

12 Appendix B. The cost effectiveness of opportunistic case finding in primary care

Background

The GDG was interested in the issue of opportunistic case finding of COPD in primary care.

Since the BTS guidelines were published in 1997²⁵, the use of spirometry has become more widespread in primary care. Spirometry can be used to detect the presence of airflow obstruction in a patient. At present, the mean age of detection of COPD in the UK is 55, as by this time the patient usually presents with symptoms. Use of spirometry can detect the presence of airflow obstruction earlier, even if no symptoms are present.

It is well known that the biggest factor that can have an impact on disease progression is smoking cessation^{46;482}. Smoking cessation can alter length of life and quality of life and the earlier smoking cessation is achieved, the greater the effect⁵⁴. Patients detected at age 55 are encouraged to quit smoking as it can alter their disease progression. If COPD were detected earlier, patients could be referred to smoking cessation programmes with an added incentive of extra benefit.

Smoking cessation has a greater effect if it is achieved earlier in life, therefore the advantages of detecting people with airflow obstruction earlier are three fold:

1. Additional life years saved.
2. Quality of life gain
3. A greater incentive to quit (as they have been diagnosed at an earlier stage of their disease, they can be told that they can make a difference if they quit smoking).

A recent study by van Schayk et al⁴⁰ found that in a population with the following characteristics; age over 35, smoker/ex smoker and a chronic cough, 27% of people had airflow obstruction when tested using spirometry.

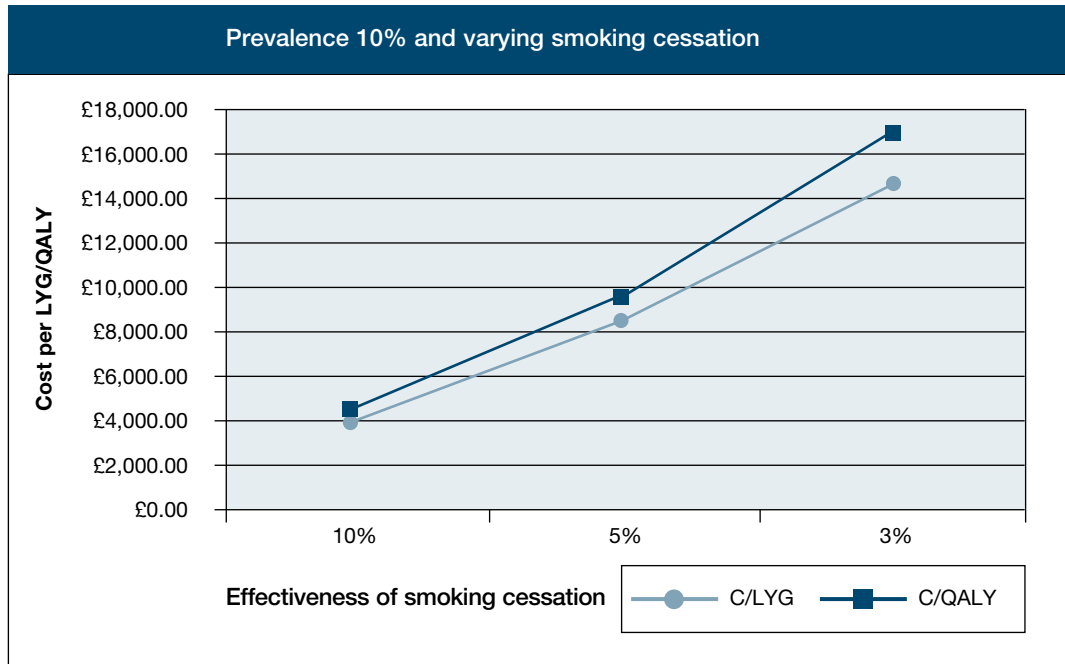
If a policy of opportunistic case finding by spirometry in primary care was followed, the results of the van Schayk study suggest that there would be a reasonably high yield. These patients could then be targeted with an intensive smoking cessation programme.

This is associated with a substantial resource input from primary care, both in terms of the time and equipment used in spirometry and the subsequent cost of smoking intervention programmes.

The GDG was interested in the cost effectiveness of this strategy, based on the results of the van Schayk study. They were interested in whether the extra resources involved in testing for airflow obstruction and the subsequent intervention of smoking cessation was worth the additional expected benefits. A simple cost effectiveness model was therefore built to look at this issue.

