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# Demand factors and cost effectiveness analysis – the importance of including financing mechanisms in economic evaluations.
## A worked example using Nicotine Replacement Therapy

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## Abstract

**Aims:** Medical interventions are often offered free at the point of use. However sometimes co-payments are applied which can effect demand and patient concordance. This paper seeks to assess the importance of including different types of financing mechanisms in cost effectiveness analyses.

**Methods:** The cost effectiveness of four methods of financing Nicotine Replacement Therapy (NRT) is estimated. A Markov model is used to calculate QALYs and costs accrued by each financing mechanism over time. A welfarist approach is taken to allow the societal perspective necessary for the study, since different financing mechanisms have altering impacts on societal welfare.

**Scenarios:** Four scenarios are modelled:

- Free NRT: Government pays the full cost of providing NRT, paid for by an increase in general taxation;
- Free NRT + Cigarette Tax: Government pays the full cost of providing NRT, raising the funds through a specific increase in cigarette taxation;
- Subsidy: Government subsidises NRT by 86% funded by the healthcare budget through general taxation. The user pays the remaining 14% through a copayment prescription charge (replicates current UK situation)
- User Pays: The smoker who demands NRT pays its full cost.

**Results:** In the base case Free NRT + Cigarette Tax is the most cost effective financing mechanism (cost per additional QALY of £1,189 compared to User Pays). Subsidy is extendedly dominated and Free NRT is dominated.

**Conclusion:** Usually cost effectiveness analysis does not take financing mechanisms into account. This study finds that the cost effectiveness of an intervention differs depending on how it is financed, which illustrates the importance of considering financing mechanisms in CEA.

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## Introduction

This paper seeks to highlight the importance of including financing mechanisms within cost effectiveness analyses (CEA). Ordinarily in CEAs the way in which a drug will be funded is not taken into account. However for some treatments the existence of financial incentives or disincentives arising from payment mechanisms may have important consequences for the effectiveness and the cost effectiveness of the treatment.

The NHS provides the majority of healthcare free at the point of delivery. Treatments are financed through general taxation and the NHS seeks to pool risks. For the majority of interventions there are strong grounds - based on insurance and equity - to provide treatments free of charge. However, within this insurance framework small charges can be applied in the form of deductibles and co-payments. Though it could be argued that such fees can discourage excessive consumption of health care and consumer moral hazard, they may discourage uptake of treatments. Arguably there are better ways to prevent moral hazard, using more supply side controls (e.g. the GP as the gatekeeper to further referrals, or rationing through waiting times).

In the NHS copayments are used in the form of the prescription charge – a fee paid by the consumer when a medicine prescribed by a doctor is dispensed. This charge is payable on Nicotine Replacement Therapy (NRT) prescriptions. Tax incentives are used to discourage the practice of certain health endangering activities (and other non-health related activities seen to cause negative externalities) such as smoking through taxes levied on the products necessary to engage in these activities (in this case cigarettes). Subsidies are used in the opposite way to encourage welfare and health promoting activities, evidenced by the fact that most healthcare in the UK is subsidised to the point that it is free at the point of use.

In this paper we assess the impact that altering the use of these financial incentives has on the cost effectiveness of treatments affected by these incentives, using the example of NRT.

## Copayments

The demand for and effectiveness of interventions subject to a copayment may be affected by the charge to the patient for using them. A patient who pays for his or her treatment (and who is therefore not fully subsidised) may be more motivated to comply fully with the intervention, increasing the probability that the intervention will be successful. However this may be counterbalanced by a reduction in uptake of the intervention due to the price paid by the consumer.

Evidence for the effect of prescription copayments is relatively scarce. Most evidence relates to copayments for health services, such as physician visits.[1] Evidence that does relate specifically to copayments on prescriptions has shown reductions in numbers of prescriptions associated with

1 Zwiefel P and Manning WG. Moral hazard and consumer incentives in health care. Ch. 8 in Culyer AJ and Newhouse JP (eds). *Handbook of Health Economics* Vol. 1a (2000). North-Holland

increasing prescription charges.[2,3] Analysis of the UK prescription charge has shown a price elasticity of demand (PED) for drugs subject to copayment of -0.23 to -0.64, with the more responsive figure associated with more recent times.[4,5] This suggests a real, although inelastic, response to prescription copayments.

There is also evidence specific to NRT that copayments improve the likelihood of success of the intervention,[6] and that having to pay for NRT deters some people from consuming the treatment.[7,8] Hence a copayment for NRT could reasonably be expected to improve compliance amongst those using the treatment (and may also influence the healthy lifestyle of the NRT user), but also to reduce uptake of the intervention. Depending on the relative importance of these competing effects the copayment could increase or decrease the cost effectiveness of the intervention in practice.

Therefore, different uses of copayments and subsidies will result in different take-up, success, and cost of interventions, and so an analysis can be undertaken to determine which use of financial incentives is the most cost effective.

**Welfare considerations**

Because this analysis is focussing on financial incentives and the cost effectiveness of the same intervention being financed in different ways the welfare effects of taxation should also be considered. As financing mechanisms outside of the health sector are being considered the extra-welfarist theoretical position is difficult to take, and instead the analysis should be viewed from a more traditional welfarist perspective. This implies that the goal of maximising social welfare given societal resources must be considered. In order to decide upon the socially optimal financing mechanism for the provision of NRT the cost effectiveness of the alternative financing mechanisms must be weighed up against the societal transfers necessary to pay for these mechanisms. This leads to the question: could the societal level social burden associated with one particular method of provision outweigh the cost effectiveness advantage one method has over another at an interventional level?

**Case study: Nicotine replacement therapy (NRT)**

2 Harris B, Stergachis A and Reid LD. The effect of drug co-payments on utilization and cost of pharmaceuticals in a health maintenance organization. *Medical Care* 28 (10): 907-917

3 Keeler EB and Rolph JE. The demand for episodes of treatment in the Health Insurance Experiment. *Journal of Health Economics* 1988; 7:301-422

4 O'Brien B.The effect of patient charges on the utilization of prescription medicines,*Journal of Health Economics* 1989;8(1):109-132

5 Hughes D and McGuire A.Patient charges and the utilization of NHS prescription medicines.Health Economics 1995; 4(3):213-220

6 Miller C, Kriven S, Rowley D, and Abram L. Be wary of subsidising nicotine replacement therapy, Letter, *Tobacco Control* 2002; 11: 380-381

7 Curry SJ, Grothaus LC, McAfee and Pabiniak C. Use and cost effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. *The New England Journal of Medicine* 1998; 339; 10: 673-679

8 Ong MK. and Glantz SA. (2005) Free Nicotine Replacement Therapy Programs vs Implementing Smoke-Free Workplaces: A Cost-Effectiveness Comparison, *American Journal of Public Health* 2005; 95; 6: 969-975

