

CEA Fundamentals: Valuing Outcomes

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Learning Objectives and Outline

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Learning Objectives

- Understand the concepts of summary measures of health, specifically, quality-adjusted life years (QALYs)
- Describe the general differences between direct and indirect methods for estimating health state utilities
- Curate model parameters for quantifying “benefits” (the denominator in the C/E ratio)



Outline

1. Valuing health outcomes: QALYs/DALYs
2. Utility weights/instruments
3. Where to get values

ICER review

$$\frac{C_1 - C_0}{E_1 - E_0} \quad (\Delta C)$$
$$\frac{\quad}{\quad} \quad (\Delta E)$$

Numerator (costs)

Valued in monetary terms

- E.g.,

\$USD / ~~₦~~NGN / KES / R

Denominator (benefits):

Valued in terms of **clinical outcomes**

- E.g.,

of HIV cases prevented

of children seizure free

of quality-adjusted life years gained

- What's important for the question at hand
- Most analyses report several different outcomes
- QALYs/DALYs enable comparability across disease areas

Valuing Health Outcomes

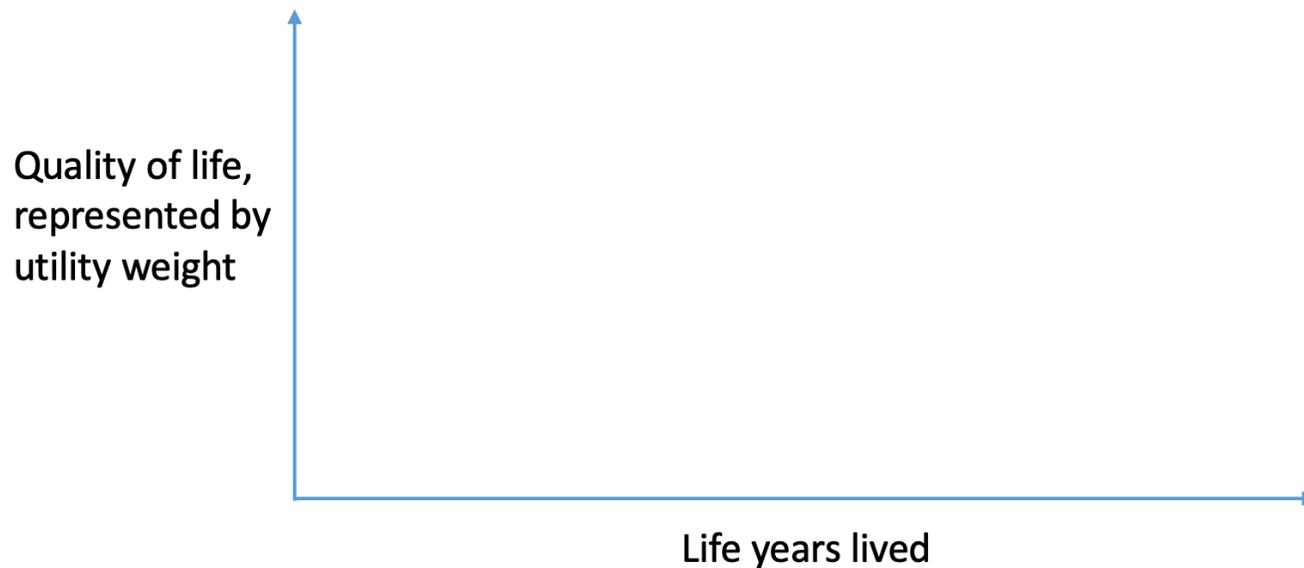
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Why summary measures of health?

- QALYs and DALYs both provide a summary measure of health
- Allow comparison of health attainment/disease burden
 - Across diseases
 - Across populations
 - Over time etc.



