Epi 213_Assignment 3
Jan 26, 2018
Assignment due: Jan 30th, 5pm

1. A treatment for a rare disease has the following possible outcomes: 5% of patients receiving the therapy die immediately of complications, 50% survive 1 year, 15% survive 2 years, and the remainder survive 4 years. What is the life expectancy of patients receiving this therapy in undiscounted years?

p	outcome	p*outcome
0.05	0	0
0.5	1	0.5
0.15	2	0.3
0.3	4	1.2

Life expectancy: 2years

Note that the term "average life expectancy" is redundant – life expectancy by definition is an expected value or "an average".

2. A treatment costs 30,000 Colombian Pesos. What is the cost in:
a) US dollars
b) International dollars

Colombian Pesos to US$:
30000/2794.71 = **US$ 10.73**

Colombian Pesos to INT$
30000/1250.30 = **INT$ 23.99**

What accounts for the difference between the two values you reported above?
International dollar accounts for the purchasing power of the Colombian Peso within Colombia (in other words, accounts for purchasing parity).

Some data sources you mind find handy for this problem:
https://data.worldbank.org/indicator/PA.NUS.PPP
http://www.xe.com/currencyconverter/convert/?Amount=1&From=USD&To=COP

3. The probability of experiencing a breast cancer relapse in a particular cohort is 50% at 5 year. What is the annual rate of relapse in this cohort?

r=-ln(1-p)/t
13.86 per 100 per year (note the units). Note that rates should not be expressed as percentages.

4. In an urban population of high-risk individuals, the rate of HIV seroconversion is 5 per 100 per year. What is the probability of seroconversion at 5 years?

p=1-e^(-rt)
0.2212 (note the absence of units) or 22.12%

5. In a particular high-risk cohort, the probability of developing diabetes is 60% at 3 years. What is the probability at 1 year?

p(3 years) = 0.6
Therefore
Rate (1 year) = 30.54 per 100 per year
Therefore
p(1 year) = 0.2632 or 26.32%

6. In the control arm of a randomized study, the probability of dying is 0.3 at 5 years. An intervention reduces the *annual rate of death* by 50%. What is the annual *rate* of death in the intervention arm? What is the probability of death in the intervention arm at 5 years?

p(control arm, 5 years) = 0.3
Therefore

Rate (control arm, 1 year)=0.0713 (or 7.13 per 100 per year)

The intervention reduces risk by 50%, so
Rate (intervention arm, 1 year) = 0.03565

Therefore,

P(intervention arm, 5 years) = 0.1632 or 16.32%

Note that p(intervention arm, 5 years) is NOT half the p(control arm, 5 years).

7. A drug costs US dollars 2000 per injection and needs to be administered once a year. Patients receiving the therapy have a life expectancy of 10 years. What is the total cost of 10-years of therapy in 2018 US dollars?

Assuming a discount rate of 3% per year, and

Present Value = Future Value / ((1 + discount rate)^(time lapsed))

Year	Undisc cost	Discounted Cost
1	2000	2000
2	2000	1941.747573
3	2000	1885.191818
4	2000	1830.283319
5	2000	1776.974096
6	2000	1725.217569
7	2000	1674.968513
8	2000	1626.183023
9	2000	1578.818469
10	2000	1532.833465
	Total	**17572.21784**

Answer = $17,572.22 (in 2018 USD)

Note that the first year is undiscounted and the last year is discounted by 9.

8. Consider the following 5 strategies for addressing a public health problem. Their total costs and QALYs generated are shown below.

Strategy Cost QALYs

A	50,000	12
B	60,000	11
C	75,000	17
D	80,000	19
E	110,000	25

a) Estimate the incremental cost-effectiveness ratio for the therapies. Be cognizant that some may be eliminated by strict or extended dominance (clearly identify these as such).

Note that the first step is to arrange all strategies by increasing QALYs. This example just happened to provide them mostly aligned correctly!