**The cost effectiveness of NRT**

NRT is generally accepted to be a cost effective intervention. In 2002 the National Institute for Health and Clinical Excellence (NICE) analysed the cost effectiveness of NRT, and estimated a cost per life year saved of between £1,000 and £2,400 for NRT plus advice.[9] Therefore NRT increases the probability of an individual being successful in a smoking cessation attempt at relatively low cost given the significant benefits of stopping smoking. This is represented by incremental cost effectiveness ratios (ICERs) that are low in comparison with many interventions that are recommended for use in health systems throughout the world.[10,11]

**How NRT is funded**

NRT is currently available in the UK via prescription. However despite the proven cost effectiveness of NRT an analysis of how the intervention can best be funded has not been undertaken. Given that studies have suggested that how NRT is provided can effect both its take-up and its clinical efficacy this appears to be an important oversight.[15,16,20]

**The costs of smoking and the benefits of cessation**

Estimates suggest that smoking accounts for 15% of total health care costs in developed countries. Smoking cessation results in less health care expenditure on the treatment of smoking induced disease, less workplace absenteeism due to such diseases and fewer illnesses suffered as a result of passive smoking. Costs related to cleaning up cigarette ends and ash are also avoided.[12] These benefits are omitted from this study's analysis meaning that results will be biased against the funding mechanisms which create more cessation. Therefore the cost per QALY ratios associated with more effective alternatives will be an overestimate.

Rasmussen et al estimated the health care cost savings associated with smoking cessation by comparing the health costs of continuing smokers and ex-smokers taking into account differences in life expectancy and the reduction in relative risks of certain diseases caused by cessation. The study estimates substantial savings for all smokers who quit, with the lifetime savings accrued by a 35 year-old male totaling approximately €24,800 (£16,693). 69% of this saving is made up by productivity costs, and 31% is associated with direct cost savings.[13]

9 Woolacott N, Jones L, Forbes C, Mather L, Sowden A, Song F, Raftery J, Aveyard P, Hyde C, Barton P. A rapid and systematic review of the clinical and cost effectiveness of bupropion SR and nicotine replacement therapy (NRT) for smoking cessation. NHS R&D HTA Programme 2002

10 Silagy C, Mant D, Fowler G, Lancaster T. Nicotine replacement therapy for smoking cessation (Cochrane Review). In The Cochrane Library Issue 3. Oxford: Update Software, 2001

11 Stapleton JA, Lowin A, and Russell MAH. Prescription of transdermal nicotine patches for smoking cessation in general practice: evaluation of cost-effectiveness, The Lancet 1999; 354; 17: 210-215

12 Parrott S and Godfrey C. Economics of smoking cessation. The British Medical Journal 2004; 328: 947-949

13 Rasmussen SR, Prescott E, Thorkild IA et al. (2005) The total lifetime health cost savings of smoking cessation to society. European Journal of Public Health Vol 15, No. 6 601-606. Oxford.

Naidoo et al estimated that a 4% drop in smoking prevalence in adults aged 35-64 between 1995 and 2010 would result in over 34,000 fewer acute myocardial infarctions and over 25,000 less strokes over their period of study.[14] This would in turn result in large cost savings for the NHS.

It seems likely that future health care costs are likely to cancel each other out to some degree as smokers are more likely to suffer complications such as lung cancer, while non-smokers are likely to live longer, incurring more old-age health care costs.

Smoking is also associated with negative externalities, as passive smokers can suffer from smoking-related illnesses despite not smoking themselves. This results in a welfare loss for society as a whole.

**Possible financing mechanisms for NRT**

A search of the economic literature was undertaken seeking to identify papers that provide data on the effectiveness of NRT within different financing mechanisms, and mechanisms for which data was found were compared in our analysis.

The funding mechanisms which are evaluated are listed below, along with a brief summary of the important factors and assumptions related to each mechanism.

**1. Free NRT: NRT provided free, funded by the government**

This funding mechanism involves smokers attempting to quit being provided NRT free of charge. In effect the government (or whoever is the payer within the health system) must fully finance NRT provision, raising the money through general taxation via the health budget.

Evidence suggests that a larger proportion of potential quitters are likely to use NRT if it is provided free.[15,16] However, study data also suggests that individual readiness to quit is a very important factor. In line with this we have assumed that people who receive NRT free of charge are less motivated to quit than people who pay for NRT, and so the probability of quitting once using NRT is lower. The literature suggests that this is because not having to pay for NRT means that less highly motivated "marginal" potential quitters demand NRT products, as well as those with more self-motivation, who would have been willing to pay for the product.[17]

14 Naidoo B, Stevens W, McPherson K (2000) Modelling the short term consequences of smoking cessation in England on the hospitalization rates for acute myocardial infarction and stroke. Tobacco Control 2000; 9:397-400.

15 Ong MK. and Glantz SA. (2005) Free Nicotine Replacement Therapy Programs vs Implementing Smoke-Free Workplaces: A Cost-Effectiveness Comparison, American Journal of Public Health 2005; 95; 6: 969-975

16 Curry SJ, Grothaus LC, McAfee and Pabiniak C. Use and cost effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. The New England Journal of Medicine 1998; 339; 10: 673-679

17 Miller C, Kriven S, Rowley D, and Abram L. Be wary of subsidising nicotine replacement therapy, Letter, Tobacco Control 2002; 11: 380-381

**2. Free NRT + Tax: NRT provided free, funded by an increase in tax on cigarettes**

This mechanism involves an increase in the price of cigarettes (in the form of a tax) sufficient to raise the necessary amount of revenue to cover the expected total cost of the NRT programme. This is a relevant scenario to model because the money to pay for the NRT would have to be raised somehow, and given the nature of cigarettes and smoking it seems feasible that an increase in tax on cigarettes may be one method of raising the necessary funds.

In this mechanism, additional to the number of people who quit using NRT when it is provided free as in Free NRT, there are a proportion of smokers who quit as a result of the increase in cigarette prices (calculated by considering how much cigarette prices would need to increase by in order to pay for NRT). This proportion is based on Price Elasticity of Demand (PED) estimates, and estimates of the proportion of the demand reduction which is due to smoking cessation.[18,19] This number of people is added to the number who quit using NRT.

**3. Subsidy: NRT partly subsidised by the government**

Another possible financing option involves people who wish to use NRT paying only a certain proportion of the price, with the government subsidising the therapy through general taxation.

There are estimates in the literature of the proportion of people who will attempt to quit using NRT if it is provided at full price, and other data provides a basis for an estimate of the relationship between price of NRT, take-up, and quit success rates. Using this information uptake of NRT and success rates can be estimated given an NRT subsidy.

**4. User Pays: Quitters pay full price for NRT**

This option involves people who wish to use NRT paying its full price. Although less people will attempt to quit using NRT if they must pay its full price, evidence suggests that they are more likely to be successful in this case.[20]

**The Model**

A decision tree was constructed to estimate the number of successful quitters, the Quality Adjusted Life Years (QALYs), and the costs, for each financing mechanism for NRT. The results of this tree were then used to construct a population-based Markov model, which calculates over time how many patients will give up smoking, the QALYs, and the costs associated with this for each financing mechanism.