- Origin story: welfare economics
 - Utility = holistic measure of satisfaction or well-being
- With QALYs, two dimensions of interest:
 - Length of life (measured in life-years)
 - Quality of life (measured by utility weight, usually between 0 and 1)



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QALY: A metric that reflects both changes in life expectancy and quality of life (pain, function, or both)

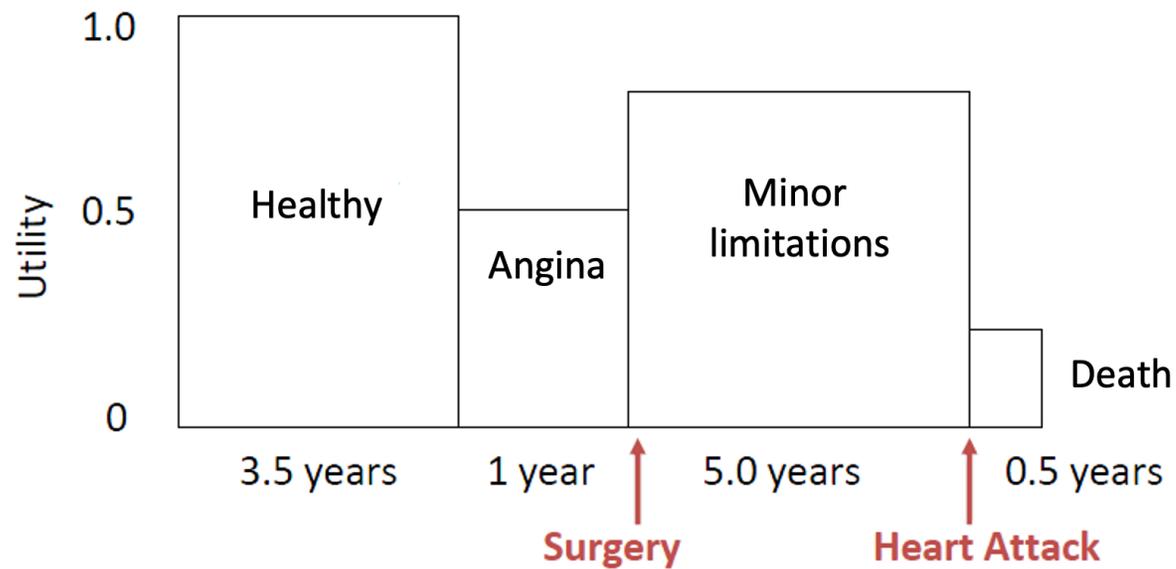
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1 = perfect health

Sum of weight * duration of life =
Quality-Adjusted Life Expectancy

0 = death

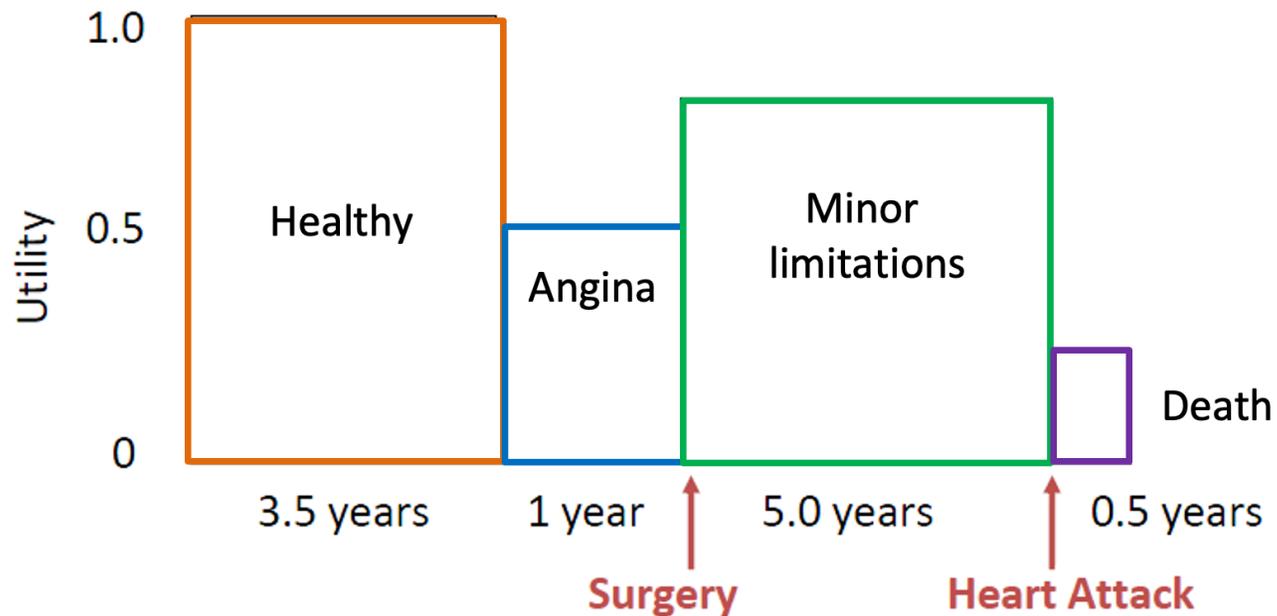
Example: Patient with coronary heart disease (with surgery)