Strategy	Cost	QALYs	ICER ($/QALY)		
B	60000	11	eliminated by strict dominance		
A	50000	12	comparator		
C	75000	17	C v A:	5000	
D	80000	19	D v C:	2500	C eliminated by extended dominance
			D v A:	4286	
E	110000	25	E v D:	5000	

Note that you would not calculate an ICER for E relative to A.

b) Assuming a willingness-to-pay threshold of $50,000/QALY, what would be the most optimal strategy to address the public health problem?

Strategy E, because ICER rel to D <50,000 and gives the most QALYs

9. Estimate the present value of the following expenditure stream in 2018 USD.

2018 $40,000
2019 $2,000
2025 $60,000
2030 -$100,000 (negative value implies some kind of return on investment, doesnt change the mathematical approach)

	Years passed	Undisc value	Disc Value(rate = 0.03)
2018	0	40000	40000
2019	1	2000	1941.747573
2025	7	60000	48785.49068
2030	12	-100000	-70137.98802

Present Value	**20589.25**

10. Estimate the present value of the following QALYs

2018	19
2019	25
2030	30

	Years passed	Undisc value	Disc Value(rate = 0.03)
2018	0	19	19
2019	1	25	24.27184466
2030	12	30	21.04139641
		Present Value	**64.31324107**

11. A public health intervention (e.g., a soda tax) reduces the incidence of heart attacks in the population. Below is the timing of the averted heart attacks from the start of the intervention. What is the total number of heart attacks averted?

2018	50,000
2019	25,000
2020	25,000
2021	70,000
2022	80,000

Total = 250,000 (note, no discounting *number of events*)

12. The table below lists the incremental cost and incremental benefit of a treatment relative to the control for the first five years of therapy.

Year	Incremental Costs (Indian Rupees)	Incremental benefits (QALYs)
1	10,000	1
2	8,000	0.8
3	8,000	0.8
4	15,000	0.6
5	5,000	0.4

a) Estimate the ICER for the treatment relative to the control over 5 years. Cue: Estimate present value of incremental costs, present value of incremental QALYs, and then calculate the ratio.

Since the discount rate for India is not specified, students are free to pick 3% a year or 5% a year.

If you assume a discount rate of 3% per year:

Year	Undiscounted Incremental Costs	Undiscounted Incremental QALYs	Disc Costs (r=0.03)	Disc QALYs (r=0.03)
1	10000	1	10000	1
2	8000	0.8	7766.990291	0.776699029
3	8000	0.8	7540.767273	0.754076727
4	15000	0.6	13727.12489	0.549084996
5	5000	0.4	4442.43524	0.355394819
		Sum	43477.31769	3.435255571
		ICER	**12656.21052**	

The ICER for the treatment relative to the control is 12,600 INR per QALY (note rounding of ICER is standard practice; 13000 would be acceptable too).

If you assume a discount rate of 5% a year (it is typical to use slightly higher rates for LMICs):

Year	Undiscounted Incremental Costs	Undiscounted Incremental QALYs	Disc Costs (r=0.05)	Disc QALYs (r=0.05)
1	10000	1	10000	1
2	8000	0.8	7619.047619	0.761904762
3	8000	0.8	7256.235828	0.725623583
4	15000	0.6	12957.56398	0.518302559
5	5000	0.4	4113.512374	0.32908099
		Sum	41946.3598	3.334911894
		ICER	**12577.95142**	**INR/QALY**

In this case (assuming a discount rate of 5%), the ICER for the treatment relative to the control is still 12,600 INR per QALY (13000 would be acceptable too). The results do not appear to be sensitive

b) What is the ICER for the treatment relative to the control over 5 years in International dollars per QALY?

Using a PPP coversion rate of 17.42 (from the World Bank database linked above), the ICER is

723 INT$/QALY (note change in units from INR per QALY to INT$ per QALY). Also note that the correct terminology is INT$ and not international USD.