Exercise: Constructing Markov models

(Exercise—Markov model.xls)

Objective of this exercise

1. To develop Markov model and input the parameters into the Excel sheet "Parameters", "PD" and "HD".

2. To input cost data, effectiveness data, and utility data into the sheet " STD practice", "HD", and "PD" and then calculate the incremental cost-effectiveness ratio on the sheet " Analysis".

3. To write the Macro function for running Monte Carlo Simulation

4. To calculate probabilistic value of incremental cost-effectiveness ratio of renal replacement therapy.

Step 1: Study the structure of Markov model for both PD and HD on the sheet "Models"

Step 2: Study parameters and values on the sheet "Parameters"

Hint: You can see that all parameters in the column B were named on the column A in order to make it more convenient for linking with other sheets and checking the formula. You can directly name these parameters using "NAME" function for calculations.

Please notice

1. On parameter values in blue column, these parameters will be used to calculate on other sheets.

   - direct medical care cost

   - indirect medical care cost

   - direct non-medical care cost

   - indirect non-medical care cost

2. Consider cell "B17:B20" which are the parameters for the calculation of transitional probability of dying for cohort in the model. These parameters obtained from the survival analysis of individual data from the registry of 6,272 patients receiving renal replacement therapy based on the Association of Renal Disease in Thailand during 1997-2003 by using one day as time period in the analysis. On the sheet "Hazard f_n of dialysis cohort", the survival analysis considering age

(year) as a factor and that you can see "Coefficient ของ Ingamma" which is one of the values of the Weibull distribution and constant [cons] and age [ageC]. The formula is as follows.

Weibull (Cumulative hazard=H(t)) = lambda*t^gamma

In this case, lambda is a function of age, so

lambda = exponential (constant + age*coefficient ของ age)
= exp(cons+age*ageC)

Step 3: To build Markov model of HD (Worksheet "HD")

1. Calculate probability of death in each cycle (1 year) using Weibull parameters. In the survival analysis, we used one day as time period, so that you need to calculate a year as days in Column C.

Hint: C6 =cycle*365

2. In Column D, calculate cumulative hazard, H(t) using Weibull equation in Column D

Hint: (Cumulative harzard=H(t)) = lambda*t^gamma

3. In Column E, calculate transitional probability of each cycle

The values in Column D are cumulative hazard, but in Column E, we need to know transitional probability of each cycle. Therefore, you need to change cumulative hazard to cycle hazard. Then change cycle hazard to cycle probability. Now, you will get the probability of death in each cycle

Hint: สูตร tp(u)=1-exp{H(t-u)-H(t)}

4. Then, we will create Markov's cohort in Column G, H, I and O, P, Q from the sheet "HD"
   - "new HD" column F6 =1. It means that cohort is coming into the model and one patient receiving HD at cycle 0.

- "HD" ใน column G is the number of patients continuing HD treatment.
    i. At cycle 0, cell G6=0
    ii. At cycle 1, cell G7 is the number of patients receiving HD treatment (**summation of F, G and H at cycle 0)** multiplied by the probability of patients continuing HD treatment **(1-pHDtoPD-the probability of death)**
- "PD Switching to HD" in column H is the number of patients used to receive PD treatment but switch to HD treatment
    i. Therefore, at cycle 0 cell H6=0
    ii. At cycle 1, cell H7 is the number of patients receiving PD treatment **(summation of N, O and P at cycle 0)** multiplied by the probability of moving from PD to HD **(pPDtoHD)**
- Column I is the probability that the cohort will be dead while receiving HD
    i. Therefore, at cycle 0, cell I6=0
    ii. At cycle 1, cell I7 is the number of patients receiving HD **(summation of F, G and H at cycle 0)** multiplied by the probability of death
- At Column O, P, Q will be calculated the same way as column G, H, I. Now, you will get all patients in the cohort. Then you continue working the following year until 99th year
    Hint: Use the right click and drag the mouse down

Checking: You can check your results of Markov cohort by considering column V and W (column V is the accumulative deaths and at Column W, when you added up all probabilities in the model, **it must be equal to 1)**

Step 4: Calculate cost, effectiveness, and utility

1. At column J, calculate the cost of treatment

When we calculate the cost based on the societal and governmental perspectives, you need to use the command **IF(logical_test,value_if_true,value_if_false)** to help us choose either the cost based on societal perspective (perspective=1) or the cost based on governmental perspective (perspective = 0)

- The cost parameters based on societal perspective (perspective=1) for patients with HD at the first year (column F และ H) are cMedHD1 and cNonMedHD.

- The cost parameter based on the governmental perspective for patients with HD at the first year is cMedHD1.

- The cost parameters based on societal perspective for patients with HD in the following years (column G) are cMedHD2 and cNonMedHD.

- The cost parameter based on the governmental perspective for patients with HD in the following years is cMedHD2.

Don't forget! Must discount the cost in the equation.

<div align="center">discounting = ต้นทุน/(1+cDC)^cycle</div>

Example: **cell J6=((F6+H6)*IF(perspective=1,cMedHD1+cNonMedHD,cMedHD1) +(G6*IF(perspective=1,cMedHD2+cNonMedHD,cMedHD2)))/(1+cDC)^cycle**

2. At Column K, calculate Life Year which can be saved ได้, it is the summation of column G and H
Don't forget! Must discount Life Year saved

3. At Column L, calculate QALY gained which is equal to LY multiplied by the utility [uHD]
4. At Column R, S, T, calculate cost, effectiveness, and utility by using the same principle.

Step 5: Copy column G:L และ O:T and paste on the sheet "PD"

Finally , you can create Markov cohort for HD and PD successfully. CONGRATULATION!!!!

Step 6: Calculate the incremental cost-effectiveness ratio
1. Now you get all cost, effectiveness, and utility values of PD and HD on the sheet "PD" and "HD" at the cell J109:L109 as well as the all cost, effectiveness, and utility values of palliative care on the sheet "STD practice" in the cell cell J8:I8.
2. Input all cost, effectiveness, and utility values on the summary table on the sheet "Analysis" in the table "Deterministic" and calculate Incremental cost-effectiveness ratio & cost-utility ratio ของ STD to PD และ STD to HD