Source: Harvard Decision Science

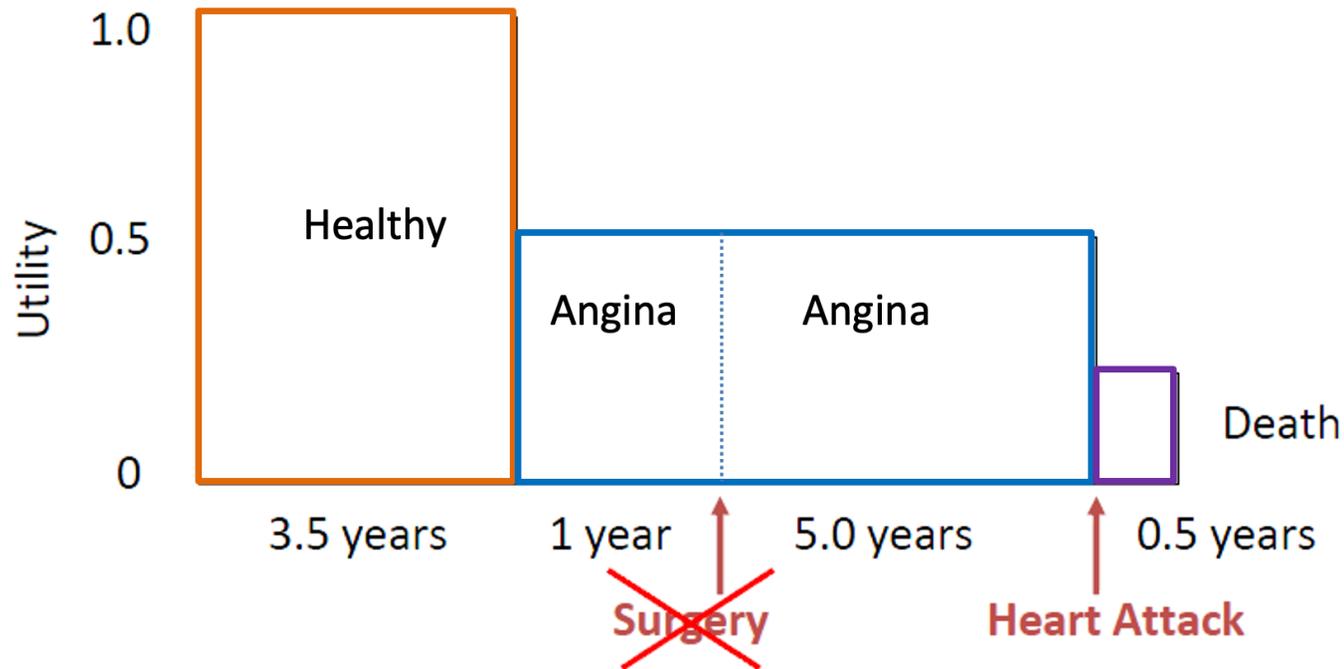
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Example: Patient with coronary heart disease (with surgery)



$$\begin{aligned} \text{QALYs} &= 3.5\text{yrs} * 1.0 + 1\text{yr} * 0.5 + 5\text{yrs} * 0.75 + 0.5\text{yrs} * .25 \\ &= 7.875 \text{ QALYs} \end{aligned}$$

Example: Patient with coronary heart disease (without surgery)



$$\text{QALYs} = 3.5\text{yrs} * 1.0 + 6\text{yrs} * 0.5 + 0.5\text{yrs} * .25 = 6.625 \text{ QALYs}$$

Example: Patient with coronary heart disease

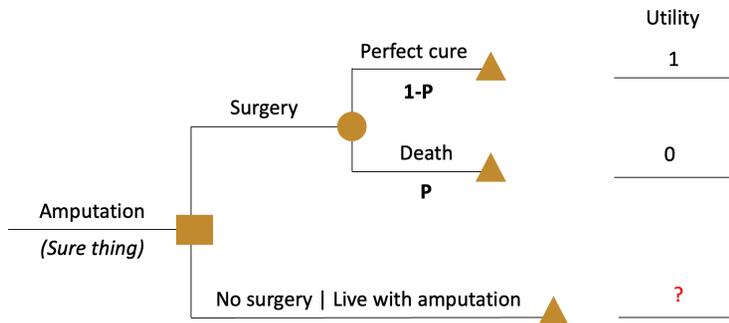
- With surgery: 7.875 QALYs
- Without surgery: 6.625 QALYs
- Benefit from surgery intervention:
 - In QALYs: $7.875 - 6.625 \text{ QALYs} = 1.25 \text{ QALYs}$
 - In life years: $10 \text{ years} - 10 \text{ years} = 0 \text{ LYs}$

Utility weights – How are they obtained?

