

Cost Utility Analysis

Definition

- Cost-Utility Analysis (CUA) is a method for comparing treatment alternatives *that integrates patient preferences and HRQOL.*
- Utility – “The value or worth placed on a level of health status, or *improvement in health status, as measured by the preferences of individuals* or society.”
- CUA can compare cost, quality, and the quantity of patient-years.
- Cost is measured in dollars, and therapeutic outcome is measured in a **quality-adjusted life year** (QALY) gained.

Introduction

- Apart from economic aspects, **PE evaluations** may also **focus** on **humanistic concern**
- For pharmacotherapy decisions.
 - various factors like **patient preferences**, patient **satisfaction**, **impact of disease** and **Rx of disease on a patient's** health related **QOL** are applied in PE.
- **QOL** : the assessment of **functional effects** of illness and **its consequent** therapy as **perceived by** the patient.
 - expressed as **emotional, physical or social impacts** on patients
 - QOL can be measured with the help of **structured questionnaires** filled by patients.

Cost-utility analysis/CUA

- CUA is a **special form** of cost-effectiveness analysis (**CEA**)
 - both in **CUA** and **CEA** we are interested in the **incremental costs** and *incremental consequences* between alternatives.
 - It is **similar** to the **CEA**, except that it includes **societal and/or patient preferences** to adjust outcomes, such as additional years of life saved
- The **difference** between the 2 methods lies in the **nature of the outcomes** compared.
 - In **CUA**, the **numerator** of (ICER) is a measure of **cost** (similar to other forms of CEA) and the **denominator** is measured typically using a metric called the *quality-adjusted life year (QALY)*.
 - In **CEA** compares alternatives based on a common **clinical effect**

CUA...

Utility

- Its expressed as the number of ***life years saved*** adjusted to account for loss of *quality* or for *disability* (***QALYs*** or ***DALYs***)
- ***Numerical estimate*** of quality of life (***QOL***) ***associated*** with a ***disease*** state or ***treatment***
 - e.g., per quality-adjusted life year (QALY) **gained**
- A ***QALY*** accounts for both ***survival*** and quality of life (***QoL***) **benefits** associated with the use of a healthcare technology.

Health utility

- In CUA the outcomes measure that is used to compare alternatives is one that combines **both** the **quality** and **quantity** of **life**. ***QALYs*** is the most commonly used in CUA

CUA...

How to **determine** utility?

- by asking **actual patients** to assign utility weights to their own health status.
- by asking *people who do not have the disease* to think about a **hypothetical** situation and then assign utility weights to the state of health described in the scenario.

How to **measure** utility?

- **rating scales**, the ***Standard Gamble*** method, or the Time Trade-off method.
- a **numerical value** between **0** and **1** is identified, with 0 being the **worst health** and 1 being the **best health**.
- Anything else...somewhere in between
- Measured using **questionnaires**

subjectivity of the assessment

CUA...

- Allows **comparison** of different health interventions
 - Provision of antiretrovirals (**ARVs**) for HIV-infected persons **VS** prevention of mother-to-child transmission (**PMTCT**)
 - Provision of **ARVs** Vs **Polio** vaccination
 - **migraine pharmacotherapy** VS **angioplasty**
- compare **cost**, **quality**, and the **quantity** of patient-years
- **policy makers** and **reimbursement agencies**.
 - With **ICER thresholds** from which **to judge** whether a drug or healthcare technology is **CE**
 - UK : **£30,000** per QALY gained ;
 - USA: **\$50,000** per QALY gained
 - WHO: **ICER < 3X** per capita gross domestic product (**GDP**) for a given country

CUA...

- When to use CUA
 - Health-Related *Quality of Life* is the important outcome
 - Programmes affect both **mortality** and **morbidity** and you want to combine both effects
 - Programmes affect wide range of outcomes and you want common unit for comparison

CUA...

- **When not to use?**
 - Only have *intermediate outcome* data
 - Effectiveness data show *outcomes* are *equivalent*
 - Effectiveness data show *dominance*
 - ***Extra cost*** of obtaining utility values is itself ***not CE***
(requires judgment on whether doing so would change result)

Outcome Measures

- Defining the outcome of interest
 - *One-dimensional*
 - Multi-dimensional
 - Measures changes in health taking into account **fatal** and **non fatal** health outcomes
 - Includes **DALY** and **QALY**

Outcome Measures...