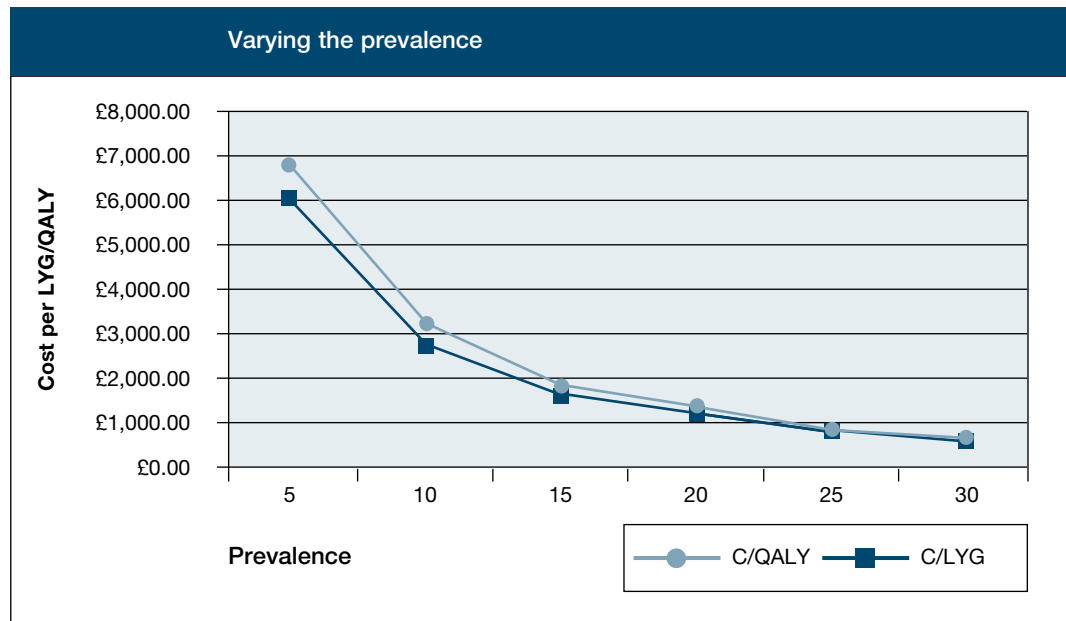
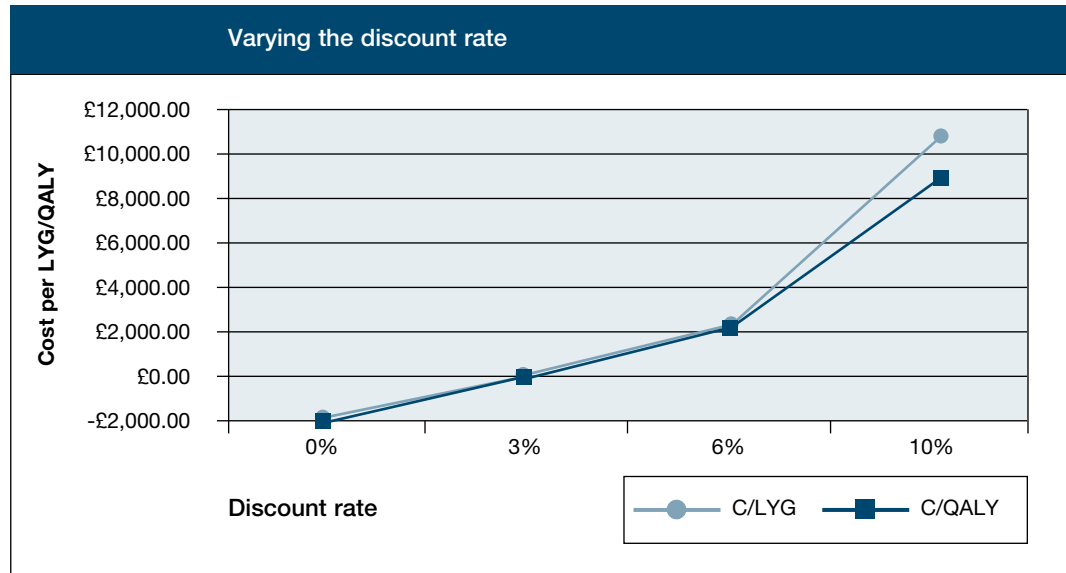
Appendix B.2