- Utility weights for most health states are between 0 (death) and 1 (perfect health)
- Direct methods
 - Standard gamble
 - Time trade-Off
 - Rating scales
- Indirect methods:
 - EQ-5D
 - Other utility instrument: SF-36; Health Utilities Index (HUI)

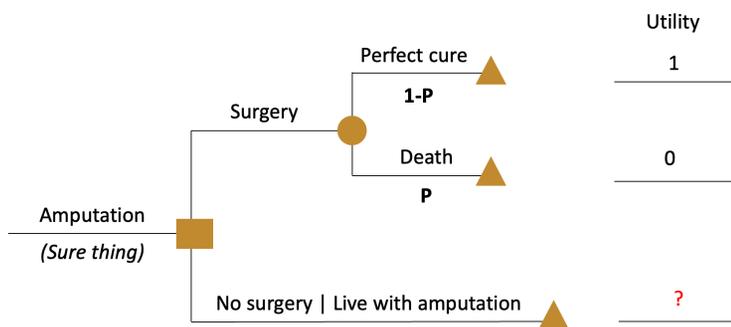
Direct methods - Standard Gamble (SG)

“What risk of death would you accept in order to avoid [living with an amputated leg for the rest of your life] and live the rest of your life in perfect health?”



Direct methods - Standard Gamble (SG)

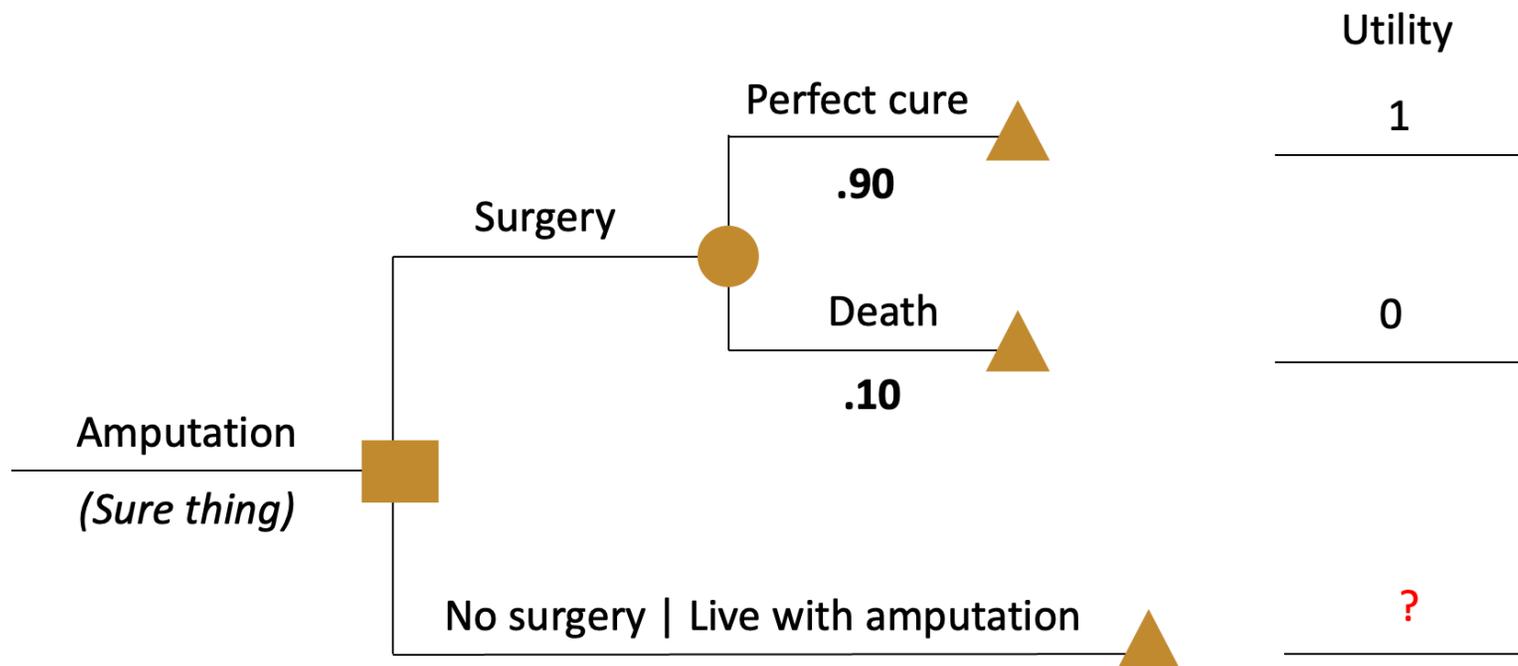
“What risk of death would you accept in order to avoid [living with an amputated leg for the rest of your life] and live the rest of your life in perfect health?”