18 Cutler DM, Gruber J, Hartman RS, Landrum MB, Newhouse JP, and Rosenthal MB (2000) The Economic Impacts of the Tobacco Settlement, JEL Classification: I1, K0

19 Chaloupka, F.J., Hu, T-W, Warner, K.E., Jacobs, R., Yurekli, A.A. (2000) The taxation of tobacco products, In Jha, P., Chaloupka, F.J. (eds.) Tobacco Control in Developing Countries, Oxford, England: Oxford University Press Inc, pp. 237-272

20 Miller C, Kriven S, Rowley D, and Abram L. Be wary of subsidising nicotine replacement therapy, Letter, Tobacco Control 2002; 11: 380-381

**Benefits**

The benefit that we primarily consider is number of quitters. Using a Quality Adjusted Life Year (QALY) score per quitter taken from the literature we also interpret this as a QALY gain.[21] The QALY score we have used is a conservative estimate, meaning that in reality QALY gains may be higher than we estimate, and are unlikely to be lower. The QALY score takes into account both the longer life expectancy of someone who quits smoking and the increased quality of life experienced by the quitter. Although QALYs need to be interpreted with care their use is helpful as they allow comparisons of the cost-effectiveness of different interventions in different disease areas.

**Costs**

As a societal perspective is taken, it is relevant to include indirect health costs as well as the direct costs of NRT treatment. However, there is considerable uncertainty with regards to the future health costs saved by a smoker quitting, since short term costs may be reduced, but in the longer term costs could possibly increase. The NICE rapid and systematic review of NRT suggests that discounting reduces the impact future costs have on the results of cost effectiveness analysis to the extent that their inclusion would be unlikely to significantly impact upon the results. Hence, for this study it is assumed that the long term costs associated with a smoker and an ex-smoker are not significantly different when transformed into present values, and so they are excluded from the analysis.

Therefore the costs included in our evaluation are the actual drug costs and the costs incurred through brief advice given to smokers by General Practitioners (GP) regarding quitting smoking. Costs incurred by the patient when attending a GP consultation are also included in line with the societal perspective taken. The intervention being considered is in line with the intervention of NRT plus brief advice considered in the NICE rapid and systematic review of bupropion and NRT published in 2002.[22] Drug costs are taken from BNF 53.[23] GP consultation costs are taken from national unit costs.[24] Sensitivity analysis is undertaken to reflect the different prices of different types of patch and gum NRT, and also the proportion of GP consultations taken up discussing smoking cessation.

Importantly, because a societal perspective is taken, the cost of NRT is assumed to be the same whether it is bought by the user or by the NHS. Over-the-counter (OTC) prices are higher, but the increased cost represents a societal transfer from the buyer to either pharmacists, pharmaceutical companies, or distributors. Hence the true cost of NRT remains the same.

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21 Keeler TE, Hu TW, Keith A, Manning R, Marciniak MD, Ong M, and Sung HY. The benefits of switching smoking cessation drugs to over-the-counter status, Health Economics 2002; 11: 389-402

22 Woolacott N, Jones L, Forbes C, Mather L, Sowden A, Song F, Raftery J, Aveyard P, Hyde C, Barton P. A rapid and systematic review of the clinical and cost effectiveness of bupropion SR and nicotine replacement therapy (NRT) for smoking cessation. NHS R&D HTA Programme 2002

23 BNF 53, March 2007

24 Curtis L and Netten A. Unit costs of health and social care 2007. Personal Social Services Research Unit, University of Kent at Canterbury 2007

## Welfare impacts

In order to provide NRT free of charge funds must be raised by the government in some way. In scenario 1 (Free NRT) it is assumed that this money is raised through general taxation, whereas in scenario 2 (Free NRT + Cigarette Tax) it is assumed that the money is raised through a specific earmarked tax on cigarettes. The current UK situation scenario (Subsidy) involves funds from the healthcare budget, raised from general taxation. For the User Pays scenario those attempting to give up (but not those smokers not attempting to quit) are charged fully for the treatment. As a societal perspective is being taken the relative merits of taxing and charging certain groups of the population must be considered along with the cost effectiveness analysis results.

## The decision tree

The first section of the model is made up of a decision tree. Part of one of the funding mechanism branches is illustrated in

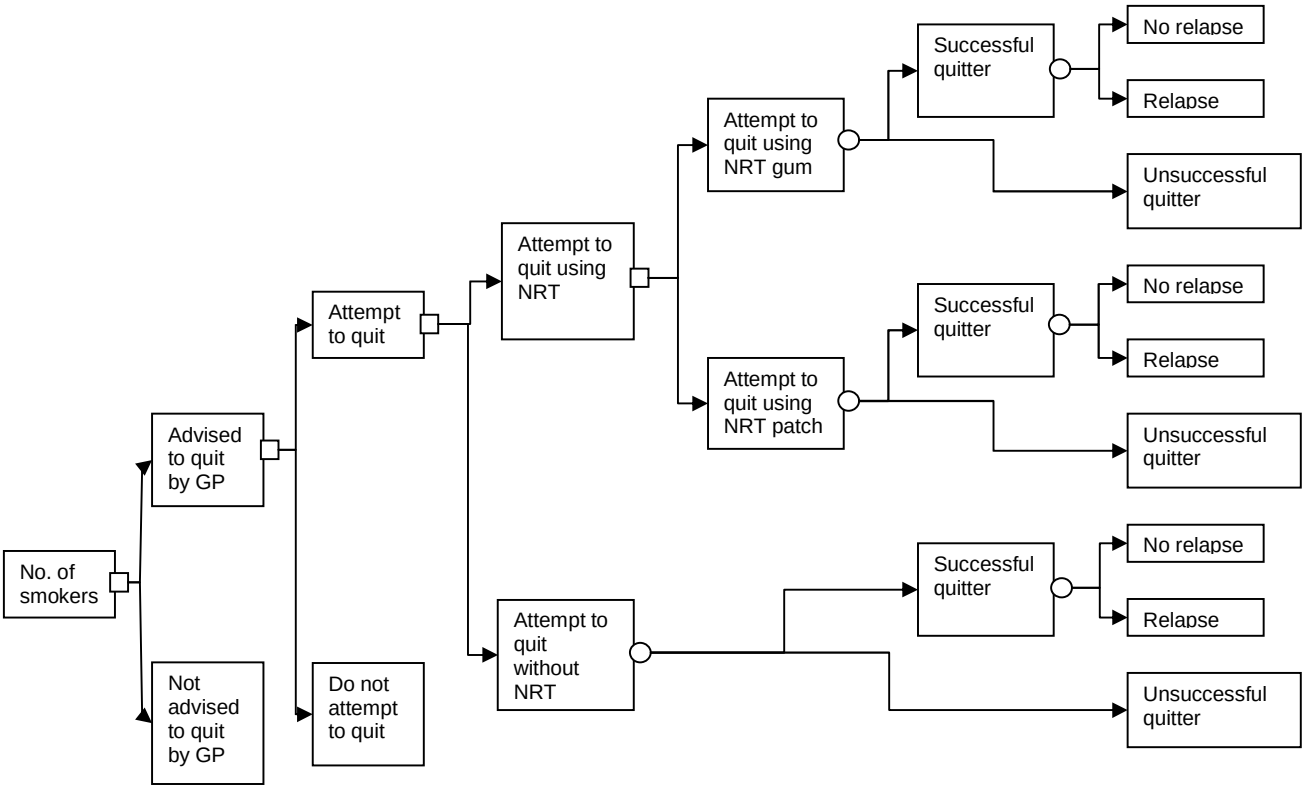
**Figure 1** below. As the model considers four scenarios, the total decision tree incorporates four of these branches. It is assumed that a certain proportion of smokers are advised to quit each year by a general practitioner. Of these patients a certain proportion will go ahead with a quit attempt, and a proportion of these people will attempt to quit using NRT. It is assumed that smokers who are not advised to quit do not attempt to quit. The decision tree allows two quit attempts per year, in line with other assumptions made in the literature.[25]