Varying the smoking cessation rate when the prevalence is 10%

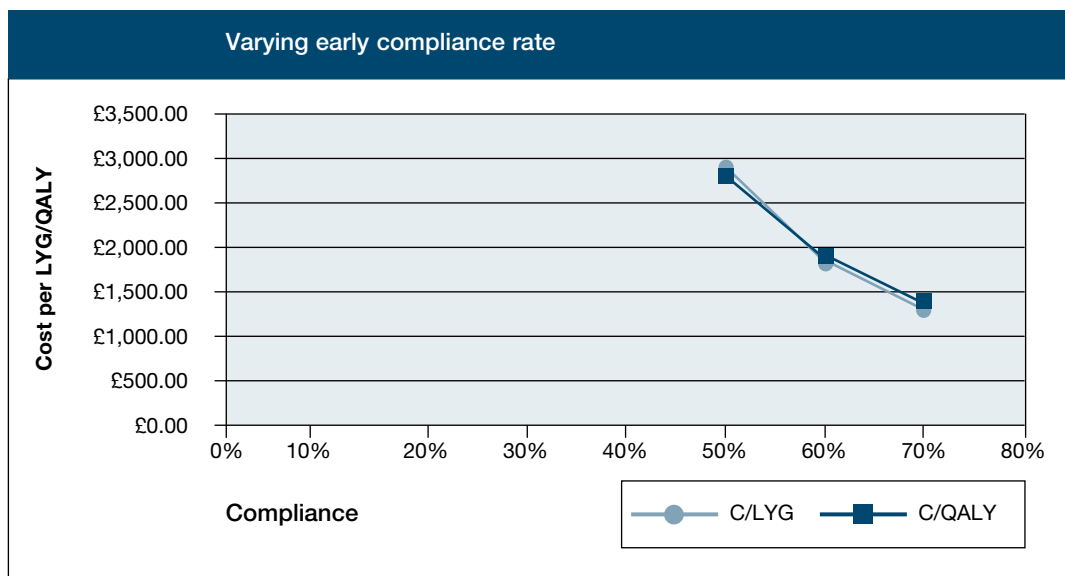
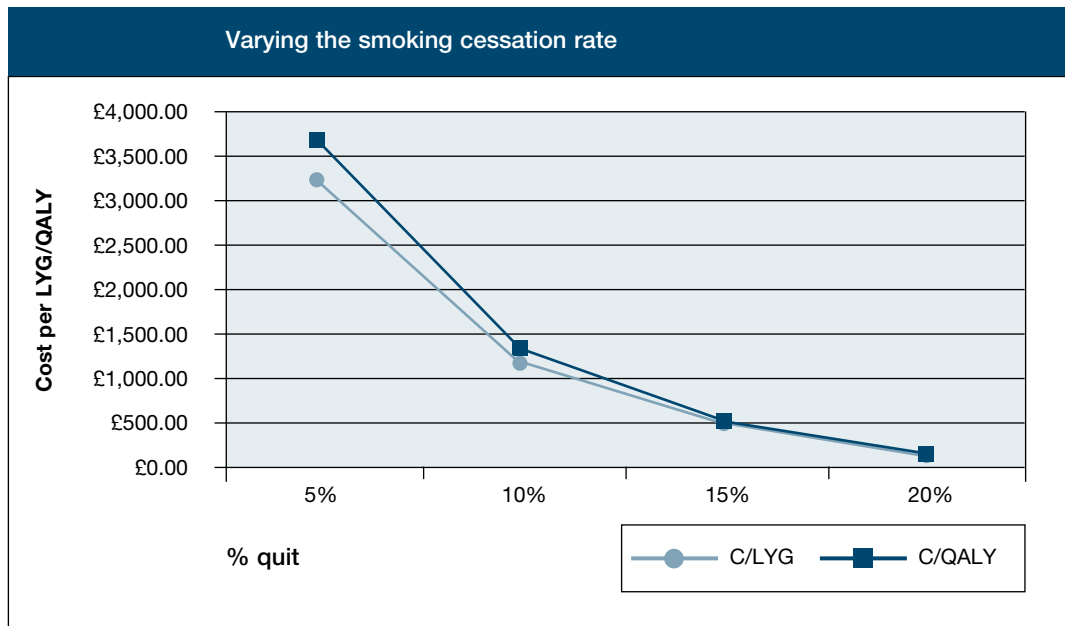


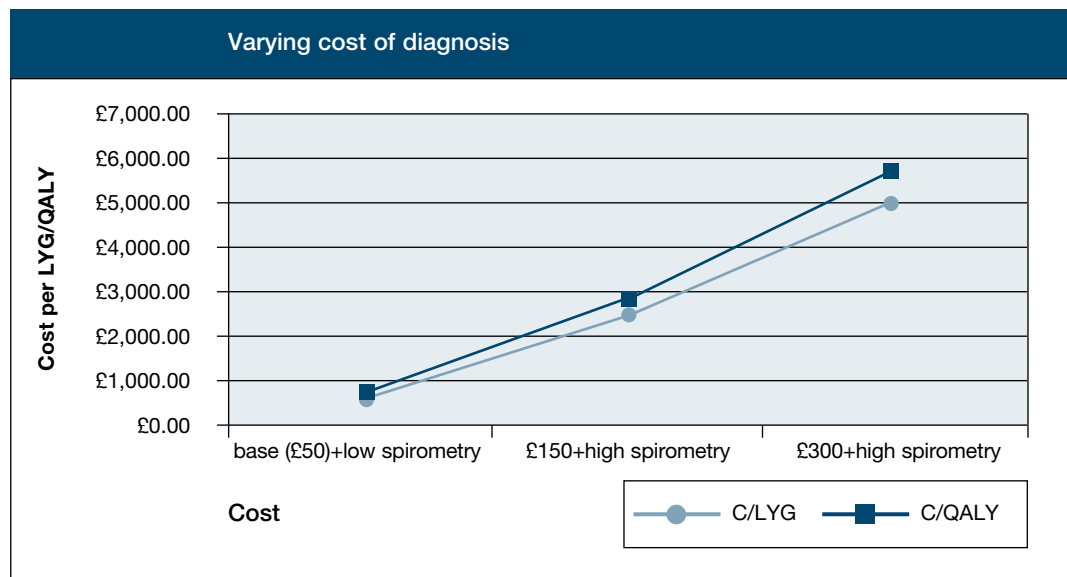
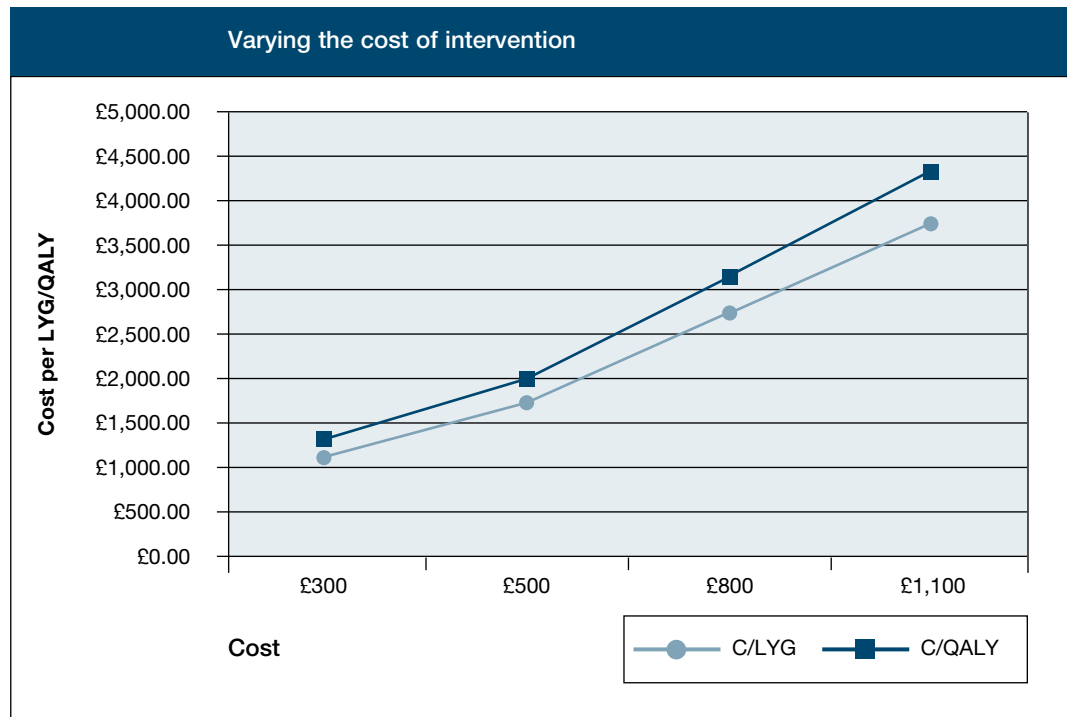
Appendix B.1