- Find the threshold p that sets $EV(A) = EV(B)$
- Assume respondent answered that they would be indifferent between A and B at a threshold of $p_{Death} = 0.10$
- Then $U(\text{Amputation}) = p * U(\text{Death}) + (1 - p) * U(\text{Perfect Health}) = 0.10 * 0 + (1 - 0.10) * 1 = 0.9 = \text{threshold of indifference between surgery \& no surgery (I will live with this rather than have a high risk of dying)}$

Direct methods - Standard Gamble (SG)

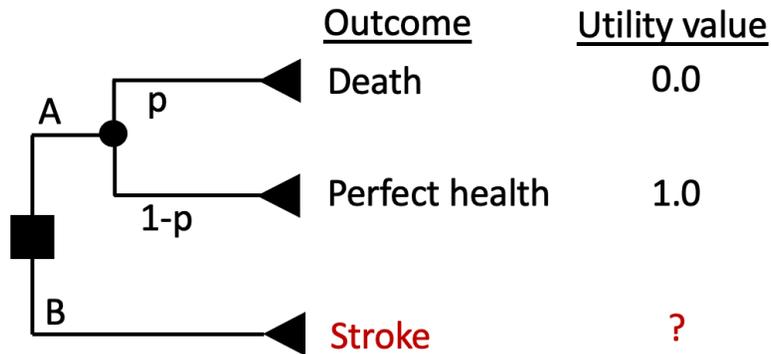
“What risk of death would you accept in order to avoid [living with an amputated leg for the rest of your life] and live the rest of your life in perfect health?”



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Direct methods - Standard Gamble (SG)

“What risk of death would you accept in order to avoid [living with stroke for the rest of your life] and live the rest of your life in perfect health?”

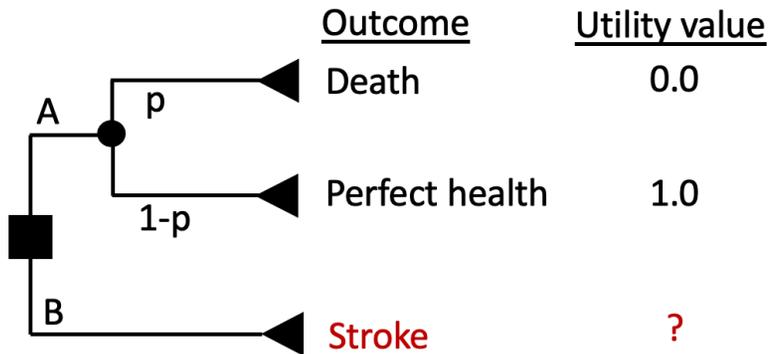


How bad is having a stroke?

- As a result of a stroke, you
 - Have impaired use of your left arm and leg
 - Need some help bathing and dressing
 - Need a cane or other device to walk
 - Experience mild pain a few days per week
 - Are able to work, with some modifications
 - Need assistance with shopping, household chores, errands
 - Feel anxious and depressed sometimes

Direct methods - Standard Gamble (SG)

“What risk of death you would accept in order to avoid [living with stroke the rest of your life] and live the rest of your life in perfect health?”