Two Basic Outcomes of Health care

Mortality

Life Years
gained

HRQOL

Health
state

Natural units cannot capture both outcomes
We need other measures like **DALY** and **QALY**

Outcome Measures... Life Years

- Life Years

- Simplest and widely used measure of health
- Used when the ***dominant gain*** from a change is **extra life** rather than *relief of pain* or *disability*

Outcome Measures... DALY

Disability Adjusted Life Years (DALY)

- Includes
 - potential **years of life lost** due to *premature death* (YLL) and
 - equivalent **years of health life lost** by virtue of being in state other than good health (equivalent healthy years lost *due to non fatal condition*)
- DALY = YLL + YLD**
- QALY = Duration of illness x (HRQL_{treated} - HRQL_{untreated}) + (years gained x mean HRQL)**
- The *non fatal* health outcomes
 - are *difficult to define*
 - contain various domain like **mobility**, **anxiety**, **pain** etc.

Outcome Measures... DALY

DALY calculation

- Calculate *years of life lost* due to ***each disease***
- Calculate *loss of quality of life* of those ***living*** with each disease
- Apply weights to reflect ***social value*** of people at different ages
- Apply ***discount rate***

Outcome Measures... QALY

Quality Adjusted Life Years (QALY)

- the number of years *of perfect health*.
- *Life expectancy adjusted* based on *utility*
- **Two basic** outcomes of health care
 - 1. mortality**
 - Mortality *benefit* expressed as *life-years gained*

2. HRQL

HRQL measurement

- described in terms of the 'health state'
- single value
- 0 (death) - 1 (good health) scale

Outcome Measures... QALY

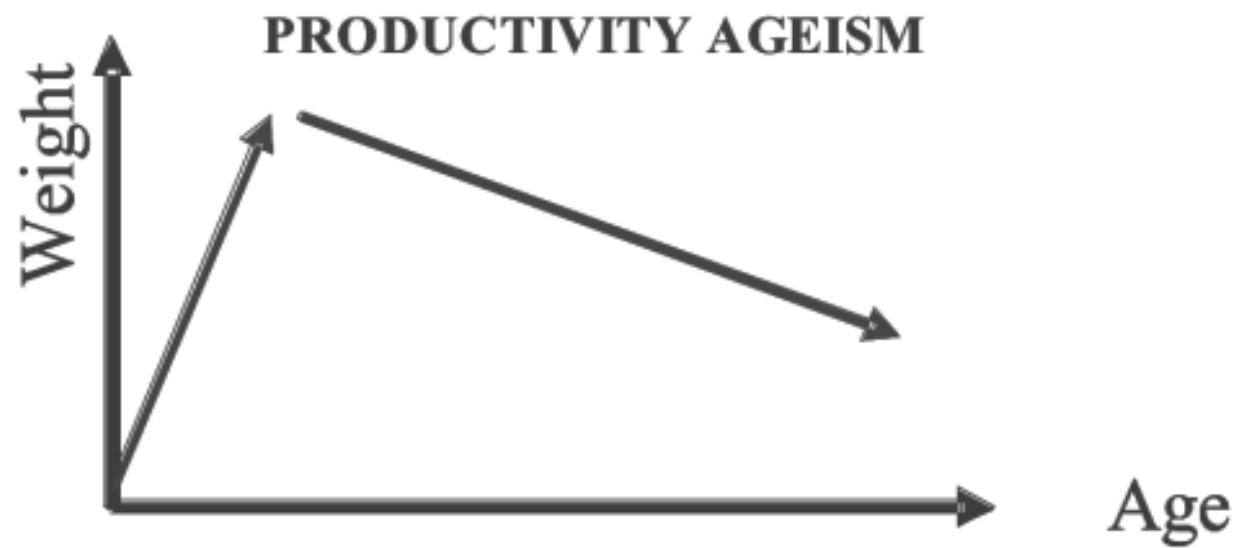
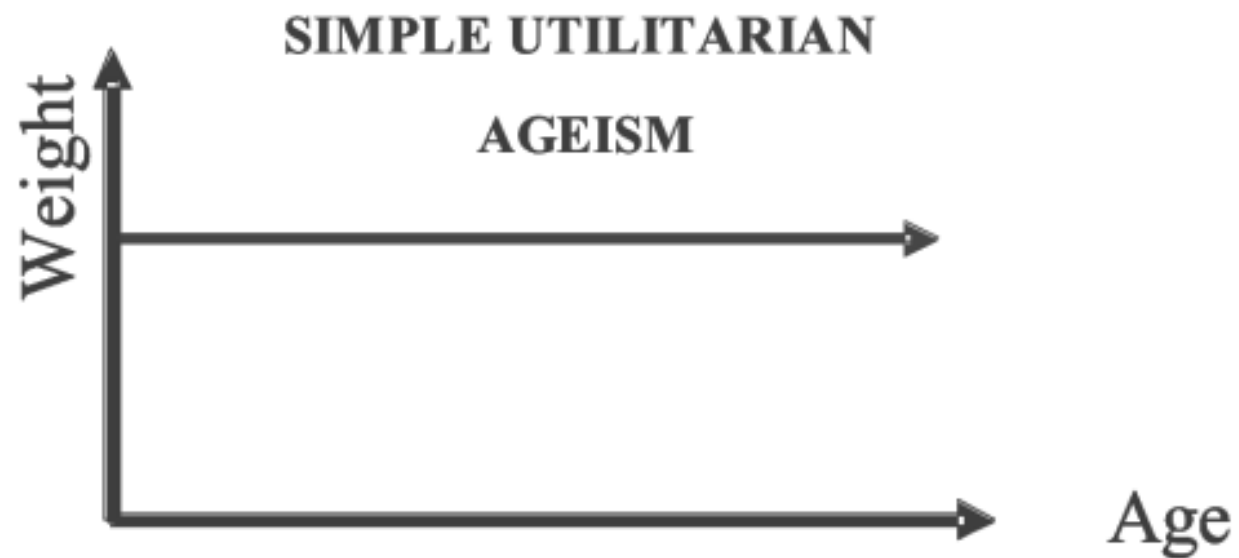
- all of the ***health benefits*** (i.e., **quality** and **length** of life)
- the sum of all of these **adjusted health states** over the planning **horizon**
- is the **product** of the **length of life** (e.g., the additional years of life gained by taking a drug) and the patient's assessment of the **quality of health** during that period of time, **or the utility** of the health status, to which people in this field refer.
 - $QALY = utility \times life\ years\ gained$
 - $QALY = utility\ of\ state \times time\ in\ health\ state$
- Combine ***morbidity*** and ***mortality*** data