One-way sensitivity analysis



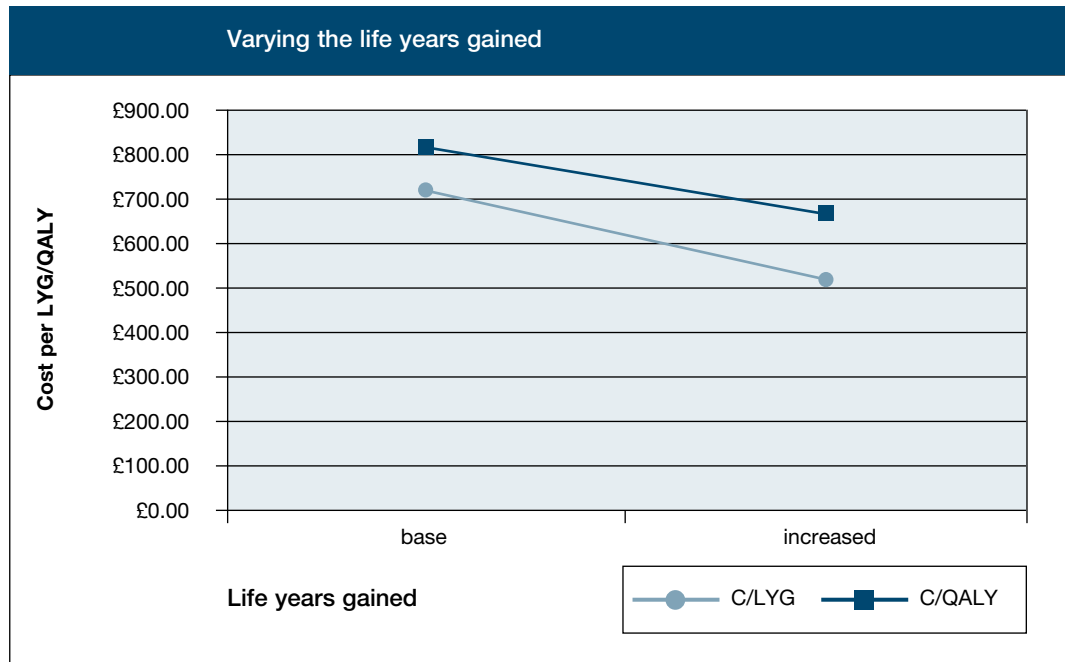
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Appendix B.3

