**Instructions for Exercise 8: Costs and Health Effects**

**Revised September 2020**

**Preliminary Notes**

1. The training exercise materials are available here: <https://www.york.ac.uk/che/research/equity/handbook/>
2. There are three relevant spreadsheets: “Ex 8 – student”, “Ex 8 – student short” and “Ex 8 – solution”. The full exercise in the student file takes about an hour; the short version only takes about half an hour. Please open the relevant version and go through the worksheets filling in the relevant cells yourself. You can look at the solution file if you get stuck.
3. When the spreadsheet is first opened a ‘Security Warning’ may be displayed below the menu bar.  Select ‘Enable this content’.
4. This exercise was produced for the Handbook of Distributional Cost-Effectiveness Analysis by Colin Angus and edited by Richard Cookson, with help from James Love-Koh and James Lomas.

## **Introduction to the exercise**

The aim of this exercise is to model the distribution of lifetime health effects and healthcare costs for the following three options for funding Nicotine Replacement Therapy in England:

1. No Public NRT: do not provide any public subsidy for nicotine replacement therapy
2. Universal NRT: offer free nicotine replacement therapy to all smokers
3. Proportional Universal NRT: Universal NRT with additional resources to encourage uptake in disadvantaged communities

Nicotine Replacement Therapy (NRT), consisting of nicotine patches, gum, tablets, lozenges, spray or an inhaler, is an effective and cost-effective aid to smoking cessation. Both smoking prevalence and the use of NRT vary with both geography and socioeconomic status (SES) and there are also socioeconomic gradients in the long-term effects of giving up smoking. Full details and data sources are provided in Chapters 5 and 8 of the handbook.

The basic structure of the model is a simple decision tree in which smokers may attempt to quit smoking, for which they may use public, private or no NRT, they may be successful in the short-term, and of those who succeed, they may relapse in the longer-term. The basic structure of the model is illustrated in Figure 1.



**Figure 1: Steps in the calculation of long-term quit rates**

For each option, we model one year of intervention, with a lifetime follow-up. We assume that the total number of smokers attempting to quit in each scenario is constant. We also assume that the number of smokers attempting to quit who pay for NRT over the counter is the same. Each scenario therefore differs only by moving smokers attempting to quit without NRT onto publicly funded NRT or vice versa. In option 1, we assume no public NRT is provided. In option 2, we model public NRT provision based on actual data from 2010. In options 3, we assume that the National Health Service invests an additional £15million on a programme to encourage increased NRT usage among more deprived groups, particularly in the north of the country.

The assumed effect of this programme on prescription NRT usage is shown in Table 1.

**Table 1: Assumed increased in NRT usage under**

**Scenario 3: Proportional Universal NRT**

|  |  |
| --- | --- |
|  | Increase in public NRT usage |
| South | Lowest | 40% |
| SES2 | 20% |
| SES3 | 0% |
| SES4 | 0% |
| Highest | 0% |
| North | Lowest | 50% |
| SES2 | 30% |
| SES3 | 10% |
| SES4 | 0% |
| Highest | 0% |

The outcomes you will be calculating in this exercise are:

* The total lifetime NHS costs associated with each scenario
* The total lifetime Health-Adjusted Life Years (HALYs) associated with each scenario
* The distribution of HALY gains across the population

The distribution of HALY gains will be assessed across 10 health groups, determined by geography (North of South of England) and SES (five groups from 1 (lowest) to 5 (highest)).

You have been provided with a starter model, which includes all of the key information you will need to complete this exercise. Where appropriate this information is stratified by SES, or by SES and geography. Where the input data is not stratified, you should assume it is the same for the entire population (e.g. where inputs are stratified by SES only you should assume they are the same for that SES group in both geographic groups).

## **Getting started – full exercise**

Open the file ‘*Ex 8 – student file’*. After the <Title Sheet>, the <Inputs 1> and <Inputs 2> worksheets contain all the input data required to build and populate the model – including estimates of baseline health-adjusted life expectancy by social group drawn from Exercise 7.

