on will power, is still abstinent after one year.[3-5] A wide range of policy measures and therapies is available to increase this rate, varying from price increases by taxation, media campaigns, or self-help manuals, to intensive individual counseling combined with pharmaceutical therapies.[5,6] For smoking cessation interventions administered by medical professionals, the percentage of quitters ranges from 7% up to 24%.[5]

Cost-effectiveness analysis is used to inform policy makers about the economic and health implications of medical programs, e.g. smoking cessation interventions. It compares the costs and effects of a program or intervention to at least one alternative (comparator). Results are usually presented in a ratio of incremental costs to incremental effects. The lower this ratio, the more cost effective it is to implement the investigated intervention. That is, the more health effects are obtained for given expenditures. Some interventions turn out to be dominant, because they are less costly and, at the same time, generate more health effects than their comparator. Other interventions result in better health but at additional costs. No general agreed upon threshold value for cost-effectiveness ratios exists. However, in the Netherlands, for preventive interventions such as smoking cessation, €20000 per life year gained is an often-used limit for cost effectiveness. This figure was first introduced in the 1998 Cholesterol consensus[7,8], in the form of a NLG 40000 threshold. Compared to this threshold, the smoking cessation interventions are very cost-effective.[9,10]

A summary of results from the international literature on cost-effectiveness of smoking cessation interventions can be found in appendix A. Costs per life-year gained varied between €215 and €10,380 when the figures from foreign studies were converted into Dutch currency, using Purchasing Power Parity data[11] and then updated to the year 2000 using consumer price indices. The majority of studies reported cost-effectiveness ratios around €2,500 per life-year gained. These figures should be interpreted with care, because the transfer of results from economic studies between countries is difficult. Part of the reviewed cost-effectiveness studies calculated costs per life-year gained or costs per quality-adjusted life-year (QALYs) gained.[10,12-23] Few cost-effectiveness studies included savings in costs of care from avoided smoking-related morbidity. Incremental cost-effectiveness ratios were scarcely reported. No complete Dutch cost-effectiveness studies of face-to face smoking cessation interventions reporting costs per life year gained and QALY were found in our literature review. The Dutch Health Care Insurance Board (CVZ) did a quick scan of available information and estimated costs per quitter for a mix of cessation methods at around €1300.[6] A paper by Mudde and co-authors[24] analysed the cost effectiveness of a community intervention offering a choice between a self-help manual and a group program. They reported costs per quitter around €860. Recent work on the cost effectiveness of experimental coverage of smoking cessation interventions reported costs per additional quitter of €470.[25]

The present study aims to examine cost-effectiveness for a subset of smoking cessation interventions, namely face-to-face smoking cessation interventions administered by medical professionals with proven effectiveness in terms of cessation rates. Five different cessation interventions were compared to current practice to report incremental cost-effectiveness ratios for the Netherlands: 1) short, low intensity counseling in a primary care setting (H-MIS), 2) Minimal counseling and nicotine replacement therapy (H-MIS+NRT), 3) Intensive counseling and NRT (IC+NRT), 4) Intensive counseling and Bupropion (IC+Bupr), and 5) Telephone counseling (TC).
Cost-effectiveness was expressed in terms of costs per quitter, costs per life-year gained and costs per QALY gained. A computer simulation model, the RIVM-Chronic Disease Model,[26] was used to project the future gains in life-years and QALYs, and the savings in health care costs, that result from a decrease in the incidence of eleven smoking-related diseases. Different scenarios of increased implementation of smoking cessation interventions were considered, for all smokers in the population and for smokers in specific age groups. Costs and effects of the increased implementation scenarios were compared to costs and effects of a current practice scenario to determine incremental cost-effectiveness ratios. Sensitivity analyses were performed to assess the robustness of the cost-effectiveness ratios with regard to variations in resource use, effectiveness, time horizon, program size and discount rates.

The current study did *not* analyse the total costs of smoking. In addition to the cost-effectiveness data presented below, so called “cost of illness”, also called “burden of disease” studies analyze the total -financial- burden of smoking. References to this kind of studies for the Netherlands are [27,28,29]. International data can be found in Jha and Chaloupka[2] and at the World Health Organisation.

Methods

To calculate Dutch cost-effectiveness figures, the following approach was used:
First, the interventions and scenarios evaluated were selected. The scenarios contain the implementation of the intervention to a given percentage of smokers for a given number of years over a given time horizon. Current practice was described as the comparator scenario. Second, the effectiveness in terms of cessation rates was estimated. Third, the costs per smoker for these interventions were calculated. Combining costs and effects resulted in costs per quitter. Fourth, cessation rates were translated into life-years gained, QALYs gained, and savings in health care costs with the help of a dynamic model to compute projections for the different intervention scenarios. This included the modeling of the current practice comparator scenario. Finally, costs per life year gained and costs per QALY gained were computed. In a sensitivity analysis, the effects on the cost-effectiveness results of variations in resource use, effectiveness, the time horizon considered, the percentage of smokers reached, the duration of the intervention, and the discount rates, were computed.

Smoking cessation interventions

This study focussed on face-to-face smoking cessation programs, administered by medical professionals or educated smoking cessation counselors. They had to have a proven effectiveness in terms of cessation rates from international meta-analyses[9,30-32] or Dutch trial data [33,34] and be currently available in the Netherlands.[5,6] Given the goals of the Dutch Ministry of Health as phrased by the Partnership Stop Smoking (a reduction to 28% smokers in 2004), only the most effective interventions, with a 12-months continuous abstinence cessation rate above 6%, were included.

Based on these criteria, the following smoking cessation interventions were selected:

1. H-MIS: Minimal counseling by a general practitioner (GP) and/or a GP-assistant in one or two consultations with a total length of 12 minutes. [33,35]
2. H-MIS+NRT: Minimal counseling combined with nicotine patches or gum, for a period of eight weeks.[5,30]
3. IC+NRT: Intensive counseling by a trained counsellor in combination with nicotine patches or gum for a period of 12 weeks. We assumed the counseling would be done by a

trained lung nurse for a total of 90 minutes after a brief stop advice from a lung physician in either an outpatient or inpatient setting.[5,30,36]

4. IC+Bupr: IC in combination with Bupropion for a period of nine weeks.[5,31,36]
5. TC: Tailoring telephone counseling as currently provided by the Dutch Foundation on Smoking and Health (STIVORO), consisting of one intake call of 30 minutes and six follow-up calls of each 15 minutes, based on a (computerised) questionnaire completed by the potential quitters.[5,32,34,37]

Scenarios

The term scenario refers to offering one of the five interventions to a given percentage of smokers for a given number of years over a given time horizon. Base-case scenarios assume that the intervention reaches 25% of all smokers, because we made the assumption that 25% of all smokers were in the preparation state (truly ready to make a serious quit attempt). This percentage is close to the 21% of current smokers who indicate that they would be willing to stop in the following year.[38]

Base-case scenarios assumed that the intervention was implemented on a permanent basis for periods of 1 year, 10 years and during the whole time horizon of 75 years. Hence, an intervention reaches 25% of all current smokers in every year for which it was implemented. After the implementation period the cessation rates return to current practice levels. In addition, scenarios for offering the interventions to 25% of all smokers aged 25 years and older, 35 years and older, 45 years and older, and 65 years and older, were analyzed.