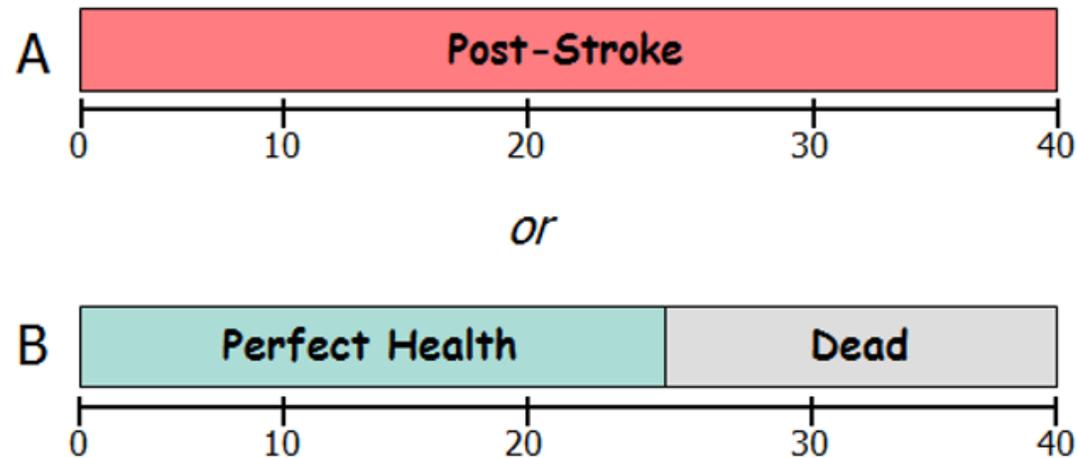
- Find the threshold p_T that sets $EV(A) = EV(B)$
- Assume respondent answered that they would be indifferent between A and B at a threshold $p_T = 0.2$
- Then $U(\text{Stroke}) = p_T * U(\text{Death}) + (1 - p_T) * U(\text{Perfect Health}) = 0.2 * 0 + (1 - 0.2) * 1 = 0.8$

Direct methods - Time Trade-Off (TTO)

- An alternative to standard gamble
- Instead of risk of death, TTO uses time alive to value health states
- Does not involve uncertainty in choices
- Task might be easier for some respondents compared to standard gamble

Direct methods - Time Trade-Off (TTO)

“What portion of your current life expectancy of 40 years would you give up to improve your current health state (**stroke**) to ‘perfect health’?”



$$U(\text{Post-Stroke}) * 40 \text{ years} = U(\text{Perfect Health}) * 25 \text{ years} + U(\text{Dead}) * 15 \text{ years}$$

$$U(\text{Post-Stroke}) * 40 \text{ years} = 1 * 25 \text{ years} + 0 * 15 \text{ years}$$

$$U(\text{Post-Stroke}) = 25/40 = 0.625$$

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SG vs TTO

- SG represents decision-making under uncertainty; TTO is decision-making under certainty
- TTO might inadvertently capture time preference (i.e., we might value health in the future less than we do today) as opposed to only valuing the health states
- Risk posture is captured in SG (risk aversion for death) but not in TTO
- Utility values from SG usually $>$ TTO for same state