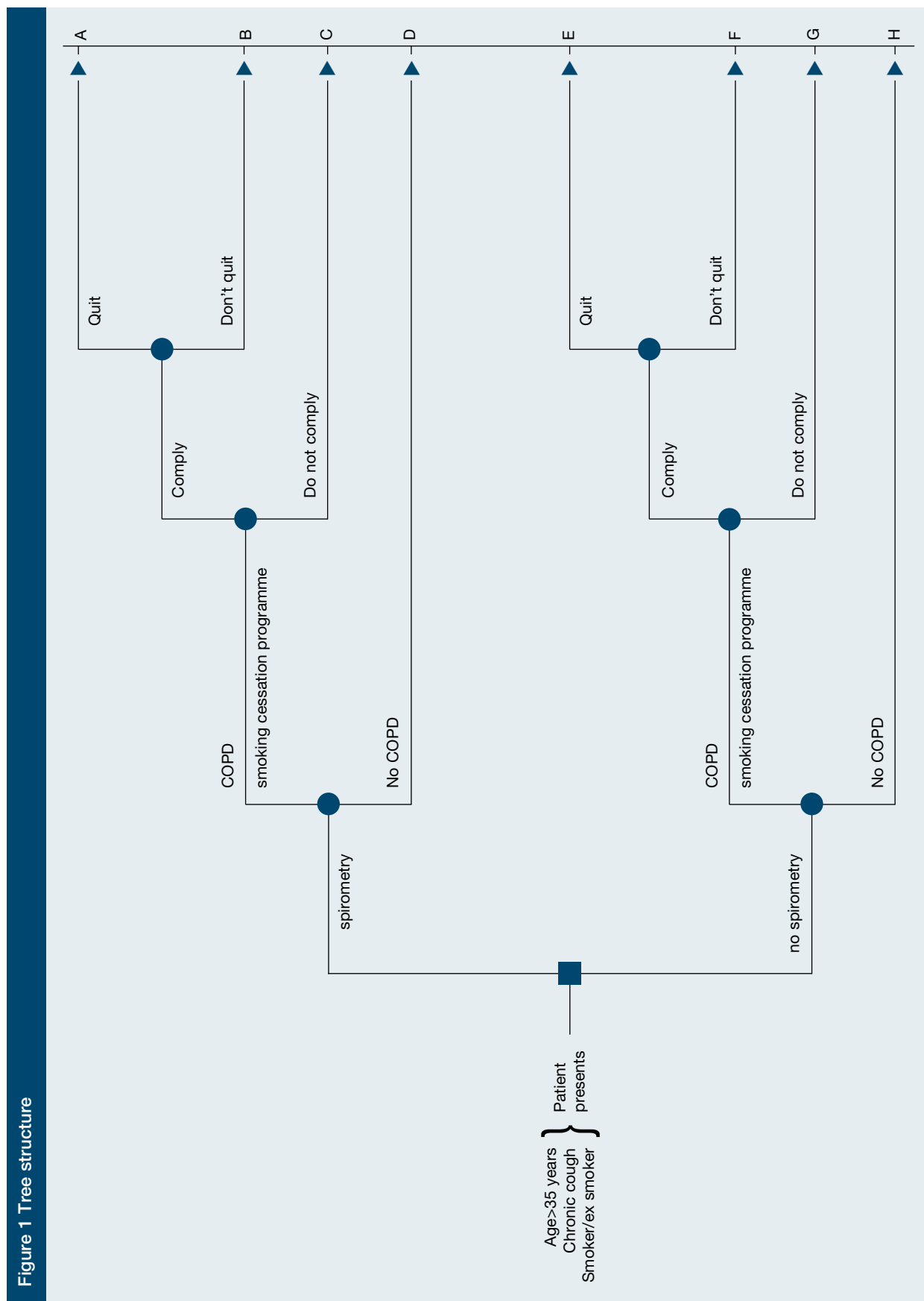
Varying the life years gained



Where 'base' is baseline parameter values of 3.5 years gained if quit smoking at age 46 and 2.1 years gained if quit smoking at age 55.

'Increased' is altering the life years gained to 5.5 years gained if quit smoking at age 46 and 3.5 years gained if quit smoking at age 55.

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Aim

The aim was to compare the costs and benefits of opportunistically testing patients who present at the GP with the following characteristics; age over 35, smoker/ex smoker, chronic cough, with the costs and benefits of current practice. The cost per life year gained and the cost per quality adjusted life year (QALY) gained were calculated.

Methods

A cost effectiveness model was built from the perspective of the NHS. A simple decision tree was constructed which outlined the pathways of the alternative options (see figure 1). A decision node is indicated by a square and a circle indicates a chance node. Each of the 8 pathways is labelled with a letter, from A to H, at the end of each pathway.

The primary outcome measure used was life years gained and the primary outcome of the model is the cost per life year gained. The use of life years gained as the primary outcome measure may not capture all the benefit, as there is likely to be a quality of life improvement if the disease progression is slowed down. A secondary outcome measure for the model is therefore quality adjusted life years (QALY) gained and the cost per QALY is calculated.

For each of the 8 pathways (A-H) of the model, the total costs, life years and quality adjusted life years were calculated. The data sources and assumptions used in calculating these are described in more detail below. The expected cost, life years and quality adjusted life years were then calculated for each arm of the decision node (opportunistically case find or don't opportunistically case find). Costs were discounted at 6% and benefits at 1.5% in line with current NICE recommendations. The incremental cost per life year saved and the incremental cost per QALY were then calculated as follows.

$$\text{Incremental cost per life year gained} = (C_1 - C_2) / (Y_1 - Y_2)$$

$$\text{Incremental cost per QALY} = (C_1 - C_2) / (Q_1 - Q_2)$$

- Where
- C_1 = Expected cost of opportunistic case finding
 - C_2 = Expected cost of not opportunistic case finding
 - Y_1 = Expected life years if opportunistically case find
 - Y_2 = Expected life years if don't opportunistically case find
 - Q_1 = Expected quality adjusted life years if opportunistically case find
 - Q_2 = Expected quality adjusted life years if don't opportunistically case find

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Data sources and assumptions

The table below lists the baseline values used in the model along with the data sources or assumption where appropriate. More details are provided on the methods of calculating each of these values below.