Calculating QALy

- Advantage over CEA:
 - it can **combine more than one measure** of effectiveness or
 - both measures of **mortality and morbidity** into a **single measure**
- DAvd:
 - **absence** of **agreement** in measuring utilities,
 - **lack of standards** for comparing QALY and
 - **problems** with the **quantification** of **patient problems**.
- **Reserved** for comparing programs and treatment alternatives whose basic **goal** is improving **QOL**.

Calculating QALy

- In order to calculate QALY we ***need two*** pieces of ***data***
 - The path of the ***health states*** and the ***duration*** of the health states over the time span for which QALY are to be calculated
 - The preference ***weight for health states*** for the same duration



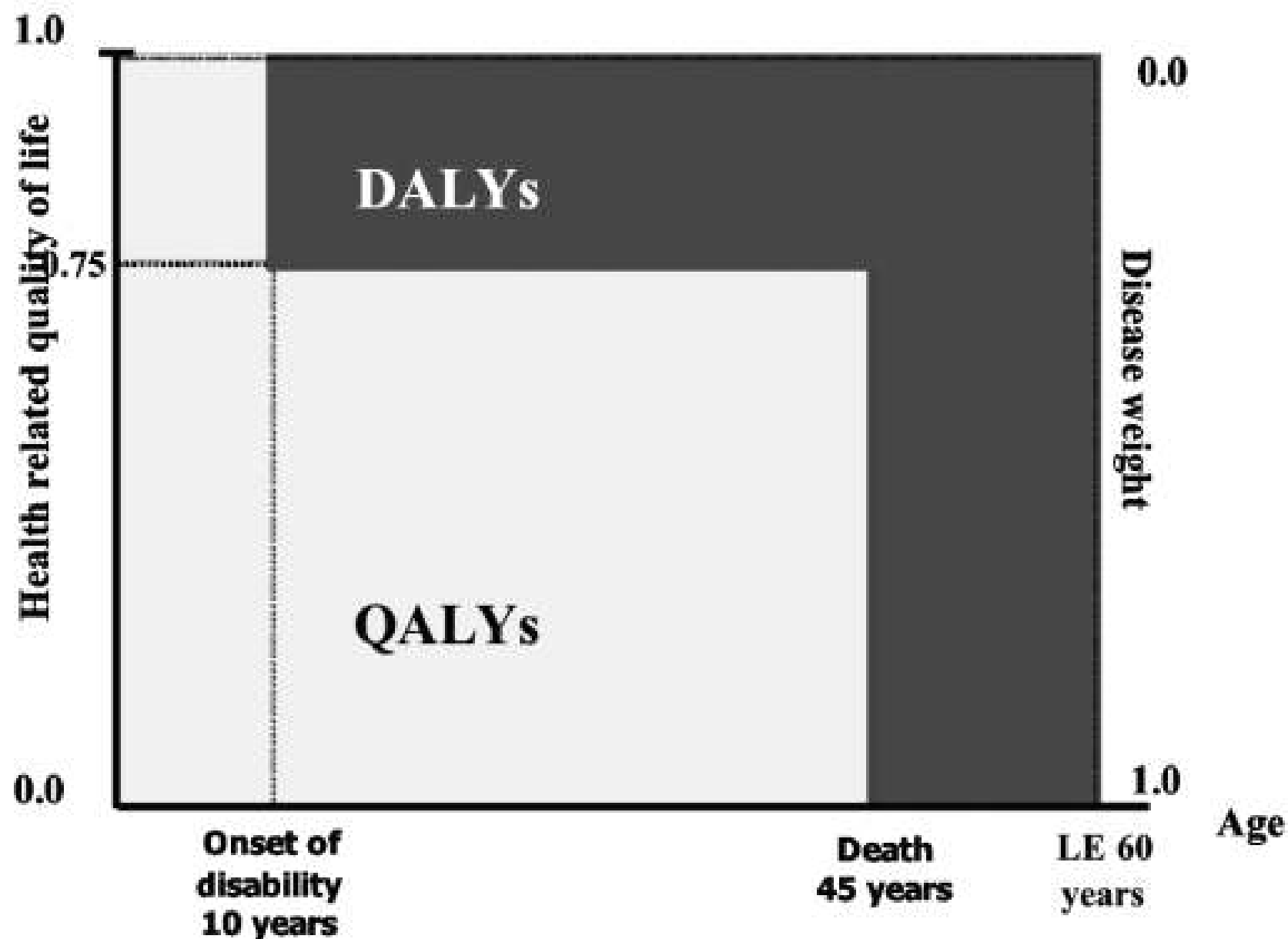


Figure 2. Relationship between QALYs and DALYs when the DALYs are not age-weighted.

Table 1. Calculation of QALYs

| Length of time in health state | Utility value for health state | Number of QALYs (equivalent to number of years of perfect health) |
|--------------------------------|--------------------------------|---|
| 0.8 years | 0.67 | 0.54 |
| 2.4 years | 0.53 | 1.3 |
| 5.2 years | 0.84 | 4.4 |

Table 2. Calculating incremental cost per QALY for docetaxel versus paclitaxel

| | Docetaxel | Paclitaxel | Difference (or increment) |
|---|-----------|------------|---------------------------|
| Mean costs of treatment per patient (£) ^x | 7,817 | 7,645 | 172 ^a |
| Mean utility (QALYs) ^y per patient | 0.7347 | 0.6485 | 0.0862 ^b |
| Average cost per QALY (=x/y) | £10,640 | £11,789 | – |
| Incremental cost per QALY of docetaxel versus paclitaxel (=a/b) | – | – | £1,995 |

Table 4. Cost per QALY league table¹

| Intervention | Extra cost per QALY gained (1990 £) |
|---|-------------------------------------|
| GP advice to stop smoking | 270 |
| Hip replacement | 1,180 |
| Cholesterol testing and treatment (all adults aged 40–69) | 1,480 |