The decision tree allows an average probability of quitting for an individual smoker per year to be calculated. It also calculates the total number of quitters in the base year, and that year's cost of NRT treatment for each funding mechanism, given the population data fed in to the model.

Total NRT costs per year are calculated by the model through allocating a cost per user for NRT gum and NRT patches, including GP consultation costs. This allows an average "cost per smoker" to be calculated. Total number of quitters is calculated by adding the number of people who reach one of the "No Relapse" end branches of the model. This is converted to the total number of QALYs gained by allocating a QALY gain per quitter taken from the literature.

25 Ong MK. and Glantz SA. (2005) Free Nicotine Replacement Therapy Programs vs Implementing Smoke-Free Workplaces: A Cost-Effectiveness Comparison, American Journal of Public Health 2005; 95; 6: 969-975

**Figure 1: Smoking cessation decision tree**



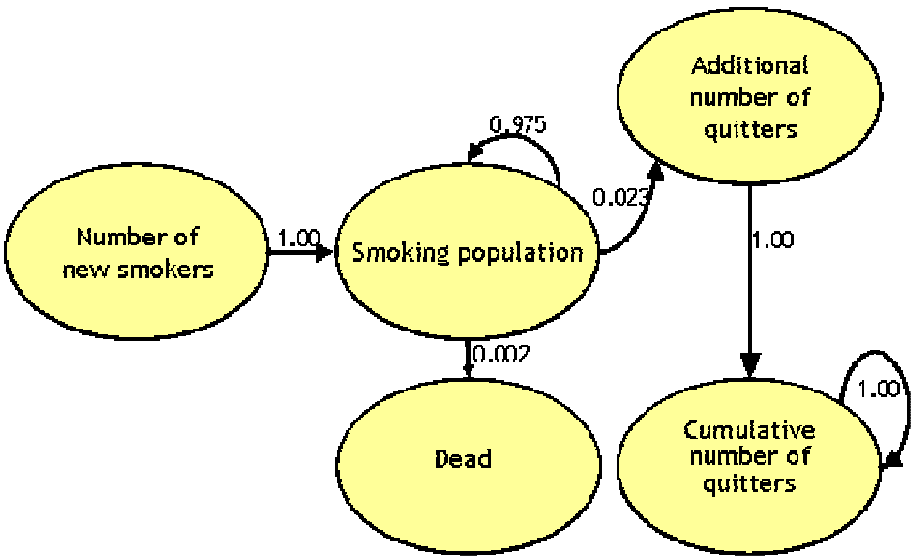

## The Markov model

The outputs of the decision tree are used in a simple Markov model which calculates the number of quitters, NRT costs, and the number of QALYs over a 25 year time period. The structure of the Markov model is shown in

**Figure 2**. The cycle length of the model is one year. It is assumed that new smokers do not quit in their first year as a smoker, and that after one year they move into the general smoking population whose quit rate is dependent on the NRT financing mechanism (figures shown in **Figure 2** are for the scenario in which NRT is provided free to the user).

Because the model allows new smokers to enter into the model it effectively calculates an average ICER across a raft of different cohorts. Note also that the Markov model assumes that once a smoker has quit, they remain a non-smoker for the remainder of the model. This is because the decision tree incorporates a relapse rate probability. Including this as a separate state in the Markov model would mean double-counting this effect.

**Figure 2: Smoking cessation markov model**




The Markov model calculates the total number of quitters, the total number of QALYs gained, and the total NRT costs for each financing mechanism for an arbitrary time period of 25 years. These results are considered in an incremental analysis in the results section of this paper.

**Model parameters**

The following table shows the estimates used for key parameters in the model. Where possible UK sources were used.

**Table 1: Model parameters**

| **Demographics** | **Estimate** | **Sources** |
|---|---|---|
| UK Population | 59,834,900 | Government statistics [26] |
| Prevalence of Smoking | 25.00% | Government statistics [26] |
| Population Growth Rate | 0.64% | Optimum population trust [27] |
| New smokers per year, per population | 0.34% | Estimated using data quoted by Department of Health, Cancer Research UK,[28] and the London Health Observatory [29] |
| Proportion of new smokers aged under 18 | 80.00% | London Health Observatory [29] |
| Proportion of new smokers aged over 18 | 20.00% | London Health Observatory [29] |
| Proportion of smokers who smoke more than 15 per day | 54.90% | Ong and Glantz (2005).[8] Fits with UK estimate that average smoker smokes around 15 cigarettes per day |
| **Price Elasticity of Demand (PED) for Smoking (for cigarette tax scenario)** | | |
| Adults | - 0.40 | Cutler et al (2000) [30] |
| Children and Adolescents | - 1.20 | Chaloupka and Warner (2000) [31] |
| Proportion of demand reduction due to smoking cessation rather than decrease in smoking | 0.50 | Chaloupka and Warner (2000) [31] |
| **Cessation** | | |
| Proportion of smokers advised to quit | 60% | Informed by Parrott et al 1998 [37] |
| Proportion of smokers advised to quit who go on to attempt to quit | 50% | Informed by Parrott et al 1998 [37] |
| Proportion of smokers ready to attempt cessation who would use NRT if NRT was free | 53% | Estimate informed by Curry et al [35] |
| Proportion of smokers ready to attempt cessation who would use NRT if had to pay full price | 25% | Parrot et al 1998 [37] |
| Proportion of smokers ready to attempt cesation who would use NRT if it was subsidized by 86% | 49% | Estimate informed by Curry et al [35] |
| Relapse Rate | 40% | Keeler et al (2002) [21] |
| No Relapse Rate | 60% | Keeler et al (2002) [21] |
| Baseline quit rate for those wishing to quit | 4% | NICE systematic review, assuming brief advice [9] |
| Quit rate with NRT when pay full price | 8.20% | Estimated using Cochrane meta analysis results [10] |
| Quit rate with NRT when have free access | 6.96% | Estimated using Cochrane meta analysis results [10] |