Life expectancy	Baseline value	Source
A	74.5	Fletcher C (1977) ⁴⁸² and HTA (2002) ⁵⁴
B	71	Fletcher C (1977) ⁴⁸² and HTA (2002) ⁵⁴
C	71	Fletcher C (1977) ⁴⁸² and HTA (2002) ⁵⁴
D	79.73	Life tables (http://www.gad.gov.uk/Life_Tables/Interim_life_tables.htm)
E	73.1	Fletcher C (1977) ⁴⁸² and HTA (2002) ⁵⁴
F	71	Fletcher C (1977) ⁴⁸² and HTA (2002) ⁵⁴
G	71	Fletcher C (1977) ⁴⁸² and HTA (2002) ⁵⁴
H	79.73	Life tables (http://www.gad.gov.uk/Life_Tables/Interim_life_tables.htm)

Probabilities	Baseline value	Source
COPD	0.27	van Schayck (2002) ⁴⁰
No COPD	0.73	van Schayck (2002) ⁴⁰
Success of smoking cessation if early	0.1305	HTA (2002) ⁵⁴
Failure of smoking cessation if early	0.8695	HTA (2002) ⁵⁴
Success of smoking cessation if late	0.1305	HTA (2002) ⁵⁴
Failure of smoking cessation if late	0.8695	HTA (2002) ⁵⁴
Compliance with smoking cessation if early	0.9	Assumption
Non concordance with smoking cessation if early	0.1	Assumption
Compliance with smoking cessation if late	0.5	Assumption
Non concordance with smoking cessation if late	0.5	Assumption

Cost	Baseline value	Source
Incremental cost p.a. for mild COPD	£159.63	Britton et al 2003 ¹³
Incremental cost p.a. for moderate COPD	£328.21	Britton et al 2003 ¹³
Incremental cost p.a. for severe COPD	£1,394	Britton et al 2003 ¹³

Cost	Baseline value	Source
Cost of spirometry test in GP practice	£9.91	From estimates provided by GDG
Cost of intensive smoking cessation programme	£171.49	HTA (2002) ⁵⁴
Other diagnosis costs	£50	Assumption

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Utility	Baseline value	Source
Mild	0.6102	Data from Harper et al (1997) ⁴⁸³
Moderate	0.5659	Data from Harper et al (1997) ⁴⁸³
Severe	0.5428	Data from Harper et al (1997) ⁴⁸³
Non COPD	1	Assumption

Explanation of assumptions and data used

Probability of airflow obstruction

The probability of having COPD was taken to be 27% (the same as the van Schayk study⁴⁰). The mean age of this sub group of smokers who have a chronic cough was ⁴⁶ (van Schayk, personal communication). This was used as the basis for calculating life expectancy as this is the average age of the population being tested.

The mean age of detection of COPD was provided by the GDG group as 55 years old.

Life expectancy and time spent in each stage of the disease

As well as estimating the life expectancy of each pathway, the years spent in each state of the disease (mild, moderate, severe) was estimated. This was to allow more accurate calculations of the cost of care and quality of life.

Data on the natural history of COPD is very limited. A paper by Fletcher and Peto⁴⁸² looked at the natural history of chronic airflow obstruction in a prospective study on London working men. They looked at the decline of % of predicted FEV₁ over a lifetime for a smoker, a non smoker/not susceptible to smoke, a smoker who stops at age 45 and a smoker who stops at age 65. These were the only data available and it should be noted that this was a highly selective population.

The definitions for severity of COPD recommended in this guideline are:

Mild: <80 % predicted FEV₁

Moderate 50-80 % predicted FEV₁

Severe <30% predicted FEV₁

Fletcher and Peto plot a graph of FEV₁ as a percentage of predicted value at age 25 against age in Figure 1 of their paper⁴⁸². Using this and the above classification for disease state, the time spent in each disease state in years and total life expectancy was read off from the graph for a smoker who does not quit.

The graph also shows the FEV₁ curve for a smoker who stops at age 65. The cost effectiveness model requires data on a person who quits at age 55. An assumption was made that the FEV₁ curve for this would be midway between the 45 year old and the 65 year old at the same rate of decline.

The age of death for a smoker who does not quit was read to be 71 from the graph.

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Data from an HTA report (2002 pp51) ⁵⁴ gives the gain in life years for someone who quits smoking at age 45-54 as 3.5 years (undiscounted) and for age 55-64 as 2.1 years (undiscounted).

The life years gained for a 45 and 55 year old were assumed to be 3.5 and 2.1 respectively. This is potentially underestimating the benefit. The years spent in each state were then read off the Fletcher and Peto graph for each of these alternatives.

The life expectancy of a smoker who does not have COPD (or is not susceptible) was estimated using life tables for a 46 year old today. (http://www.gad.gov.uk/Life_Tables/Interim_life_tables.htm)

Men and women's life expectancy was combined and divided by 2. (This may be an overestimate as even though they are not diagnosed with COPD, they are still at a greater risk for other diseases).

The life expectancy was estimated as 79.73. From the Fletcher and Peto graph, a person who has never smoked or is not susceptible to smoke has mild airflow obstruction at age 62. They therefore spend $79.73 - 62$ years = 17.73 years in the mild state. Although this is a very crude method, this was the best data available at the time.