For all scenarios the model projected numbers of smokers and quitters, morbidity, mortality and health care costs for 11 smoking related diseases. These projections were compared to a projection based on current practice to determine cost-effectiveness ratios. Our time horizon was 75 years to enable the full effect of smoking cessation to become visible.

Current practice

Current practice (CP) was defined as the currently applied mix of the above-mentioned five interventions and all other interventions directed at smoking cessation. The estimated current use of the selected interventions is shown in Table 1. In total about 1.3 % of smokers used one of the selected interventions. The smoking cessation rates in the current practice scenario were based on STIVORO data (1998-1999)[39-41] and three Dutch cohort studies.[42-44] The average cessation rate over all gender and age classes was 3.4%.

Table 1: Current Practice: percentage of smokers that used the interventions in 2000 in the Netherlands

Intervention	Use of the intervention as a percentage of the total number of smokers in the Netherlands (4.5 10^6)	Background
H-MIS	0.36%	30% of the GPs (6,542 full-time equivalents) provided minimal GP counseling [45 46]
		76% of the Dutch population contacted their GP at least once a year [1]
		the average number of contacts for minimal GP counseling was estimated 0.75 per week per GP, of which roughly 71% was a first consultation [47]
		35% of the GPs provided minimal counseling without advice to use NRT [47]
H-MIS+NRT	0.66%	65% of the GPs often to always advised to use NRT in combination with minimal counseling [47]
IC+NRT	0.16%	27% of the lung physicians (number of full-time equivalents: 375) provided intensive counseling [48]
		the average number of contacts for counseling by a lung physician was estimated 3.1 per week per physician [48]
		52% of the lung physicians often to always advised to use NRT in combination with intensive counseling [48]
IC+Bupr	0.14%	48% of the lung physicians often to always advised to use Bupropion in combination with intensive counseling [48]
TC	0.026%	in 2001, 1.2 thousand smokers were reached by telephone counseling at STIVORO [37]

Effectiveness

Effectiveness in terms of cessation rates was obtained from twelve months prolonged abstinence rates given in a recent Dutch review,[5] and from Dutch trials.[33,34] Table 2 lists these abstinence rates for the different smoking cessation interventions. Effectiveness of minimal GP counseling was based on the available Dutch effectiveness research only.[33] For telephone counseling at STIVORO, Cochrane data were pooled with a Dutch evaluation study[34]. For the remaining interventions, no Dutch effectiveness research was available and the figures given in the Dutch review study were based on international randomized controlled trials as included in Cochrane reviews.

Table 2: Twelve months continuous abstinence rates for different smoking cessation interventions

Intervention	Abstinence rate	95%-CI	Source
Current Practice	3.4 %		STIVORO data and three Dutch cohort studies[39-41,42-44]
H-MIS	7.9% *	4.7% - 11.1%	1 Dutch randomized controlled trial (RCT)[33]
H-MIS+NRT	12.7%	11.9% - 13.5%	17 international RCTs[5,30]
IC+NRT	15.1%	14.1% - 16.1%	26 international RCTs[5,30]
IC+Bupr.	17.2%	14.0% - 20.4%	4 international RCTs[5,31]
TC	7.6%	6.9% - 8.3%	9 international RCTs[5,32]and 1 Dutch evaluation study[34]

**Cessation rate in trial: 8.2%. 9% used H-MIS in combination with nicotine gum. Cessation rate for minimal GP counseling: 8.2-(0.09*11.0)/0.91=7.9%*

Intervention costs

The viewpoint in this cost-effectiveness analysis was that of the Ministry of Health and, therefore, intervention costs included direct medical costs that were based on bottom up estimates of real resource use and costs per unit. All costs were expressed in Euros, for the start year 2000. For future costs, we used these same figures.

Table 3 presents the calculated costs of the different smoking cessation interventions. For current practice, resource use was based on Dutch empirical data. For the interventions, resource use was based on Dutch practice guidelines [35,36] and (for the duration of NRT and Bupropion) on the international trials that were used in the Cochrane meta analyses underlying the effectiveness data, to estimate the costs of an "optimal" implementation of the smoking cessation interventions in line with the effectiveness figures.

Costs per unit were combined with resource use to estimate intervention costs. For the costs of minimal GP counseling, we used the standard cost of a GP consultation from the Dutch guideline for economic evaluations.[50] This standard cost included overhead costs. We assumed that one GP consultation lasts 10 minutes and calculated costs per minute. Material costs for self-help manuals were added separately.[37]

To compute the costs of current practice for NRT and Bupropion, the mean number of prescriptions per person[51] was multiplied by the mean gross costs per prescription.[52] Costs of adverse effects were assumed to be negligible.[53] For the pharmacological costs in the increased implementation scenarios, average costs per defined daily dosis (DDD)[52,54] were multiplied by the total duration of use as estimated from international meta-analyses.[30,31] For intensive counseling and telephone counseling, the salary of a counsellor (respiratory nurse, or trained counsellor at STIVORO, respectively) per unit of time was multiplied with counseling time.[36,49] This included material and overhead costs. In addition, the standard costs of a lung physician consultation[50] were used to find the costs of a two minutes stop advice. Material costs for self-help manuals were added separately.[37] The base-case estimates of the costs per smoker for the different smoking cessation interventions were: €21 for H-MIS, €163 for H-MIS+NRT, €349 for IC+NRT, €334 for IC+Bupr and €70 for telephone counseling.

Table 3: Costs of the components of smoking cessation interventions for the current practice scenario and for the increased implementation scenarios (Euro, year 2000 price level)

Component	Volume			Unit costs	Total costs per quitter	
		Current practice	Intervention programs		Current practice	Intervention programs
H-MIS	GP time (minutes)	6.5	12	1.70#	11	20
	Self-help manuals	1.0	1.0	1.00	1	1
NRT	Prescriptions	1.6		20*	32	
	Defined daily doses (DDDs) of patches or gum (combined with H-MIS) **		65.01	2.18*		142
	DDDs patches or gum (combined with IC) ***		80	2.18*		175
IC	Lung physician time (minutes)	2	2	3.29#	7	7
	Lung nurse time (minutes)	110	90	1.85#	204	167
	Self-help manuals	1.0	1.0	1.00	1	1
Bupr	Prescriptions	1.5		47*	71	
	DDDs Bupropion****		63	2.53*		160
TC	Counsellor time (minutes)	60	120	0.43	26	52
	Overhead (as cost per minute)	60	120	0.15	9	18

Total gross price.** One DDD equals 14 mg for patches. ***One DDD equals 30 mg for gum. ****One DDD equals 300 mg for Bupropion. #Includes overhead.