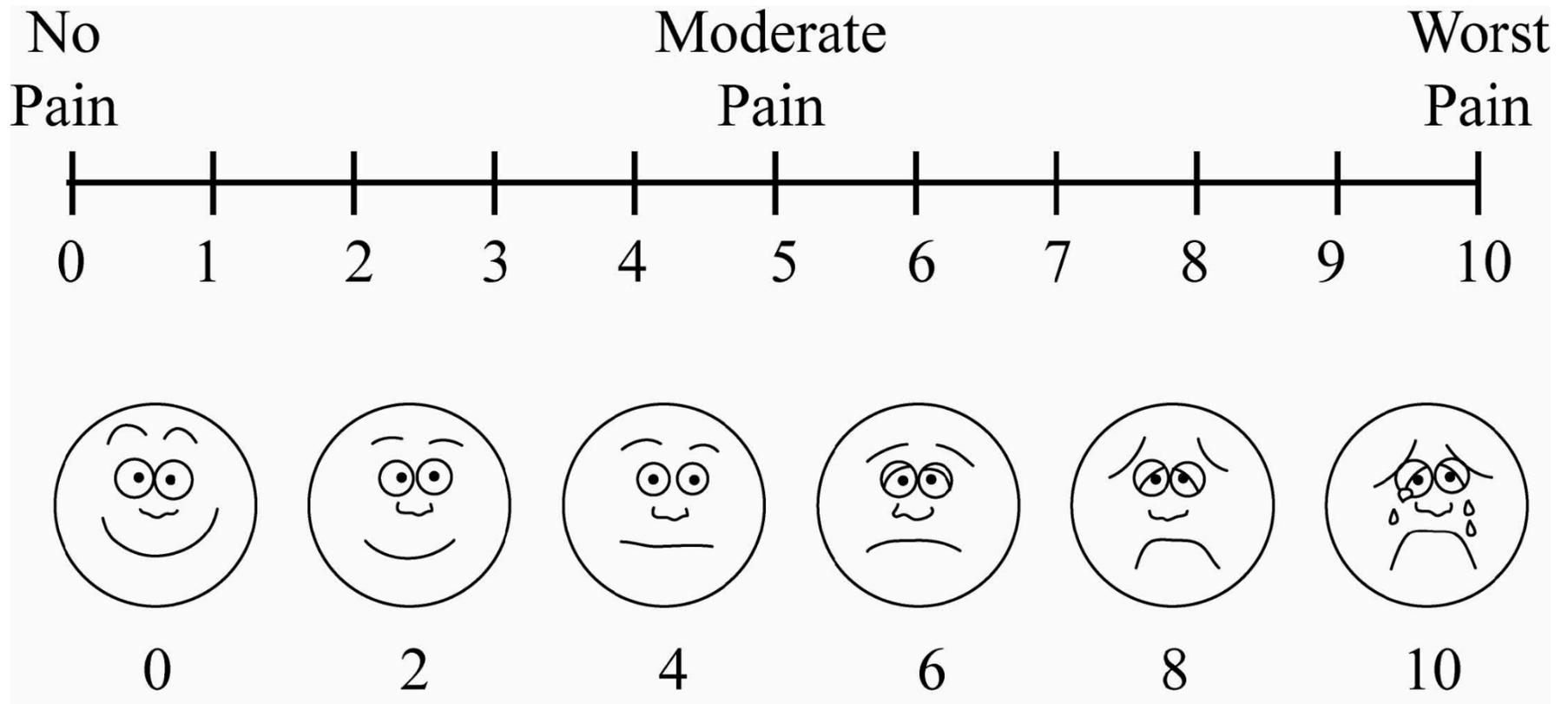
Direct methods – Rating scales

“On a scale where 0 represents death and 100 represents perfect health, what number would you say best describes your health state over the past 2 weeks?”

- Problem: It does not have the interval property we desire
 - A value of “90” on this scale is not necessarily twice as good as a value of “45”

Visual Analogue Scale (VAS)

The Visual Analog Scale (VAS) is a commonly-used rating scale



Source: <https://assessment-module.yale.edu/im-palliative/visual-analogue-scale>

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Direct methods – Rating scales

- Easy to use: Rating scales often used where time or cognitive ability/literacy prevents use of other methods
- Very subjective and prone to more extreme answers!
Usually, utilities for **VAS < TTO < SG**

Indirect methods - EQ-5D

- System for describing health states
- 5 domains: mobility; self-care; usual activities; pain/discomfort; and anxiety/depression
- 3 levels: 243 distinct health states (e.g. 11223)
- Valuations elicited through population based surveys with VAS, TTO

Mobility

- I have no problems in walking about
- I have some problems in walking about
- I am confined to bed

Self-Care

- I have no problems with self-care
- I have some problems washing or dressing myself
- I am unable to wash or dress myself

Usual Activities (*e.g. work, study, housework, family or leisure activities*)

- I have no problems with performing my usual activities
- I have some problems with performing my usual activities
- I am unable to perform my usual activities

Pain/Discomfort

- I have no pain or discomfort
- I have moderate pain or discomfort
- I have extreme pain or discomfort

Anxiety/Depression

- I am not anxious or depressed
- I am moderately anxious or depressed
- I am extremely anxious or depressed

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Indirect methods

- HUI – Health Utility Index
- EQ5D – EuroQol health status measure
- SF-6D – Converts SF-36 & SF-12 scores to utilities
- QWB – Quality of well-being scale

- Origin story: Global Burden of Disease Study
- Deliberately a measure of health, not welfare/utility
- Similar to QALYs, two dimensions of interest:
 - Length of life (differences in life expectancy)
 - Quality of life (measured by disability weight)

DALY

Disability Adjusted Life Year is a measure of overall disease burden, expressed as the cumulative number of years lost due to ill-health, disability or early death

$$= \text{YLD} + \text{YLL}$$

Years Lived with Disability + Years of Life Lost



$$\text{DALYs} = \text{YLL} + \text{YLD}$$

- YLL (Years of Life Lost)
- YLD (Years Lived with Disability)

DALYS = YLL + YLD

- **Years of Life Lost (YLL):** changes in life expectancy, calculated from comparison to synthetic life table
- YLL example: Providing HIV treatment delays death from age 30 to age 50
 - Life years gained = 20 years
 - YLL?