[26] http://www.statistics.gov.uk/CCI/nugget.asp?ID=6 Government Statistics, accessed 08/09/07
[27] http://www.optimumpopulation.org/opt.more.ukpoptable.html Optimum Population Trust, accessed 08/09/07
[28] http://info.cancerresearchuk.org/images/publicationspdfs/factsheet_lung_cancer.pdf, Cancer Research UK, accessed 08/09/07
[29] http://www.lho.org.uk/HIL/Lifestyle_And_Behaviour/Smoking.aspx London Health Observatory, accessed 08/09/07

30 Cutler DM, Gruber J, Hartman RS, Landrum MB, Newhouse JP, and Rosenthal MB (2000) The Economic Impacts of the Tobacco Settlement, JEL Classification: I1, K0

31 Chaloupka, F.J., Hu, T-W, Warner, K.E., Jacobs, R., Yurekli, A.A. (2000) The taxation of tobacco products, In Jha, P., Chaloupka, F.J. (eds.) Tobacco Control in Developing Countries, Oxford, England: Oxford University Press Inc, pp. 237-272

| | | |
|---|---|---|
| Quit rate with NRT when NRT is subsidised x% | 7.14% | Estimated using Cochrane meta analysis results [10] |
| Proportion of NRT users who use patches | 90% | Prescription Pricing Authority [32] |
| Proportion of NRT users who use gum | 10% | Prescription Pricing Authority [32] |
| Increase in cigarette packet price to pay for NRT | 2.17% | Estimated based on demand for NRT[33,34,35] no of cigarette packets purchased per year |
| **QALYs** | | |
| Relapse-free QALY per quit, compensating for background quit rate | 2.7 | NICE systematic review, based on Parrott et al [9 34] |
| **Costs** | | |
| Cost per gum treatment (inc dispensing cost, assuming 4 prescriptions) | £49.20 | BNF 53 (2007) [23] |
| Cost of patches (inc dispensing cost, assuming 4 prescriptions) | £99.85 | BNF 53 (2007) [23] |
| Cost of GP consultation | £25.00 | Curtis and Netten (2007) [24] |
| Cost to patient | £7.90 | Curtis and Netten (2007) [24] |
| **Death Rates (per 1,000 people)** | | |
| Non-smoker | 1.24 | National statistics |
| Smoker | 2.47 | Based on Doll et al 2004 [36] |
| Ex-smoker | 1.55 | Based on Doll et al 2004 |
| **Discount Rates** | | |
| Discount Rate (Costs) | 3.5% | NICE reference case |
| Discount Rate (Benefits) | 3.5% | NICE reference case |

## Key parameters

- NRT Subsidy (scenario 3)

One of these is how the current 'subsidy' of NRT was calculated. As shown below, in Table 2, the prescription charge in the UK results in NRT effectively being subsidised by 86%.

**Table 2: The NHS Subsidy of NRT**

32 http://www.ppa.nhs.uk/index.htm

33 Ong MK. and Glantz SA. (2005) Free Nicotine Replacement Therapy Programs vs Implementing Smoke-Free Workplaces: A Cost-Effectiveness Comparison, American Journal of Public Health 2005; 95; 6: 969-975

34 Parrott S and Godfrey C. Economics of smoking cessation. The British Medical Journal 2004; 328: 947-949

35 Curry SJ, Grothaus LC, McAfee and Pabiniak C. Use and cost effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. The New England Journal of Medicine 1998; 339; 10: 673-679

36 Doll R, Peto R, Boreham J and Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors. British Medical Journal 2004; 328:1519

| | Nicotine Patches | Nicotine Gum |
|---|---|---|
| Assumed number of prescriptions per treatment course | 4 | 4 |
| Prescription charge | £6.50 | £6.50 |
| Amount paid by user | 4 * 6.50 = £26.00 | 4 * 6.50 = £26.00 |
| Dispensing fee paid by NHS | £0.90 | £0.90 |
| Treatment cost | £96.25 | £45.60 |
| Total treatment cost paid by NHS (assuming 4 prescriptions dispensed separately) | £99.85 | £49.20 |
| Proportion of total NHS cost paid by user | 26% | 53% |
| Therefore amount by which NHS subsidises treatment | 74% | 47% |
| Combined proportion of total treatment cost paid by NHS (assuming 90% of users use patches) | 71% | |
| Proportion of population exempt from prescription charge (Department of Health, 2006) | 50% | |
| **Average NHS subsidy of NRT** | **86%** | |

- Take-up of NRT

Another key parameter within the model is the proportion of patients who attempt to quit using NRT given how much they have to pay for it. There are estimates in the literature of the proportion of people who will attempt to quit using NRT if it is provided at full price, and other data provides a basis for an estimate of the relationship between price of NRT and take-up. Parrott et al estimate that 25% of those making an attempt to stop smoking will try NRT if they have to pay the full price.[37] They state that this figure will rise if NRT is subsidised. Although data on price elasticities of demand for NRT is scarce, Curry et al (1998) provide information from NRT use in an insurance market which allows demand responses to be calculated for price falls.[38] Using this information a demand curve for NRT can be estimated. These estimates and demand responses are shown in Table 3 and Figure 3.