Costs of smoking related diseases

We included eleven smoking-related diseases, i.e., coronary heart disease (myocardial infarction and other coronary heart disease), stroke, COPD, lung cancer, larynx cancer, oral cavity cancer, oesophagus cancer, pancreas cancer, bladder cancer and kidney cancer. Health care costs for these diseases were obtained from a Dutch cost-of-illness study that allocated total direct costs of health care using a top-down approach.[29] These 11 disease accounted for 9% of the total costs of health care in the Netherlands in 1999.[29]

Model and input data

A computer simulation model that was developed at the National Institute of Public Health and the Environment (RIVM) in Bilthoven, the Chronic Disease Model,[26] was used to translate effects in terms of increased cessation rates for groups of smokers into future gains in life-years, QALYs, and savings of health care costs. This dynamic population model describes the life course of parallel Dutch population cohorts annually over time. We simulated changes in smoking prevalence rates and the resulting changes in incidence rates of smoking-related chronic diseases, stratified by gender and by 5-year age-classes. The model was described in more detail elsewhere[26,55,56] and has been used previously to evaluate the effects of smoking cessation scenarios.[28,57-59] We choose 2000 as the start year of the simulations.

Input data on birth, migration and all-cause mortality rates came from Statistics Netherlands.[1] Disease-specific input data of the Chronic Disease Model included prevalence, incidence, and mortality rates of smoking-related diseases,[55,56] risk ratios for incidence of these diseases for current and former smokers [60] and quality-of-life weights for life-years with disease.[60,61] Table 4 summarises these data, and gives incidence rates, and quality-of-life weights for eleven smoking-related diseases. For co-morbidity of 2 diseases at maximum, the assumption was made that risk ratios were multiplicative, conditional on smoking status, and that the quality-of-life weight for a combination of diseases is equal to the lowest quality-of-life weight of one of these diseases.

Table 4: Incidence rates, risk ratios for incidence for current and former smokers and quality-of-life weights of eleven smoking-related diseases, stratified by gender

Disease	Incidence rates (per 1000) [55,56]		RRs for incidence for current and former smokers * [60]				Quality-of-life weights [60,61]	
			Current smokers		Former smokers			
	Men	Women	Men	Women	Men	Women	Men	Women
Myocardial infarction	3.2	1.7	2.9	3.2	1.6	1.3	0.29	0.29
Coronary heart disease	3.1	2.2	2.9	3.2	1.6	1.3	0.29	0.29
Stroke	2.0	2.3	3.3	3.8	1.3	1.4	0.61	0.61
COPD	2.4	1.4	13.1	11.8	10.7	7.9	0.31	0.31
Lung cancer	1.0	0.23	26.8	14.2	10.6	4.5	0.43	0.43
Larynx cancer	0.083	0.014	10.5	17.8	5.2	11.9	0.12	0.12
Oral cavity cancer	0.12	0.058	27.5	5.6	8.8	2.9	0.12	0.12
Oesophagus cancer	0.091	0.042	7.6	10.3	5.8	3.2	0.73	0.73
Pancreas cancer	0.092	0.088	2.1	2.3	1.1	1.8	0.51	0.56
Bladder cancer	0.22	0.065	2.9	1.9	2.6	1.9	0.09	0.11
Kidney cancer	0.11	0.078	3.0	2.0	2.1	1.9	0.24	0.38

Prevalence rates of current and former smokers in the Netherlands were based on yearly population monitoring studies of STIVORO for the time period 1997-2000.[37,39-41,62] Transition probabilities included start, cessation and restart probabilities. Cessation probabilities for the current practice scenario were based on a weighted average of STIVORO data over the period 1998-1999 [39-41] and data from three Dutch cohort studies [42-44] and were an approximation of 12 months continuous abstinence. Start and restart probabilities were estimated by combining smoking prevalence rates from STIVORO over the period 1997-2000 with the cessation probabilities. Table 5 summarizes model input on smoking and presents smoking transition probabilities that were used for the current practice scenario. Age and gender specific current practice cessation rates were multiplied with the ratio of the overall cessation rates reported for the different interventions (Table 2) and the overall current practice rate for the target group of smokers (target groups were 25% of all smokers, and 25% of smokers in selected age groups) to compute cessation rates for the intervention scenarios. Start and relapse rates were not changed for the intervention scenarios.

Table 5: Start, cessation and restart probabilities for the current practice scenario, stratified by gender and by 5 year age-class. [37,39-41,42-44,62]

Age-class	Men			Women		
	Start	**Cessation**	**Restart**	**Start**	**Cessation**	**Restart**
0 – 4	0	0	0	0	0	0
5 – 9	0	0	0	0	0	0
10 – 14	0.028	0.007	0	0.037	0.007	0
15 – 19	0.046	0.015	0	0.039	0.015	0
20 – 24	0.042	0.018	0.031	0.016	0.027	0.014
25 – 29	0.006	0.025	0.097	0	0.033	0.053
30 – 34	0	0.031	0.129	0	0.038	0.097
35 – 39	0	0.036	0.114	0	0.040	0.098
40 – 44	0	0.039	0.099	0	0.041	0.114
45 – 49	0	0.042	0.085	0	0.042	0.099
50 – 54	0	0.045	0.070	0	0.043	0.084
55 – 59	0	0.048	0.055	0	0.043	0.069
60 – 64	0	0.049	0.040	0	0.044	0.055
65 – 69	0	0.049	0.025	0	0.046	0.040
70 – 74	0	0.047	0.010	0	0.051	0.025
75 – 79	0	0.047	0	0	0.051	0.010
80 – 84	0	0.047	0	0	0.051	0
85 +	0	0.047	0	0	0.051	0
Mean	0.007	0.033	0.042	0.005	0.034	0.042

Cost-effectiveness

Costs per smoker were multiplied by the total number of smokers and by the percentage of smokers receiving the smoking cessation intervention, to compute total intervention costs for the increased implementation scenarios. For the current practice scenario, costs per smoker were multiplied by the total number of smokers which was multiplied with the percentage of smokers reached by the different smoking cessation interventions (Table 1). The difference between these two resulted in the additional intervention costs. To compute costs per life-year or QALY gained, the cost savings from avoided smoking-related diseases were subtracted from the additional intervention costs. Additional quitters, life years, or QALYs were computed as the difference between the number of quitters, life years, or QALYs under the intervention scenario and the current practice scenario.

Cost-effectiveness ratios for each intervention compared to current practice were calculated by dividing the difference in costs by the difference in the number of quitters, life-years, or QALYs. Base-case estimates of costs per QALY and life-year gained included cost savings from reduced health care costs for smoking related diseases, but we also computed the ratio of intervention costs to the difference in QALYs or life-years, to have very conservative estimates of the cost-effectiveness ratios. Future costs and effects were discounted at the Dutch standard annual percentage of 4%.[63]

Sensitivity analysis

A series of one-way sensitivity analyses was carried out to investigate the robustness of the cost-effectiveness ratios with regard to variations in cessation rates, intervention costs, discount rates, time horizon, and the percentage of smokers reached by the intervention. Cessation rates were varied by their 95%-confidence limits (see Table 2). Intervention costs were varied from minimum to maximum estimates of resource use. These are shown in Table 6. Discount rates on costs and effects of 0, 3 and 5% were used, and a discount rate of 4% for costs combined with 0% for effects. The percentage of smokers that was offered the intervention was varied from the base-case 25% to 10% and 50% of all smokers. Finally, results were computed for time horizons of 20, 30 and 50 years.

