**Infectious Disease Modelling course, Fudan University 2019**

**Economic evaluation of infectious disease interventions**

Practical solutions

**Note: There is a hidden worksheet in "measles economics.xls" which has a completely filled out version of the model.**

Open the worksheet “measles economics.xls”. This is the same measles model which you have seen before, with a timescale of 200 days. Births and deaths have not been included due to the short time scale.

Notice that a new table has been added entitled “Economic parameters”. This gives the cost of treating a measles case, the cost of vaccinating someone with measles and the QALYs lost due to a case of measles. The discount rate is set to 3%.

1. Fill in Columns Q to S with the number of new measles cases every day, the cost of treating those cases, the cost of vaccinating people and the QALYs lost due to those cases respectively. Assume that vaccination happens at time 0.

*Q15, R15 and T15 should be filled with zeroes respectively since there are no cases yet.*

*S15 should give the cost of vaccinating all the vaccinated people in the population:  
S15:* *=G15\*cost\_vaccine*

*The relevant formulae for Q16, R16 and S16 are:*

*Q16: =beta\*B15\*D15*

*R16: =Q16\*cost\_measles*

*S16:=0*

*T16 =Q16\*qaly\_measles*

*Notice that Q15 is the number of* ***new*** *cases that occurred during that time step (i.e. incidence) rather than the number of people who have measles at that time (i.e. prevalence).*

*You can then copy those cells down the table to do the same for the remaining time steps.*

2. Fill in cells Q12, R12 and S12 to find the total number of measles cases and their cost and QALY loss implications over the course of the 200 days.

*The relevant formulae are:*

*Q12:=SUM(Q15:Q215)*

*R12:= SUM(R15:R215)*

*S12:= SUM(S15:S215)*

*T12:= SUM(T15:T215)*

*You should find that there are 99,999 measles cases (i.e. the entire population except for the initial case) costing 1,999,980 to treat the cases, 0 to vaccinate (since vaccine coverage is 0) and causing 20,000 QALYs to be lost.*

3. Increase vaccine coverage to 80% (by inserting 0.80 in to cell N9). How many cases of measles are prevented, both directly and through herd protection?

*80% of the population is immediately moved to the vaccinated compartment in the first time step, so the number of susceptibles decreases immediately from 99,999 to 19,999. The number of measles cases drops to 18,156. Since there are 1,843 susceptibles who did not acquire measles, these must have been protected through herd protection from the vaccinated people.*

4. What is the net difference in costs spent and QALYs lost with vaccination? Hint: Remember to take into account the cost of vaccination.

*The cost falls to 363,115. However, the cost of vaccinating 80,000 people is 80,000 x 5 = 400,000. So the net cost is 763,115. This represents a cost saving of 1,236,865 from the situation without vaccination.*

*The number of QALYs lost falls to 3,631, so 16,369 are gained compared to the situation without vaccination.*

5. Would you recommend a measles vaccination programme in this situation?

*Yes, because measles vaccination would both save costs and gain health. It isn’t surprising that measles vaccination is such a good buy – measles spreads very rapidly (almost everyone would be infected if nobody was vaccinated), and the vaccine is much cheaper than treating people with measles.*

6. The next step is to recalculate your outcomes taking into account discounting. The discount factor at each time step is the factor with which to multiply your costs and QALYs lost at that time step. It is given in column T. Look at the formula used and see if you can understand it.

*This is simply the discounting formula 1/(1+r)^n* *where r is the discount rate and n is the time elapsed since the base time. In the formulae, n is divided by 365 to turn it into an annual time step, since the discount rate is given for a year.*

7. Work out the discounted costs spent and QALYs lost with vaccination by filling in columns U and V. Did the answer change much? Why or why not?

*You need the following formulae in U15 and V15:*

*U15: =R15\*T15*

*V15: = S15\*T15*

*You can then copy these formulae down to the rest of the table and calculate the totals.*

*Discounted costs have changed to 359,770 (or 759,770 including the cost of vaccination). Discounted QALYs lost are 3,598. Note that the cost of vaccination is not discounted since we are assuming this happens at the first time step.*

*This is a very small change from the previous figures of 763,114 and 3,631. This is because the model only follows the population for 200 days, which is too short a time interval for discounting to make much difference.*

8. The model you have built does not take into account people who die of measles. If this was incorporated, what would be the effect on the cost-effectiveness calculations you have made? Would the difference between discounted and undiscounted results change?

*Measles deaths would be rare (on average fewer than 1 per 1000 measles cases die of measles in high-income countries) but each death would impose a large impact on QALYs lost (far greater than 0.2). Hence the overall QALYs saved by measles vaccination would increase.*

*However, discounting would have a large effect on the number of QALYs lost per measles death, since the years of life lost mostly occur years in the future.*