Synthetic, Reference Life Table

Age	Life Expectancy	Age	Life Expectancy
0	88.9	50	39.6
1	88.0	55	34.9
5	84.0	60	30.3
10	79.0	65	25.7
15	74.1	70	21.3
20	69.1	75	17.1
25	64.1	80	13.2
30	59.2	85	10.0
35	54.3	90	7.6
40	49.3	95	5.9
45	44.4		

Source: <http://ghdx.healthdata.org/record/ihme-data/global-burden-disease-study-2019-gbd-2019-reference-life-table>

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Synthetic, Reference Life Table

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DALYs = YLL + YLD

- Years of Life Lost (YLL): changes in life expectancy, calculated from comparison to synthetic life table
- YLL example: Providing HIV treatment delays death from age 30 to age 50
 - Life years (LYs) gained: 20 years
 - YLL: $LE(50) - LE(30) = 39.6 - 59.2 = -19.6$ DALYs = **19.6 DALYs averted**

Note

YLL (measured as DALYs averted) \neq LYs gained!

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$$\text{DALYS} = \text{YLL} + \text{YLD}$$

- Years Lived with Disability (YLD): calculated similar to QALYs, utility weight $\approx 1 - \text{disability weight}$
- YLD example: Effective asthma control for 10 years
 - Disability weight (uncontrolled asthma) = ?
 - Disability weight (controlled asthma) = ?

Disability Weights

- Common values for small set of named health conditions (e.g. early/late HIV, HIV/ART)
- First iteration: expert opinion
- Second iteration: Pop-based HH surveys in several world regions (13,902 respondents)
 - Paired comparison of two health state descriptions which worse
 - Probit regression to calculate disability weights
 - 235 unique health states

	Estimate
Infectious disease	
Infectious disease	
Acute episode, mild	0.006 (0.002–0.012)
Acute episode, moderate	0.051 (0.032–0.074)
Acute episode, severe	0.133 (0.088–0.190)
Post-acute effects (fatigue, emotional lability, and insomnia)	0.219 (0.148–0.308)
Diarrhoea	
Mild	0.074 (0.049–0.104)
Moderate	0.188 (0.125–0.264)
Severe	0.247 (0.164–0.348)
Epididymo-orchitis	0.128 (0.086–0.180)
Herpes zoster	0.058 (0.035–0.090)
HIV: symptomatic, pre-AIDS	0.274 (0.184–0.377)
HIV/AIDS: receiving antiretroviral treatment	0.078 (0.052–0.111)
AIDS: not receiving antiretroviral treatment	0.582 (0.406–0.743)
Intestinal nematode infections: symptomatic	0.027 (0.015–0.043)
Lymphatic filariasis: symptomatic	0.109 (0.073–0.154)
Ear pain	0.013 (0.007–0.024)
Tuberculosis	
Without HIV infection	0.333 (0.224–0.454)
With HIV infection	0.408 (0.274–0.549)

Source: Salomon, Joshua A., et al. “Disability weights for the Global Burden of Disease 2013 study.” *The Lancet Global Health* 3.11 (2015): e712–e723.

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DALYs = YLL + YLD

- Years Lived with Disability (YLD): calculated similar to QALYs, utility weight $\approx 1 - \text{disability weight}$
- YLD example: Effective asthma control for 10 years
 - Disability weight (uncontrolled asthma) = 0.133
 - Disability weight (controlled asthma) = 0.015
 - $\text{YLD} = 10 * 0.015 - 10 * 0.133 = -1.18$ DALYs = **1.18 DALYs averted**

DALYs for CEA

- Recommended calculation approach has changed over time (age weighting, discounting, now both out)
- Some will calculate a “QALY-like” DALY, using utility weight = 1- disability weight
- Discounting still generally done for CEA

Important

Common practice

- High-income setting: QALYs
- Low- and middle- income setting: DALYs
 - ***Since disability weights are freely & publicly available (these weights are required for DALY calculations), it can reduce costs/time/resources compared to collecting QALY estimates

Next up: Incremental CEA!

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