Table 6: Minimum and mMaximum resource use, used in sensitivity analyses

Component	Resource use	Min.	Base-case	Max.
H-MIS	GP time (minutes)	3.0	12	20
NRT	DDDs patches or gum (combined with H-MIS) **	49	65	141
	DDDs patches or gum (combined with IC) ***	70	80	93
	Duration NRT in weeks (combined with H-MIS)	7.4	7.8	16
	Duration NRT in weeks (combined with IC)	11	12	14
IC	Lung nurse time (minutes)	40	90	110
Bupr	DDDs Bupropion****	49	63	84
	Duration Bupr in weeks	7	9	12
TC	Counsellor time (minutes)	90	120	150

***** One DDD equals 14 mg for patches. ***One DDD equals 30 mg for gum. ****One DDD equals 300 mg for Bupropion.***

Results

Cost per quitter

Table 7 shows total intervention costs as well as cost-effectiveness ratios for the year 2000. Costs per quitter included only intervention costs and ranged from about €443 for minimal GP counseling to about €2800 for intensive counseling with nicotine patches or gum.

Table 7: Number of additional quitters, total additional intervention costs and costs per quitter for the increased implementation scenarios compared to the current practice scenario for the starting year 2000 (EURO, year 2000 price level)

Intervention	Additional quitters (*10^3)	Intervention costs (*10^6)	Costs per quitter
H-MIS	53.4	23.7	443
H-MIS+NRT	111	181	1,630
IC+NRT	140	387	2,800
IC+Bupr.	165	370	2,240
TC	49.7	77.7	1,560

Cost per life year and cost per QALY

Table 8 shows the estimates of cumulative costs and effects over a period of 75 year and the resulting cost-effectiveness ratios in terms of life years and QALYs gained when the smoking cessation interventions are offered for a period of 1, 10 and 75 years.

H-MIS was a dominant strategy compared to current practice, regardless of whether the intervention is offered for 1, 10 or 75 years. For a 75-year implementation period, the absolute gain in life years and QALYs and the savings in costs for not having to treat smoking related disease were highest, but the intervention costs were also highest. For H-MIS about 330,000 life years or 410,000 QALYs were gained. The number of QALYs gained includes morbidity changes and was therefore higher. Intervention costs were about €520.1 million and about €1.4 billion in health care costs for smoking related diseases were saved. Therefore, implementing H-MIS on a permanent basis for 25% of all smokers would save more than it costs.

The four other interventions yielded higher costs than savings and cost-effectiveness ratios were calculated. For example, implementation of IC+NRT for a period of 75 years would result in a gain of about 740,000 life years or about 940,000 QALYs. Intervention costs were about €7.8 billion while savings were about €3.2 billion, resulting in net additional costs of about €4.6 billion. Dividing the additional costs by the gain in health, costs per life year gained and per QALY gained were estimated to be about €6200 and €4900 respectively.

The 1 and 10 year implementation scenarios show the effects of shorter than permanent implementation. Total intervention costs as well as savings and gains in life years and QALYs were of course much lower. The cost-effectiveness ratios were not very much affected by the choice of the implementation period.

Table 8: Base-case estimates of number of life-years and QALYs gained, total additional intervention costs, total savings, and cost-effectiveness: costs per life-year gained and costs per QALY gained for the different scenarios cumulative for the years 2000-2075, discounted at 4% for both costs and effects (EURO, year 2000 price level).

Intervention	LYs gained* ($*10^4$)	QALYs gained** ($*10^4$)	Intervention costs*** ($*10^9$)	Savings from prevented diseases**** ($*10^9$)	Costs per LY gained	Costs per QALY gained
1 year implementation						
H-MIS	1.4	1.7	0.023	0.057	†	†
H-MIS+NRT	2.8	3.6	0.18	0.12	2300	1700
IC+NRT	3.5	4.5	0.39	0.15	6800	5200
IC+Bupr.	4.1	5.3	0.37	0.17	4700	3600
TC	1.2	1.6	0.077	0.053	2000	1500
10 year implementation						
H-MIS	12	15	0.19	0.50	†	†
H-MIS+NRT	23	30	1.4	0.98	1900	1500
IC+NRT	29	37	3.0	1.2	6300	4900
IC+Bupr.	33	43	2.8	1.4	4400	3400
TC	11	14	0.64	0.46	1600	1200
Permanent implementation						
H-MIS	33	41	0.52	1.4	†	†
H-MIS+NRT	62	78	3.8	2.7	1800	1400
IC+NRT	74	94	7.8	3.2	6200	4900
IC+Bupr.	84	110	7.3	3.6	4300	3400
TC	31	38	1.7	1.3	1400	1100

** Compared to a cumulative total of 412.10^6 life-years from the current practice scenario.** Compared to a cumulative total of 392.10^6 QALYs from the current practice scenario.*** Compared to cumulative costs of continued current practice of 120. 10^6 EURO. **** Compared to cumulative costs of care of 142.10^9 EURO from the current practice scenario.† Minimal GP counseling dominated current practice, due to cost savings and higher effects.*

Targeting interventions to age groups

Table 9 presents cost-effectiveness ratios for the permanent implementation scenarios targeted to specific age groups for IC+Bupr. The results for all other interventions showed a similar pattern. Cost-effectiveness ratios became more favorable when reaching the older population. Costs per QALY gained compared to current practice were about €2300 for the group of smokers 25 years and older (this is 85% of all smokers), while IC+Bupr was cost saving when applied in a scenario reaching 25% of smokers aged 65 years and older (i.e. 10% of all smokers). Total costs and effects were obviously much lower in the latter case.

Table 9: Number of life-years and QALYs gained, total additional intervention costs, total savings, and cost-effectiveness: costs per life-year gained and costs per QALY gained for IC plus Bupropion, for different age groups, cumulative for the years 2000-2075, discounted at 4% for both costs and effects (EURO, year 2000 price level).