**Table 3: PED for smoking cessation services**

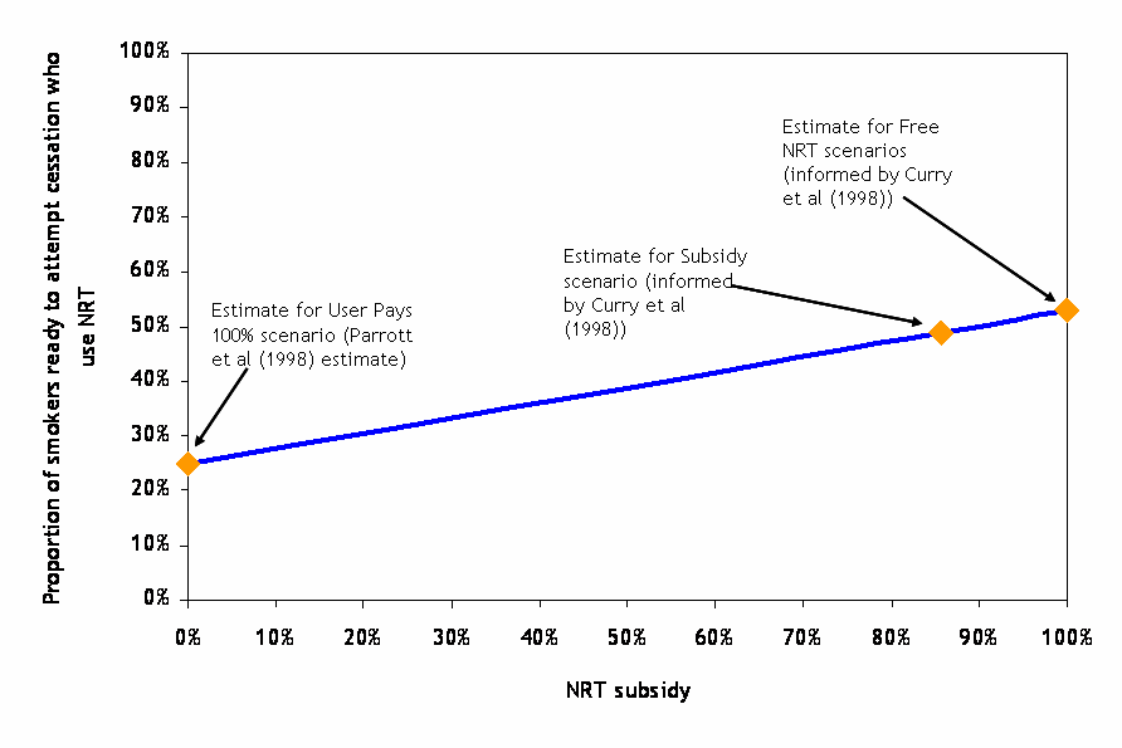
| **Increase in insurance coverage** | | |
|---|---|---|
| % reduction in price of smoking cessation services* | Increase in demand for smoking cessation services* | Estimated PED for price fall |
| 80.95% | 91.98% | 0.9198/-0.8095 = -1.14 |
| **Assumptions used in model** | | |
| | **% smokers attempting to quit who use NRT** | |
| User pays full price | 25% (Parrott et al, 1998) | |
| 85.65% subsidy (assumed current case) | 49% (calculated using PED for price fall) | |
| Free NRT | 53% (calculated using PED for price fall) | |

37 Parrott S, Godfrey C, Raw M, West R, McNeill A. Guidance for Commissioners on the Cost Effectiveness of Smoking Cessation Interventions. Thorax 1998; 53: 2-37

38 Curry SJ, Grothaus LC, McAfee and Pabiniak C. Use and cost effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. The New England Journal of Medicine 1998; 339; 10: 673-679

* From Curry et al 1998

**Figure 3: The relationship between NRT subsidy and the proportion of smokers ready to attempt cessation who use NRT**




- Quit rates

Other key parameters are the odds ratios for quitting used in the model to estimate quit rates for different levels of payment by the user. These estimates are based on those calculated in the Cochrane Systematic Review of NRT products.[39] Odds ratios used for consumers paying the full price of the product represent the higher confidence interval limit from the review while the odds ratio for those who do not pay represents the mean estimate. This is arbitrary, but given evidence in the literature that those who pay for their treatment are more likely to quit, and because these estimates represent the confidence limits associated with quitting when taking NRT, they are reasonable. Sensitivity analysis around these parameters was undertaken. A positive linear relationship between odds ratio and subsidy has been assumed to form the odds ratio estimate for the subsidy scenario. These are shown in Table 4, below.

**Table 4: Quitting odds ratios**

| | Odds ratio: Free NRT* | Odds ratio: 85% Subsidy** | Odds ratio: User pays*** |
|---|---|---|---|
| Nicotine patch | 1.74 | 1.78 | 2.05 |
| Nicotine gum | 1.76 | 1.80 | 2.04 |

*Represent the mean odds ratios calculated in the Cochrane review[39]

39 Silagy C, Mant D, Fowler G, Lancaster T. Nicotine replacement therapy for smoking cessation (Cochrane Review). In The Cochrane Library Issue 3. Oxford: Update Software, 2001

**Estimate assuming linear relationship between subsidy and odds ratio
***Represent upper confidence limit of odds ratios from the Cochrane review[39]

## Results

### Base case scenario

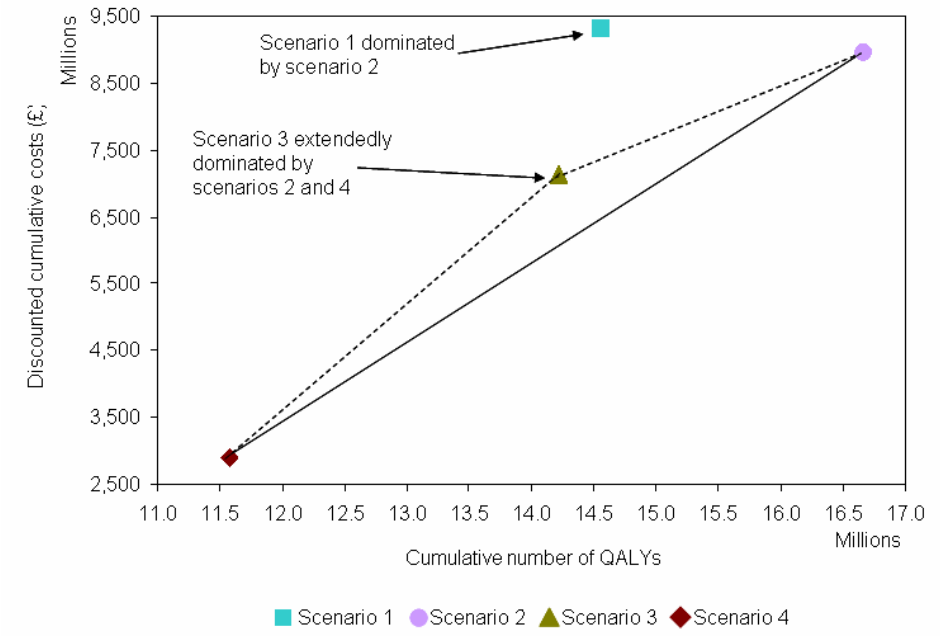
In order to discover which financing mechanism considered was the most cost effective an incremental analysis of the results was undertaken. The base case ICERs are illustrated in the following table and diagram.

**Table 5: Base case results**

| | Number of quitters (m) | Discounted total number of QALYs (m) | Discounted total costs (£bn) | ICER (£ per additional quitter) | ICER (£ per additional QALY) |
|---|---|---|---|---|---|
| **4. User Pays** | 6.23 | 11.58 | 2.90 | | |
| **3. Subsidy** | 7.60 | 14.21 | 7.14 | 3,109 (ED) | 1,607 (ED) |
| **2. Free NRT + Tax** | 8.84 | 16.66 | 8.95 | 2,320 (vs. User Pays) | 1,189 (vs. User Pays) |
| **1. Free NRT** | 7.77 | 14.56 | 9.30 | Dominated | Dominated |

Note: ED = Extendedly Dominated
ICER = Incremental Cost Effectiveness Ratio

**Figure 4: Base case Incremental Cost Effectiveness Ratios (ICERs) – QALYs**



In the base case both Free NRT (scenario 1) and Subsidy (scenario 3) are dominated. Free NRT is clearly dominated by Free NRT + Tax as it is both more expensive and results in fewer quitters and QALYs. This makes sense as Free NRT + Tax involves an increased price of cigarettes which will cause more people to quit, which in turn creates less demand for NRT over time. Interestingly, the ICER between Free NRT and Subsidy is £6,171, suggesting that providing NRT free of charge would be more cost effective than the current prescription charge regime.