The <Quit Calcs> sheet is your first task. Here you will calculate the rates of successful long-term quitters under each option. In the <Costs and Effects> sheet you will then convert these into long-term costs and health effects. In the <CEA> sheet you will perform a standard cost-effectiveness analysis, with findings displayed in a cost-effectiveness plane. In the <Dist Table> sheet you will summarise the distributional findings in a table, with findings displayed in a bar chart in the <Dist Fig> sheet.

## **Getting started – short version**

Open the file ‘*Ex 8 – short version’*.After the <Title Sheet>, the <Inputs 1>, <Inputs 2> and <Quit Calcs> worksheets contain all the input data required.

The <Costs and Effects> sheet is your first task. You will take data on long-term quit rates from the <Quit Calcs> sheet and convert them into long-term costs and health effects. In the <CEA> sheet you will perform a standard cost-effectiveness analysis, with findings displayed in a cost-effectiveness plane. In the <Dist Table> sheet you will summarise the distributional findings in a table, with findings displayed in a bar chart in the <Dist Fig> sheet.

**Step-by-step instructions**

**NB For the Short Version please skip steps a) to c) and start at step d).**

1. **Deriving the baseline population**

Open the <Quit calcs> worksheet to begin the exercise. You will see three (incomplete) tables of output data, one for each programme option. Your first task is establish the size of the population who stand to benefit – i.e. current smokers who are attempting to quit. Use the population data from the <Inputs 1> sheet to populate the ‘Adult population’ and ‘Smokers’ columns for the ‘Programme 1: No NRT’ option. The cells that you should populate for this part, B5:C16, are shaded orange. Once populated, these orange cells should now show the total number of smokers in England in each of the 10 socioeconomic groups. Once you have done this, you will see that the corresponding grey cells in the data tables for the other 2 options below have automatically updated with the same values. Next, use the data on the proportion of smokers who attempted to quit in the past year to populate the total number of quit attempts (in a year) in the <Quit Calcs> sheet cells D5:D16. Again, this is constant across all options.

1. **Estimating NRT usage**

Unlike the baseline populations, NRT usage will differ between the three options. We need to think carefully about how to use the data on NRT usage from the <Inputs 1> worksheet to populate the cells in columns E, F, G and H.

1. Universal NRT

The data on public/private NRT usage in the <Inputs 1> sheet relates to a time in 2010 when NRT was available publicly for free on prescription, as well as privately over the counter; which is equivalent to ‘Programme 2: Universal NRT’. Therefore, for this programme only: starting in the ‘Total NRT quit attempts’ column (column G), and using the data for the use of NRT in the last quit attempt, calculate the total number of those quit attempts which used NRT (column G), and then use the provided data on the proportion of NRT usage on prescription to partition these attempts between prescribed (column E) and over the counter NRT (column F). Finally, calculate the number of non-NRT quit attempts (column H). The remaining parts in b) relate to estimating these quantities for programmes 1 and 3.

1. Over the counter NRT

For programmes 1 and 3, the number of quitters using over the counter NRT is the same as programme 2. Therefore set these cells for programes 1 and 3 (cells F5:F16 and F35:F46, respectively) equal to the corresponding cells for scenario 2 (cells F20:F31).

1. Use of prescription NRT

For programme 1, there is no public NRT, so you can enter zero use of prescription NRT in cells E5:E16. For programme 3 the use of prescription NRT is higher than programme 2 in more deprived groups, as detailed in cells H21:K30 in the <Inputs 1> sheet.

1. Non-NRT quit attempts

For all programme options we now have the total number of NRT quit attempts (whether prescribed or purchased over the counter) for each group and, since we know the total number of quit attempts, we can also calculate the total number of non-NRT quit attempts for programmes 1 and 3 in column H.

1. **Modelling the success of quit attempts**

For all programmes, the process for calculating the number of successful long-term quitters is the same. The cells in columns I to M have automatically been calculated for you for programmes 1 and 2. It now remains to calculate these quantities for programme 3. You can have a look at the formulae for how these have been calculated for programmes 1 and 2 if you wish.