Permanent implementation of IC+Bupr for smokers from the age groups:	LYs gained* ($*10^4$)	QALYs gained** ($*10^4$)	Intervention costs*** ($*10^9$)	Savings of not having to treat smoking-related disease**** ($*10^9$)	Costs per LY gained	Costs per QALY gained
all smokers	84	110	7.3	3.6	4300	3400
25+	84	110	6.1	3.6	3000	2300
45+	76	91	3.3	3.2	120	100
65+	24	19	0.86	0.90	†	†

** Compared to a cumulative total of 412.10^6 life-years from the current practice scenario.** Compared to a cumulative total of 392.10^6 QALYs from the current practice scenario.*** Compared to cumulative costs of continued current practice of 120. 10^6 EURO. **** Compared to cumulative costs of care of 142.10^9 EURO from the current practice scenario. † IC+Bupr for 65+ dominated current practice, due to cost savings and higher effects.*

Effects and costs over time

In the current practice scenario, the number of smokers declined from 4.43 million in 2000 to 3.74 million in 2075, which were 32% and 25% of the Dutch population of 10 years and older respectively. For the intervention scenarios reaching 25% of the smokers, the number of smokers declined to 2.92 million in 2075 for permanent implementation of intensive counseling with Bupropion at maximum. For the intervention scenarios of 1 and 10 years implementation, effects gradually disappeared after the intervention stopped and the number of smokers in 2075 was 3.74 million like in the current practice scenario. The maximum difference between the number of smokers in current practice and that in the intervention scenarios was 23% for permanent implementation for 75 years, 19% for 10 year implementation and 4% for 1 year implementation.

In all scenarios, a lag time of about 20 years between an increased implementation of smoking cessation interventions and the full gain in life-years and QALYs could be observed. Figure 1 shows the undiscounted number of QALYs gained for the base case intervention scenarios with 10 years of implementation, compared to current practice, in each of the years 2000 to 2075. The –discounted at 4%- cumulative gain in QALYs ranged from 140,000 for telephone counseling to 430,000 for intensive counseling with Bupropion.

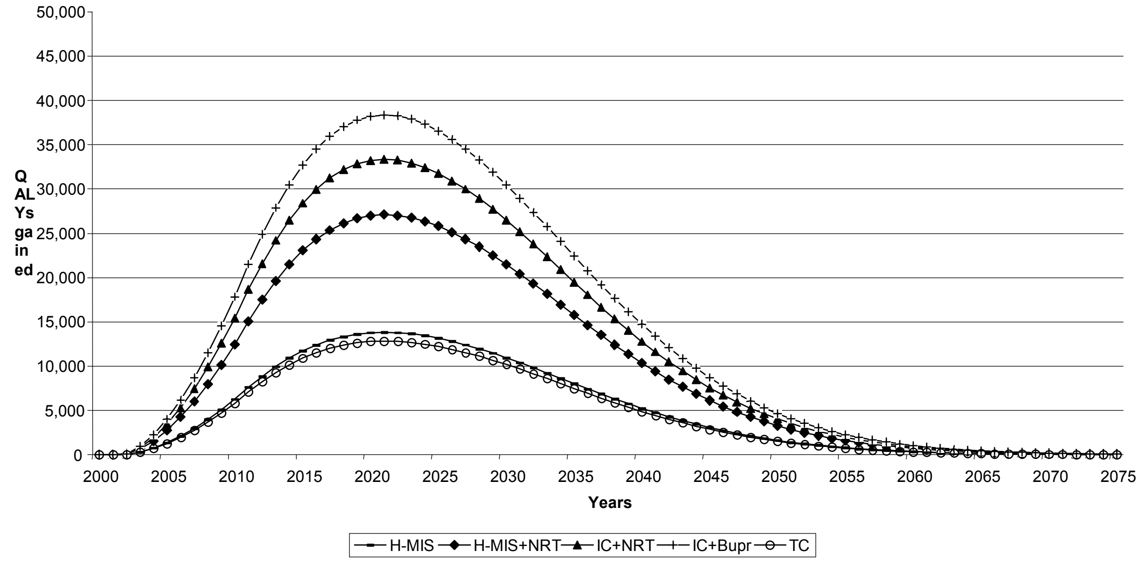

Figure 1: Number of QALYs gained in each individual year for the increased implementation scenarios, compared with current practice, over the years 2000-2075, 0% discounting, 10 year implementation period

Figure 2 shows the undiscounted cumulative savings in health care costs for smoking related diseases and the additional intervention costs for the base-case scenario in which H-MIS+NRT is offered for 1 year, compared to current practice. Of course, intervention costs occur only in year 1. The break-even point is reached after 25 years, when cumulative savings become equal to the intervention costs.

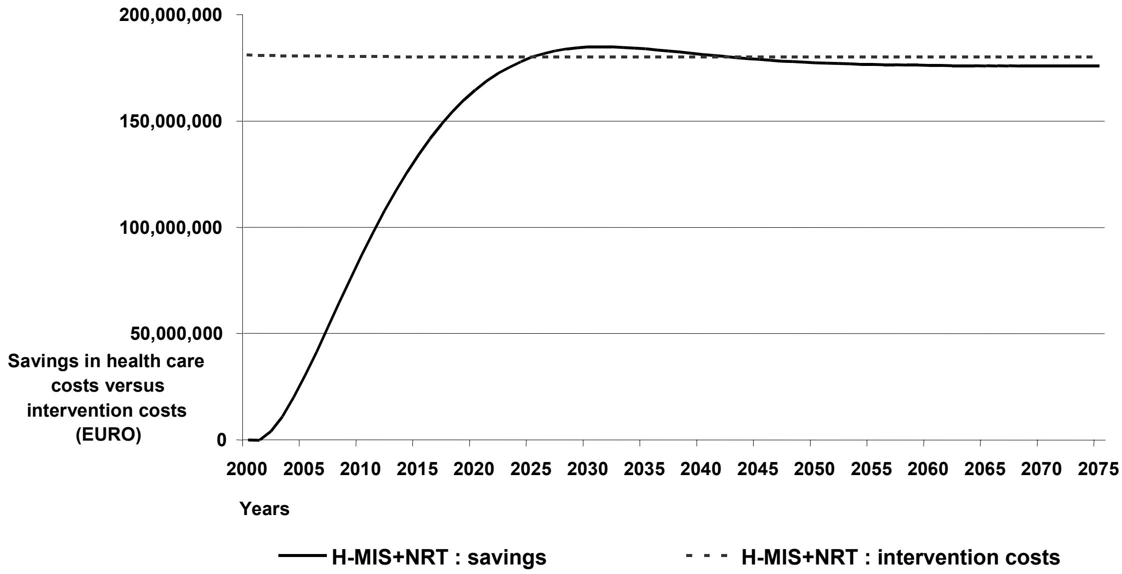

Figure 2 :Cumulative intervention costs and savings in health care costs for base-case 1 year implementation of H-MIS+NRT, compared with current practice, over the years 2000-2075, 0% discounting.

Sensitivity analysis

Figure 3 presents costs per quitter plus uncertainty ranges over resource use and cessation rates (Table 2, Table 6). Figure 4 presents gains in total costs (i.e. including cost savings from reductions in the incidence of 11 smoking related diseases) and QALYs plus uncertainty ranges over resource use and cessation rates, for permanent implementation of the smoking cessation interventions compared to current practice (75 year time horizon, net present value at 4% discounting). Changes in cessation rates do not only lead to changes in QALYs gained but also to changes in the incidence of smoking related diseases and hence to changes in total additional costs. This explains why the horizontal confidence lines in figure 4 are not completely horizontal, but slightly diagonal. The slope of the imaginary lines from the origin (the current practice scenario) to the point estimates represents the incremental cost-effectiveness ratios, compared to current practice. The slope of the imaginary lines between two point estimates represents the incremental cost-effectiveness for the interventions compared to each other.