Subsidy is extendedly dominated by a combination of Free NRT + Tax and User Pays (scenario 4). This is illustrated in figure 4 by the shallower slope of the line joining scenarios 3 and 2 compared to that joining scenario 4 and scenario 3.

This leaves User Pays and Free NRT + Tax as the only financing mechanisms worth considering in the base case. The ICER between User Pays and Free NRT + Tax suggests that if there is a willingness to pay £1,189 for an additional QALY (£2,320 for an additional quitter) Free NRT + Tax is the cost effective financing mechanism. It is likely that this would be viewed as cost effective in the UK given the NICE benchmark of £20,000 to £30,000 per additional QALY.

**Equal demand and effect scenario**

The demand and effectiveness assumptions are the drivers behind the analysis in this paper. It is these assumptions that make considering financing mechanisms in cost effectiveness analysis important. A supplementary analysis was completed looking at the results if it was assumed that the financing mechanism had no effect on demand for NRT or the effectiveness of NRT. These results are shown below.

**Table 6: Equal demand and effect results**

| | Number of quitters (m) | Discounted total number of QALYs (m) | Discounted total costs (£bn) | ICER (£ per additional quitter) | ICER (£ per additional QALY) |
|---|---|---|---|---|---|
| **4. User Pays** | 5.95 | 11.03 | 4.71 | Dominated | Dominated |
| **3. Subsidy** | 5.95 | 11.03 | 4.71 | Dominated | Dominated |
| **2. Free NRT + Tax** | 6.37 | 11.84 | 4.65 | | |
| **1. Free NRT** | 5.95 | 11.03 | 4.71 | Dominated | Dominated |

Note: ED = Extendedly Dominated

Under these assumptions the number of quitters and costs are identical under User Pays, Subsidy, and Free NRT. This is because there is equal demand for NRT in each scenario, and the effectiveness of NRT under each scenario is also assumed to be the same, resulting in equal costs. Free NRT + Tax involves more quitters because of the price elasticity of demand effect associated with increasing the price of cigarettes, and this also cuts costs. These results are logical, and suggest that even if financing mechanisms are assumed not to affect demand and effect implementing a higher cigarette tax will increase the number of quitters, making that scenario the most cost effective.

## NHS perspective scenario

The analysis conducted so far has viewed costs from a societal perspective in the respect that the purchase costs to individual consumers as well as to the NHS have been considered. However most analyses undertaken by NICE are from the NHS perspective – that is they would not consider costs incurred by individual consumers. Hence it is interesting to run the model excluding costs not incurred by the NHS. The results of this analysis are shown below.

**Table 7: NHS perspective results**

| | Number of quitters (m) | Discounted total number of QALYs (m) | Discounted total costs (£bn) | ICER (£ per additional quitter) | ICER (£ per additional QALY) |
|---|---|---|---|---|---|
| **4. User Pays** | 6.23 | 11.58 | 1.33 | | |
| **3. Subsidy** | 7.60 | 14.21 | 6.10 | Dominated | Dominated |
| **2. Free NRT + Tax** | 8.84 | 16.66 | 2.68 | 521 (vs. User Pays) | 267 (vs. User Pays) |
| **1. Free NRT** | 7.77 | 14.56 | 8.67 | Dominated | Dominated |

Note: ED = Extendedly Dominated

Excluding costs not incurred by the NHS alters the results of the analysis drastically. The User Pays option becomes much cheaper, as does the Subsidy scenario. The Free NRT + Tax scenario also appears much cheaper because the cost to the consumer of the tax increase is not included in the analysis. This leads to the Free NRT + Tax scenario dominating both Free NRT and Subsidy. The ICER between User Pays and Free NRT + Tax is very low due to the low added cost incurred by the NHS in switching to Free NRT + Tax as the cost of the NRT is covered by the tax increase incurred by smokers.

## Welfare effects

## Moral hazard

The theory of moral hazard suggests that when a service is provided free of charge incentives exist causing the consumer to over-consume. In the UK health sector – where GPs act as gatekeepers to further care – producer moral hazard may also exist. GPs may prescribe NRT to smokers who perhaps do not need the intervention (they would quit even without it), or to patients who show no signs of being motivated to make good use of the therapy, simply because the product is free for the consumer. Such over-consumption is a type of negative externality and at it seems logical to reduce this using a copayment or prescription charge, or even to charge the user fully for use of the product which is being over-consumed.

However, it also seems logical that encouraging more use of a cost-effective therapy is unlikely to result in overall welfare losses.[40] Indeed the evaluation results show that the scenarios where users receive NRT free of charge prove cost effective compared to those where are charge is included, even taking into account the lower motivation and likelihood of quitting for those who receive NRT free. Hence from a societal perspective the scenarios involving free access to NRT offers benefits compared to the user charge perspectives from a moral hazard point of view.

**Taxation**

The efficiency of taxes depend on the income and substitution effects associated with them. Taxes reduce the disposable income of the taxpayer, and taxes on certain commodities affect private sector decisions and behaviour. Altered decisions reflect distortions created by the tax, and these are associated with the excess burden, or deadweight loss, of a tax. The deadweight loss is greater when demand for the product being taxed is elastic, and rises with the square of the tax rate.

Free NRT (scenario 1) implies that the funding required to pay for NRT is raised through general taxation. In the UK this is likely to mean that the money is raised through income tax. The tax is payable by a large proportion of the population and so the tax rate would be low, leading to a low deadweight loss of the tax. However income taxes are associated with distorted work-leisure decisions, resulting in welfare losses. Also, from an equity point of view, this would involve all those who pay income tax having to pay for the provision of NRT treatment, which does little for internalising the externalities associated with smoking.

Free NRT + Cigarette Tax (scenario 2) involves taxing a smaller population (smokers) which means a higher tax rate than scenario 1 which is associated with greater tax-related distortions. However this option places a tax on a habit which creates negative externalities. This will increase the price and reduce the consumption of smoking. Given that by definition (as it creates negative externalities) smoking is under-priced and over-consumed, this should result in a societal welfare gain. This presumes that the current level of taxation on cigarettes has not already fully internalised the external costs associated with smoking.

Subsidy (scenario 3) assumes that the current UK situation prevails. The funds used to subsidise NRT are raised through general taxation, again most likely to be through income tax (as this is the tax that raises the most in the UK). Therefore, as with Free NRT a low (additional) tax rate will be required to pay for NRT, creating low distortions, but again this does not address the externalities caused by smoking.

User Pays (scenario 4) involves those who attempt to quit smoking using NRT paying the full price of the product. This does not involve taxation, but can possibly be seen to promote a negative externality, through creating disincentives to quit. Hence it seems unlikely that this option would be optimal from a societal perspective.