Compliance

This was estimated to be 90% if detected at age 46 and 50% if detected at age 55. This was an assumption and different rates will be tested out in the sensitivity analysis.

Success of the intervention (smoking cessation)

This was taken as 0.1305 and was taken from the HTA report ⁵⁴. The quit rate was assumed to be the same for both a 46 year old and a 55 year old. A study by Risser and Belcher⁴² looked at whether giving patients information about their pulmonary status provided enhanced motivation to quit. Although not statistically significant from the control group, 20% of patients had CO validated cessation at 12 months when assuming loss to follow up to be smokers. Although not a long term quit rate, this figure will be used in the sensitivity analysis.

Costs

All costs are for the year 2000/01

Cost of spirometry

The cost of spirometry was estimated using data provided by a member of the GDG.

Equipment cost for a spirometer was given as £300-£1500 with a useful lifetime of 5 years. Maintenance and consumables cost £200 p.a. It takes a practice nurses 10 minutes to carry out the test and spirometry is carried out approximately 1-10 times per week. Assuming a practice nurse salary is £27 per hour⁴⁸⁴ and a 6% discount rate and not paid in arrears for calculating the annual equivalent cost for the spirometer, the cost per test was estimated as £9.91. The minimum cost was estimated as £5.01 and the maximum cost as £14.81.

Diagnosis costs

When a patient is diagnosed, there are other procedures recommended in the guideline to be carried out. They are:

- chest radiograph
- assessment of breathlessness
- full blood count
- BMI calculated.

The cost of these is assumed to be £50, as time constraints did not permit detailed costing of these. This figure was tested out in the sensitivity analysis.

Intervention

The cost of the intervention (smoking cessation programme) was taken from the HTA report⁵⁴. It is the lifetime quit rate for a package of counselling, NRT and bupropion SR. The same intervention is given to patients whether they are 45 or 55 at the time of diagnosis.

Cost of care

As the model is taking a lifetime perspective, the costs of care for each year alive are included for each pathway.

For COPD, the cost of care each year is taken by using data by Britton¹³ on the costs for mild, moderate and severe COPD and multiplying it by the time spent in each state. It is assumed that patients not diagnosed until the age of 55 still occur the costs of their underlying disease, however this will be tested in the sensitivity analysis.

For non COPD costs of care, no cost is applied apart from the years in mild disease, as the COPD cost from the Britton data¹³ is taken to be the incremental cost of having COPD (i.e. the cost over and above the cost of a non COPD person to the NHS). For the years in mild, the cost of mild COPD is assumed. The paper by Britton asks patients about their resource use to do with their COPD, giving more weight to this assumption. Patients with severe COPD are approximately 8 times more expensive p.a. than patients with mild COPD. By slowing the progression of the disease, patients will be in the milder state for longer, therefore reducing the costs.

QALYs

There is extremely limited data available for generating QALYs for COPD health states. Data was obtained from a study comparing outcome measures in COPD⁴⁸³. One of the outcome measures used was the SF-6D which is a preference based measure of quality of life and can be used to estimate QALYs as each health state generated is associated with a utility value. In the study, SF-6D values were collected as well as % predicted of FEV₁. Using the classification of disease severity recommended in this guideline, a mean SF-6D score was calculated for mild, moderate and severe COPD. This data must be treated with caution, as it has not been adjusted for anything. The mean SF-6D utility was multiplied by the number of years spent in each state to give the total number of QALYs. Area under the curve was not used to calculate the QALY gain. Instead, the patient was assumed to stay at the utility level of the mild state for all the years

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they were in the mild state until they reached the moderate state. The utility value for a non COPD person was assumed to be 1.

Discounting

Benefits (life expectancy and QALYs) are discounted at 1.5% in line with current NICE recommendations and costs are discounted at 6%. Sensitivity analysis will examine the effects of using rates of 0% for both, 3% for both 6% for both and 10% for both.

General assumptions of the model

Those who present and have spirometry, with a result of no airflow obstruction, would usually be offered brief smoking cessation advice from the GP. As the lifetime cessation success rate is small (0.018)⁵⁴ and there is unlikely to be an incentive due to them receiving a 'clear' diagnosis, and the cost of this intervention (estimated at £3.53⁵⁴ is small, this has been excluded from the model, in order to keep the model simple.

The mean age of the van Schayk cohort was 46. The Fletcher and Peto graph shows the decline in lung function of a person who quits at age 45. This decline is assumed to be the same as for a 46 year old for the model, as there is only 1 year of difference.

Results

The results of the model using baseline values are shown below.

Opportunistically case finding	
Life expectancy	25.25
QALYS	19.36
Cost	£1,731.83

Not opportunistically case finding	
Life expectancy	25.20
QALYS	19.32
Cost	£1,696.33

Incremental life expectancy	0.050
Incremental QALYs	0.044
Incremental cost	£35.49

Incremental cost effectiveness ratio (ICER)	
Cost per life year gained	£713.16
Cost per QALY	£814.56

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Under the base case analysis, the cost per life year gained is £713.16 and the cost per quality adjusted life year gained is £814.56. Under current decision making conditions, this is a very favourable cost effectiveness ratio.