The relative large uncertainty about the effectiveness of H-MIS is reflected by the relatively wide horizontal uncertainty range. Nevertheless, the result that H-MIS is a cost saving intervention is robust for uncertainties in resource use and effects. Uncertainty ranges overlap, so that the dominance of intensive counseling with Bupropion over intensive counseling with NRT is quite uncertain, while that of minimal GP counseling over telephone counseling is also uncertain. Besides, due to the large uncertainty range in costs, it may well be that minimal counseling with NRT is also dominated by either intensive counseling with NRT or intensive counseling with Bupropion.

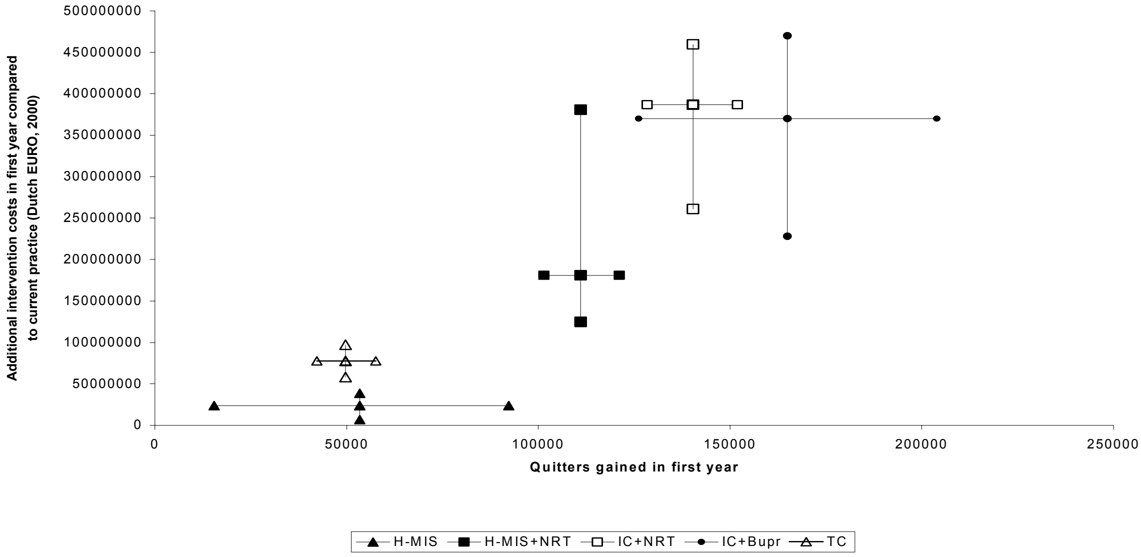

Figure 3. Additional intervention costs in the first year and number of additional quitters in the first year for the 75 year intervention scenarios compared to current practice and the ranges in additional costs and quitters based on the sensitivity analyses.

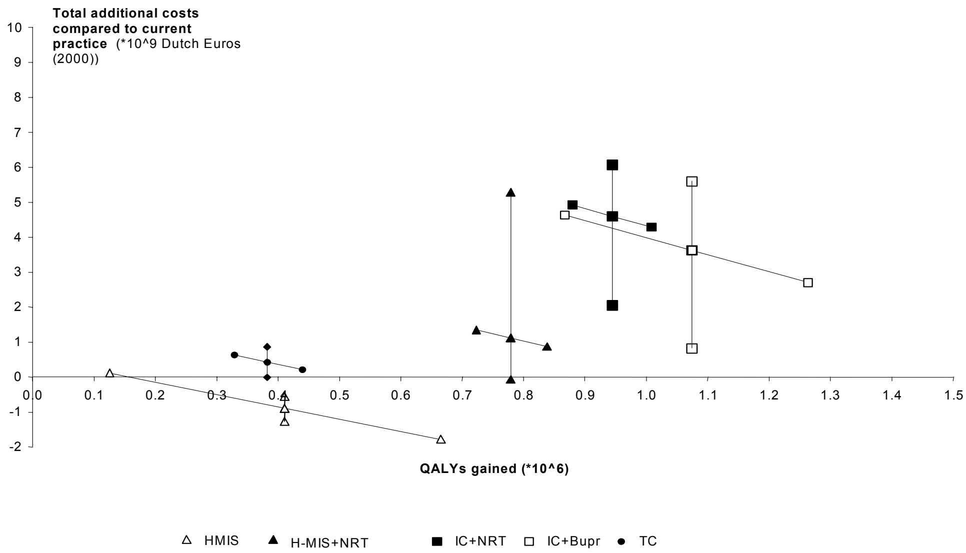

Figure 4. Total additional costs and total QALYs gained for the 75 year intervention scenarios compared to current practice and the ranges in costs and effects based on the sensitivity analyses, cumulative over the years 2000-2075. Discount rate was 4%, time horizon 75 year.

Table 10 shows incremental cost-effectiveness ratios for different discount rates for costs and effects, compared to current practice, for base-case 1, 10 and 75 years implementation scenarios. Discounting had a considerable effect on cost-effectiveness ratios, reducing the impact of both future savings in health care costs and future health effects.

Table 10: Incremental costs per QALY gained for the increased implementation scenarios for different discount rates for both costs and effects, cumulative for the period 2000-2075 (EURO, year 2000 price level).

Intervention	**Costs per QALY for different discount rates**			
	Discount rate for costs and effects 0%	**Discount rate for costs and effects 3%**	**Discount rate for costs and effects 5%**	**Discount rate for costs 4% and for effects 0%**
1 year implementation				
H-MIS	†	†	†	†
H-MIS+NRT	54	1200	2400	820
IC+NRT	1700	4100	6500	2500
IC+Bupr.	950	2800	4600	1700
TC	†	1000	2100	720
10 years implementation				
H-MIS	†	†	†	†
H-MIS+NRT	†	980	2100	600
IC+NRT	1500	3800	6100	1900
IC+Bupr.	800	2500	4300	1300
TC	†	760	1800	500
75 years implementation				
H-MIS	†	†	†	†
H-MIS+NRT	210	990	2000	310
IC+NRT	2300	4000	5900	1000
IC+Bupr.	1400	2700	4200	730
TC	10	720	1600	240

Table 11 shows the impact of the time horizon on life-years, QALYs and total costs as well as cost-effectiveness ratios. It gives results for three different time-horizons: 2000-2020, 2000-2030 and 2000-2050, for the base-case permanent 75-year implementation scenario. For all time horizons, minimal GP counseling was a cost saving intervention. Cost-effectiveness ratios became more favourable for a longer time period. For intensive counseling with Bupropion, costs per QALY gained ranged from about €13,000 for a time horizon of 20 years to about €3,900 for a time horizon of 50 years.