1. Successful NRT quitters at 12 months

Calculate the number of people who successfully quit after 12 months in each group using NRT in cells I35:I46. For each NRT quit attempt, the quit success probability is the quit success probability without NRT (which varies by the 5 deprivation groups and is given in cells D4:D8 of the <Inputs 2> worksheet) multiplied by the Relative Risk for NRT use (which is fixed, cell B4 of the <Inputs 2> worksheet).

1. Successful non-NRT quitters at 12 months

Next, calculate the number of people in each group who successfully quit without using NRT in <Quit Calcs> cells J35:J46.

1. Total quitters at 12 months, relapsers and long-term successful quitters

Then calculate the total 12-month quitters in cells K35:K46 by adding up NRT and non-NRT quitters. Then, using the given relapse rate, calculate the number of 12-month quitters in each group who subsequently relapse in cells L35:L46. We now estimate the number of adults in each group who successfully give up smoking in the long term in column M by subtracting the number of relapsers from the number of successful quitters at 12 months. Refer to Figure 1 to see how your calculations correspond to the decision model structure.

1. **Calculating costs and health effects**

We include all long-term quit successes in this calculation of NHS costs and health effects, including private NRT and non-NRT quit successes as well as public NRT quit successes. This is because all three types of NRT quit success vary across the programmes. The <Inputs 2> sheet already tells us the incremental individual-level healthcare costs and HALY gains for each long-term quitter compared to those who continue to smoke. From a population-level perspective we need to know the number of courses of NRT publicly provided on prescription and the total number of smokers who successfully quit in the long-term (including private NRT and non-NRT quit successes). These have been automatically linked in your spreadsheet from columns E and M in <Quit Calcs>, respectively, to columns C and D in the <Costs and Effects> sheet.

You first need to calculate the overall NHS cost of public NRT delivery for each programme. This cost is made up of three components – the cost of the appointment to prescribe it, the cost of dispensing it and the cost of the NRT itself. Now, using the incremental long-term NHS savings per quitter from the <Inputs 2> sheet, calculate the long-term NHS saving from successful long-term quitters, which differs according to socioeconomic status. From these two cost columns, calculate the net cost to the NHS of each programme, remembering to treat costs and savings appropriately. For programme 3, you should also include the £15m cost of the targeting intervention from the <Inputs 2> sheet in the population total cost when calculating the total net NHS costs in cell G46.

Finally, moving onto the health outcomes: using the incremental long-term HALY gains per quitter from the <Inputs 2> sheet, calculate the lifetime HALY gain from successful long-term quitters, noting that this differs according to socioeconomic status.

1. **Standard CEA**

We will now bring together the aggregate, population-level results as we would in a standard cost-effectiveness analysis. In the <CEA> sheet, the summary table has been populated with the net cost and total HALY gain across the whole population in cells B5:C7. From these, calculate the incremental costs and HALYs versus programme 1 and versus the next best alternative for programmes 2 and 3. Then calculate the corresponding ICERs i.e. for programme 2 versus programme 1 and for programme 3 against programme 2.

All being well, the cost-effectiveness plane should now have been populated. If this is not the case, then use the template chart and select the relevant sources of data yourself to compare programmes 2 and 3 with programme 1 on the cost-effectiveness plane.

1. **Distributional analysis**

Now turn to <Dist Tab> sheet and populate cells C5:C14 using the values from the <Inputs 2> sheet. Next, fill in columns D, E and F using the total HALY gains for each social group from the relevant cells in the <Costs and Effects> sheet. Calculate the increments required in columns G, H and I.

The table below will then automatically re-order your results by social group ranked by Health-Adjusted Life Expectancy. This data will then populate the bar chart in <Dist Fig> showing the incremental HALY gains in each group under programmes 2 and 3 compared to scenario 1.

1. **Questions**

Which programme is the most cost-effective, assuming a cost-effectiveness threshold of £13,000?

Which programme has the greatest health benefit for the most deprived group?

You have now built your first distributional cost-effectiveness model – well done! The next exercise – Exercise 9 – will show you how to add the distribution of health opportunity costs to the model and to plot the findings in an equity-efficiency impact plane.