40 Held PJ and Pauly MV. Benign moral hazard and the cost effectiveness of insurance coverage, Journal of Health Economics 1990; 9(4): 447-461

Indeed, although Free NRT and Subsidy would result in little additional distortions created by a very small increase in the income tax rate in order to raise money for NRT, these scenarios are unlikely to be socially optimal when compared to Free NRT + Cigarette Tax. This is because the cigarette tax is likely to create distortions in the private market that will actually increase social welfare, because the distortions create a disincentive to smoke. Taxation principles show that distortions created by taxation are lower when demand for the product being taxed is inelastic, which has been shown to be the case for cigarettes. Because the demand for cigarettes is inelastic with respect to price, the burden of the tax will largely be passed on to cigarette smokers which in turn will create incentives to quit smoking, reducing the negative externalities associated with smoking.

An argument against the use of a cigarette tax could relate to the regressive nature of such a tax. If a greater than or equal proportion of low income groups smoke compared to higher income groups, then taxing cigarettes will reduce vertical equity. However some data has shown that in fact expenditure on tobacco products does increase with income, reflecting a higher intensity of smoking, or spending on more expensive products in higher income groups.[41] Also of note, studies have found lower income groups to be more responsive to price of cigarettes compared to higher income groups.[42, 43, 44] Hence the tax may result in more lower income smokers quitting (and benefiting from free NRT). This reduces concerns of the regressivity of cigarette taxes.

The literature suggests that other methods for reducing the prevalence of smoking may be more efficient than a tax on cigarettes, due to the difficulties in calculating the social marginal cost of smoking (as the most efficient Pigouvian tax applies a tax rate that equalises marginal private and marginal social costs). For example restrictions on where people can smoke may be more efficient. However these methods do not raise funds which can be used to provide NRT.

This brief analysis of the social benefits and costs of the different financing mechanisms included in the analysis of this paper shows that the scenario which includes a cigarette tax is likely to be socially optimal. This adds to the cost effectiveness results which also show this option to be optimal.

An important note to this analysis is that we have considered that the user pays and subsidy scenarios are funded by increases in general taxation. Alternatively, funds could be diverted from a different health service (or other government programmes). If this were the case, from a societal perspective the question would be about the relative welfare benefits of financing NRT rather than an alternative public service. The outcome of this analysis would depend upon the foregone service. Despite this altered analysis it remains likely that funding NRT through a

41 Chaloupka FJ and Warner KE.. The economics of smoking. Ch 29 in Culyer AJ and Newhouse JP (eds). *Handbook of Health Economic*s Vol. 1b 2000. North-Holland

42 Chaloupka F. Rational addictive behaviour and cigarette smoking. NBER Working Papers 3268, 1991. National Bureau of Economic Research, Inc

43 Farelly MC, Bray JM, Pechacek T and Woolery T. The response to increases in cigarette prices by race, income, and age groups. Working Paper, Research Triangle Institute 1998

44 Townsend J, Roderick P and Cooper J. Cigarette smoking by socioeconomic group, sex, and age: Effects of price, income, and health publicity. British Medical Journal 1994; 309:923-926

cigarette tax (despite it's distortionary effects on private consumption) is likely to be preferable to displacing an existing public service due to the expected reduction in negative externailities.

**Discussion**

It is already widely accepted that NRT is a cost effective medical intervention. However this paper brings into question the way in which NRT is financed and seeks to show why it may be important to consider financing mechanisms in economic evaluations. Currently the prescription charge must be paid for NRT in England. However this paper suggests that it would actually be more cost effective to provide NRT completely free of charge funded by an increase in tax on cigarettes. Indeed, the analysis shows that providing NRT free of charge whether or not the funds are raised through an increase in tax on cigarettes is cost effective compared to the current prescription charge regime. This has important implications in a health system which strives to make the most cost effective use of resources, and shows that it is important to consider whether the way in which an intervention is funded will affect its cost effectiveness.

The two most important factors which need to be considered when deciding whether considering the financing mechanism is important are:

- Whether the demand for the intervention is likely to be affected by its price to the consumer (in the current case this will usually be the prescription charge);
- Whether the price to the consumer of the intervention is likely to effect the effectiveness of the intervention, or the compliance associated with it.

Research has suggested that smokers are dissuaded from using NRT if they have to pay a monetary price for it,[45,46] and this suggests that the prescription charge in the UK may decrease the number of smokers who attempt to quit smoking.
The second factor is likely to be mainly driven by compliance, but patient motivation could also be a factor. Patient motivation could be linked to the placebo effect whereby patients who think they are being treated believe they have experienced an improvement in their condition. Given this, it also seems possible that a patient may experience a more beneficial effect from a treatment if they have paid for the treatment and so have a greater belief that it should work. Studies focussing on patients who have paid for a treatment compared to those who did not pay would be interesting to inform this issue.

Whether or not these factors are relevant for a large number of other treatments, the literature does seem to suggest that they are relevant for NRT. Considering the proportion of people who smoke and the long term health costs that can be saved by quitting smoking it seems important to take these factors into account when considering the cost effectiveness of the intervention. This is particularly the case when this analysis suggests that NRT could be better provided under a different financing mechanism than the current situation – leading to substantial health gains in the future, and possibly creating large cost savings for the NHS in the long term.

45 Ong MK. and Glantz SA. (2005) Free Nicotine Replacement Therapy Programs vs Implementing Smoke-Free Workplaces: A Cost-Effectiveness Comparison, American Journal of Public Health 2005; 95; 6: 969-975

46 Curry SJ, Grothaus LC, McAfee and Pabiniak C. Use and cost effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. The New England Journal of Medicine 1998; 339; 10: 673-679

## Further Research

Our analysis has shown how the most important parameters within our model are those that dictate the relationship between demand for NRT and the price of treatment, and the relationship between the likelihood of quitting and price. Further research into these relationships in reality would be of great interest for informing the assumptions used in this model.

Given that this paper advocates no prescription charge for NRT it would be useful to consider other treatments subject to the charge that may be sensitive to price.

## Conclusions

This paper has outlined that under reasonable assumptions it appears that it would be cost effective to not require a charge to be paid on prescriptions for NRT. This is controversial, but raises important questions for the rationale of including cost effectiveness analyses in health care decision making. If the most cost effective decisions are to be made, all factors that impact upon the cost effectiveness of an intervention should be included. In the case of NRT it therefore seems sensible to include financing mechanisms in CEAs.

In demonstrating the importance of including different financing mechanisms in a CEA for NRT, this paper presents an argument that financing mechanisms should be taken into account in any CEA evaluating an intervention which has an effect that can be altered by patient motivation or compliance, or where consumption of the treatment may be affected by having to pay a copayment. This adds another step to CEA – extending the analysis from one of the costs and effects of the intervention, to one that considers how these costs and effects might be altered by different financing mechanisms. This analysis is intended to provide an illustration of how different financing mechanisms might influence the cost effectiveness of interventions.