Cost-effectiveness ratios of intervention scenarios compared to current practice for scenarios reaching 10% and 50% of all smokers rather than 25% did not differ much from the base-case estimates, due to a roughly similar change in both cost and effects. Total costs and effects were of course different.

Table 11: Number of life-years and QALYs gained, total additional intervention costs, total savings, and cost-effectiveness: costs per life-year gained and costs per QALY gained for the 75 years increased implementation scenario cumulative for different time periods, discounted at 4% for both costs and effects (EURO, year 2000 price level).

Intervention	LYs gained (*10^4)	QALYs gained (*10^4)	Intervention costs (*10^9)	Cost savings of treatment for diseases (*10^9)	Costs per LY gained	Costs per QALY gained
Time horizon 20 years						
H-MIS	5.8	9.0	0.33	0.52	†	†
H-MIS+NRT	11	18	2.9	1.0	12,400	7,900
IC+NRT	14	22	6.1	1.2	27,300	17,300
IC+Bupr.	16	25	5.7	1.4	20,600	13,000
TC	5.3	8.3	1.3	0.48	11,500	7,300
Time horizon 30 years						
H-MIS	14	19	0.40	0.89	†	†
H-MIS+NRT	26	37	2.4	1.7	4,800	3,400
IC+NRT	32	45	5.0	2.1	12,700	9,000
IC+Bupr.	36	52	4.7	2.4	9,200	6,500
TC	13	18	1.1	0.82	4,100	2,900
Time horizon 50 years						
H-MIS	27	34	0.48	1.3	†	†
H-MIS+NRT	51	65	3.5	2.4	2,200	1,700
IC+NRT	61	79	7.2	2.9	7,100	5,500
IC+Bupr.	69	90	6.7	3.3	5,000	3,900
TC	25	32	1.6	1.2	1,700	1,400

Conclusions and discussion

The present study analyses the cost-effectiveness of five face-to-face smoking cessation interventions compared to current practice. Costs per life year gained for IC+NRT, H-MIS+NRT, IC+Bupr and TC are well below € 20.000. Costs per QALY are even lower. Only for H-MIS net savings accompany the health gains, because the savings from reduced costs of care for smoking related diseases offset the intervention costs. These results were robust for variations in the percentage of smokers reached, the duration of implementation, the resource use estimates and the cessation rates. The results were very sensitive to the rate of discounting.

Comparing the results for the five interventions to each other, two interventions were relatively cheap: H-MIS and TC. But they were also less effective than the other interventions. The effectiveness of H-MIS in the Netherlands was based on a single trial. This was reflected in large uncertainty ranges. We choose this Dutch trial [33] instead of a Cochrane review on physician counseling [64], because we felt that the 11 studies on minimal counseling included in the review did not sufficiently reflect the Dutch H-MIS.

Two other interventions, IC combined with either NRT or Bupr were more effective, but also more expensive. Although their respective cost-effectiveness ratios were higher than the ratios of H-MIS and TC, they remain very favourable. For these interventions, costs were more difficult to estimate, because there are great variations in the duration and intensity of IC and the duration of NRT use.

One intervention, minimal counseling combined with NRT, fell in between. Its costs were highly uncertain, resulting in an uncertainty range that goes from slight cost savings up to high additional costs. This was in line with results from Cochrane reviews that state that the added effect of NRT to low intensity counseling was hard to prove. The trials included in the Cochrane reviews showed a high variance in the duration of NRT, mainly due to differences in compliance. It should be noted here that we combined nicotine patches and gums, although the evidence for the effectiveness of gums, especially when combined with low intensity counseling, is weaker. We focussed on nicotine patches and gum, because these are most commonly used types of NRTs in the Netherlands and there is less published evidence on the effectiveness of nicotine inhalers and tablets.

Figures 1 and 2 showed that it took 15 to 20 years before the reduction in the incidence of smoking related diseases became substantial. Therefore, on the short term, cost-effectiveness ratios reached values close to € 20000. However, when the time horizon is long enough to capture the effects of smoking cessation, cost-effectiveness ratios are well below the € 20000 limit.

How favourable these cost-effectiveness ratios are is best demonstrated by comparing them to other preventive interventions. For example, the Dutch 1998 cholesterol guidelines advise to reimburse cholesterol lowering treatment up to NLG 40,000 per QALY[7,8]. A US study published in 2000, found the costs per QALY of cholesterol lowering therapies to range from US$ 5,4000 to US$ 1,400,000 depending on patient characteristics.[72] An Australian study from 1991, found the cost per QALY of pharmacological hypertension treatments to range from UK£ 11,058 to UK£ 194,989.[73]

In contrast with most cost-effectiveness analyses of smoking cessation, we took cost savings of avoided smoking-related diseases into account. If we would assess the cost-effectiveness of permanent introduction (i.e. 75 year implementation), and ignore these savings in the costs of care for smoking-related diseases, the costs per life-year gained would vary from about € 1,600 for H-MIS to € 10,500 for IC combined with NRT.

Our study differs from others in another aspect. Our model is dynamic and takes account of relapse rates. Hence, not all smokers who quit in the 1-year scenario would remain non-smokers for the whole time horizon. This led to higher cost-effectiveness ratios than we would have obtained if we had ignored relapse.

Comparing our ratios with those of a recently published cost-effectiveness analysis in the United Kingdom [10], care must be taken to compare the right scenarios. Our results refer to interventions that were implemented on a continuous basis (repeated every year) for 1, 10 and 75 years and adopted time horizons of 20, 30, 50 and 75 years. Parrott et al assumed a once-only implementation with a time horizon of 40 years and reported undiscounted costs per life year saved from the health authority perspective. These were £112, and £173 for brief advice, and brief advice+self-help+NRT, respectively. If we take our one-year scenario with a time horizon of 40 years H-MIS, H-MIS+NRT, and TC were cost saving and costs per life year gained for IC+NRT and IC+Bupr were about €2100 and €1100, respectively. However, many factors render international comparison of cost-effectiveness results difficult (see Drummond and Pang[66]). In this case, we need to point at differences in the contents of the interventions and in modelling. For example, we included relapse rates for quitters, whereas Parrott et al did not. Despite this, the low costs per life year gained from Parrott et al. are close to our cost savings for H-MIS and H-MIS+NRT.

Health care costs unrelated to smoking in life years gained from smoking cessation were ignored in our computations. Whether or not costs of care for diseases not related to smoking (so-called unrelated medical costs) should be included in cost-effectiveness analyses is a topic of discussion in the literature (see e.g. Drummond[65,] p57). In practice, most cost-effectiveness analyses exclude these costs, for reasons of data availability. The Dutch guideline for economic evaluations [63] advises to exclude unrelated medical costs. For that reason, in the present study these costs were also excluded so that the results can be compared to other cost-effectiveness analyses.

A complicating factor in comparing the results for the five interventions to each other is that the cessation rates used came from different trials and meta-analyses with different patient groups and comparators. We had to assume that the absolute cessation rates in the meta-analyses and trials were valid for our mixed population of all smokers in the Netherlands. In reality, different smoking cessation interventions are offered to different types of smokers. Therefore, since the cost-effectiveness ratios for the high intensity interventions were still low, the study results cannot be interpreted as a support for discouraging the use of the high intensity interventions.