Sensitivity Analysis

As the model is subject to much uncertainty due to the many different data sources and the uncertainty associated with these, one way sensitivity analysis was carried out on key parameters. One way sensitivity analysis varies one parameter at a time whilst keeping the other parameters at their baseline values.

The main parameters of the model were varied one at a time to examine the effect on the model results. Parameters varied were the discount rate, the prevalence of COPD, smoking cessation success rate, concordance with smoking cessation programme if diagnosed early, cost of diagnosis and the cost of the intervention.

The parameters were varied between the following ranges as these were thought to be plausible or were guided by the literature.

Parameter	Range			
Discount rate of costs and benefits	Both 0%	Both 3%	Both 6%	Both 10%
Prevalence of COPD	5%	10%	20%	35%
Smoking cessation success rate	3%	5%	10%	20%
Compliance for early diagnosis	50%	60%	70%	
Cost of diagnosis	Base+low spirometry	£150+high spirometry	£300+high spirometry	
Cost of the intervention	£300	£500	£1,000	

Appendix B.1 shows the results of the 1 way sensitivity analysis. The costs per life year gained/QALY are plotted against the different values of the parameter being varied.

The results are fairly sensitive to the discount rate, as increasing benefits to be in line with costs at 6% gives a cost per LYG of £2,261.59 and a cost per QALY of £2,219.26. Increasing both discount rates to 10% gives a cost per LYG of £10,770.89 and a cost per QALY of £8,935.03.

Decreasing the prevalence (or proportion who are found to have airflow obstruction when tested) reduces the cost effectiveness, however even at 5%, the cost per life year gained is £6,009.59 and the cost per QALY is £6,864.04 which would still be considered to be reasonably cost effective.

The results are fairly sensitive to the smoking cessation rate. Altering the early smoking cessation rate to 20%⁴² and leaving the later quit rate at the baseline value of 0.1305 gives a cost per LYG of -£23.30 and a cost per QALY of -£27.76. These are both dominant cases, in that the intervention increases the benefit and decreases the cost (graph not shown).

Altering both smoking cessation rates to just 5% gives a cost per LYG of £3,246.21 and a cost per QALY of £3,707.76.

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Reducing the concordance rate to 50% for patients diagnosed early gives a cost per LYG of £2,945.18 and a cost per QALY of £2,833.34.

The results are sensitive to the cost of the intervention (smoking cessation programme). When the cost of the intervention is increased to £1,100, the cost per LYG increases to £3,755.82 and the cost per QALY increases to £4,289.83.

Finally, the cost of diagnosis was varied. The cost of the other tests was increased to £300 and the highest value for the spirometry test was used. This gave a cost per LYG of £5,016.15 and a cost per QALY of £5,729.34.

In order to test out the assumptions of the model further, the prevalence rate was lowered to 10% and the percentage who quit smoking was varied from 3-10%.

The results of this are shown in Appendix B.2.

At a smoking cessation rate of 3%, the cost per LYG is £14,885.41 and the cost per QALY is £17,001.82.

The life years gained by quitting smoking at age 46 and 55 was taken from the HTA report⁵⁴. The life years gained for a person who quits at age 35-44 is 5.5, age 45-54 is 3.5 and age 55-64 is 2.1.

The benefit used for a 46 year old was taken to be 3.5 and for a 55 year old, 2.1. Altering this assumption and giving a benefit of 5.5 years to the 46 year old quitter and 3.5 years to the 55 year old quitter does not make a big difference to the model results. The results are shown in Appendix B.3. The cost per life year gained decreases to £510.94 and the cost per QALY decreases to £661.31

The assumption that a patient undiagnosed until 55 incurs costs of care the same as those with a patient with mild COPD is perhaps unrealistic as they will not be receiving treatment. They may still incur some costs, for example more frequent visits to the GP, or be given treatment for mild symptoms. To test this assumption, the model was recalculated assuming 0 costs of care until diagnosis. This gave a cost per LYG of £6,567.43 and a cost per QALY of £7,501.19 (graph not shown).

Discussion

Even when conservative assumptions are applied, opportunistic case finding is a relatively cost effective strategy compared to current practice, in the current climate of current decision making.

This model is a simplistic version of real life and is built using many data sources and assumptions. The results are fairly sensitive to changes in parameters. Key parameters are the prevalence and the smoking cessation rate.

This model also assumes that spirometry has 100% sensitivity and specificity and is carried out by staff who are trained and competent in its use and interpretation. This is not the status quo at present and not every practice has a spirometer. Things are changing however, especially since the publication of the BTS guidelines in 1997.

In order to improve the model, better data on the natural history of the disease, especially in relation to smoking cessation and quality of life would be desirable.

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The Fletcher and Peto diagram gives the % predicted values for a 25 year old. This would be different for a 46 year old. This means that the benefit has been underestimated in this model, which would decrease the cost effectiveness ratios.

The utility weights used were also from a small sample of patients in a different study. There is a lack of utility data for COPD as most studies tend to use disease specific based measures rather than preference based measures. This is a simple deterministic model and better data would help to build a more sophisticated model.

Conclusion

In summary, opportunistic case finding in primary care is a relatively cost effective strategy, subject to the assumptions outlined above. Key parameters are the prevalence of COPD that is undetected and the smoking cessation success rate. It should be noted that the model is quite sensitive to some of the parameters and there are many assumptions. Therefore, the results must be interpreted with this in mind.



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