For several reasons our results are conservative. The effects of smoking cessation on the course of disease were not included, nor were the effects of passive smoking, and the effects of smoking cessation by pregnant women on the health of their future infants. Furthermore, savings from reduced productivity losses were not included. A Dutch study estimated that the productivity gains of a quitter would be about € 105 per quitter per year in the long run[67]. If this figure were multiplied with, for example, the number of additional quitters generated by a 1-year implementation of H-MIS+NRT than the productivity gains would be € 11.6 million per year. Finally it should be noted that a large part of the future effects of the intervention efforts during the last 15-20 years of the permanent implementation scenario were not taken into account, because these health gains did not occur within the time horizon.

In contrast, two reasons why our results may somewhat overestimate cost-effectiveness ratios must be mentioned. The first is that the estimates of effectiveness were obtained from clinical trials. If trial populations were a selection of motivated smokers, our cessation rates would be too high. This applies in particular to the more intensive interventions and to a less extend to the H-MIS(+NRT) and TC, because for the latter interventions, trials were often done in an unselected group of smoking GP patients. The second is that the model did not include a delay effect of smoking cessation, i.e. all quitters got the lower relative risks of disease incidence of former smokers the year after quitting. However, the estimates of the relative risks in our model were conservative. Relative risks of former smokers were estimated as an average of the relative risks of all former smokers regardless of how long ago they had stopped. This implies that for the first years after quitting the reduction in relative risk in our model is too high, while for later years it is too low. This simplification will have the largest impact on the elderly. Because the incidence of smoking related disease among older smokers is high the effects of smoking cessation in the subgroup of older smokers may be overestimated. Therefore, our finding that smoking cessation interventions become more cost effective when targeted at older age groups (all interventions were cost saving for the age group of 65 years and older) should be interpreted with care.

In conclusion, when assessing the cost-effectiveness of five face to face smoking cessation interventions, we found that H-MIS was cost saving compared to current practice, whereas the cost-effectiveness ratios of minimal counseling plus nicotine replacement therapy, intensive counseling with nicotine replacement therapy, intensive counseling with bupropion, and telephone counseling were quite small. Implementation of these interventions on a permanent basis for an additional 25% of all smokers, resulted in estimated cost-effectiveness ratios that varied from € 1100 to € 4900 per QALY.

Instead of offering the smoking cessation interventions on a permanent basis, decision makers can opt for a much shorter period. This reduces the intervention costs considerably, but still produces important health gains and savings resulting from a reduced incidence of smoking-related disease. However, it is obvious that these gains and savings become much smaller as the implementation period is reduced. The cost-effectiveness ratios are not very much affected by the choice of the implementation period.

This information is useful for politicians, healthcare insurers and healthcare providers in their efforts to reduce smoking prevalence.

Appendix A Short review of cost-effectiveness results for smoking cessation interventions in the literature.

A literature search was performed to identify economic evaluations of smoking cessation interventions. The 18 relevant economic evaluations selected are summarized in tables A1 and A2.[10,12-24,68-71] Two recent international systematic reviews of cost-effectiveness of smoking cessation interventions also discussed many of these studies.[9,10] The transferability of results from foreign economic studies is difficult (see for example Drummond and Pang[66]). The numbers given in the tables and below were simply converted from figures in foreign currencies using Purchasing Power Parity data[11] and then updated to the year 2000 with the help of consumer price indices, and should therefore be interpreted with care. Ultimately, the health outcomes of smoking cessation interventions are gains in morbidity and mortality from smoking related diseases. To find these, modeling has to be used to translate cessation rates into life-years or QALYs gained. An intermediary outcome often used in cost-effectiveness analyses is the number of quitters. Costs per life-year gained varied from €215 to €10.380 with the majority of studies reporting cost-effectiveness ratios around €2500 per life-year gained. Most studies focussed on intervention costs only. Few cost-effectiveness studies included savings in costs for avoided smoking-related diseases.
Dutch cost-effectiveness studies for smoking cessation were scarce. We could identify only one study, which reported costs per quitter for a group program plus self help cessation manual.[24]

Conclusion: Smoking cessation interventions are cost-effective in general. Based on the international literature, taking account of the pitfalls involved in transferring international results, it seems safe to conclude that smoking cessation interventions fall well below the €20000 per QALY limit.

Table A1. Overview of cost-effectiveness ratio's per life years saved or QALYs saved in EUROs (price level 2000; societal perspective)

Study smoking cessation intervention(s)	Ratio compared to usual care, no intervention or placebo	Ratio for other comparator than usual care, no intervention or placebo	Comparator
1. Brief advice	€5097 * [16] €215 [10]		
Brief advice + self-help	€417 [10]		
Brief advice + NRT	Patches: €2475 Gum: €5851 * [16]	€10 380 ** ## [19]	Brief advice only
Brief advice + self-help + NRT	€1507 [10]		
2. Intensive counseling (IC)	€2362 * [16]		
IC+ self-help	€250 ** [17] €4096 **** [18]	1. €574 ** [22] 2. €1947## [68]	1. Brief advice 2. Brief advice+self help
IC + NRT	Patches: €2006 Gum: €6200 *[16]	€5044 (QALY) * ## [14] €2559 * ## [23] €5276 ** [13] €1780 ** [12] Patches: €7638 ### Gum: €5596 ### [20]	IC alone
IC + self-help + NRT		€648 ** # [21]	IC +self help
3. Group program (GP)	€1657 *[16]		
GP + NRT	Patches: €1568 Gum: €2579 * [16]		
4. Specialist smoking service			
Specialist smoking service: brief advice + self-help + NRT	€1358 [10]		
Specialist smoking service: IC+ group program + NRT	€3840 ** [69]		

* Perspective of patients/smokers; ** Perspective of third party payers/NHS; *** Perspective of employers; **** Perspective of implementing hospital

Aged 45-54; ## Aged 45-49; ### Aged 40-49

Table A2. Overview of cost-effectiveness ratio's per quitter in EUROs (price level 2000; societal perspective)

Study smoking cessation intervention(s)	Ratio compared to usual care, no intervention or placebo.	Ratio for other comparator than usual care, no intervention or placebo	Comparator.
1. *Self-help (see also 3)*	€856 * [24]		
2. *Brief advice*	€133 [15]		
3. *Intensive counseling (IC)*	€939 [15]		
IC + self-help	€431 ** [17] €4114 **** [18]	€1276 ** [22]	Brief advice
IC + NRT	€1032 * [70]	€1460 ** [13] €892 ** [12]	Intensive counseling
IC + self-help + NRT	€520 [71]		
4. *Group program (GP)*	€230 * [24] €1661 [15]		

* Perspective of patients/smokers; ** Perspective of third party payers/NHS; *** Perspective of employers; **** Perspective of implementing hospital

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