| Kidney transplantation (cadaver) | 4,710 |
| Home haemodialysis | 17,260 |
| Hospital haemodialysis | 21,970 |
| Erythropoietin treatment for anaemia in dialysis patients (assuming 10% reduction in mortality) | 54,380 |
| Neurosurgery for malignant intracranial tumours | 197,780 |

| Evidence quality | Cost per QALY gained (£) | | | |
|---|--------------------------|----------------------|-----------------|---------------|
| | <£3K | £3–20K | >£20K | Negative |
| I. At least one randomised controlled trial | Strongly recommended | Strongly recommended | Limited support | Not supported |
| II. Well designed controlled trial | Strongly recommended | Supported | Limited support | Not supported |
| III. Expert consensus or opinion | Supported | Limited support | Limited support | Not supported |
| IV. Conflicting or inadequate evidence | Not proven | Not proven | Not proven | Not supported |

Outcome Measures...

QALY Measurement

Generic

Disease Specific

Quality of Well Being (**QWB**)

Asthma Quality of Life
Questionnaire

-Health Utilities Index (**HUI**)

-Euro Qol (**EQ-5D**)

Calculating QALYs

Exercise 1

Exercise 1

- Suppose you have **drug Y** and **drug X**. Suppose that you knew that the **QoL** of people living with the disease that these drugs treat is relatively *poor*.
- If the research has shown the **utility value** for this health status to be **0.3**.
- Drug Y saves 6 years of life and Drug X saves 5 years of life
- With this information, **calculate** the **QALYs** associated with each drug and **interpret** both by utility value and health status ??

Exercise 1 ...

- **For Drug Y**

- Utility value= 0.3
- Number of years of life saved= 6

$$\text{QALY} = 0.3 \times 6 = 1.8 \text{ years}$$

How do you interpret this result???

Exercise 1 ...

Interpretation:

- drug Y achieve the equivalent of ***1.8 years of life at a utility of 1***

or

- drug Y achieve the equivalent of ***1.8 years of life of the best possible health.***

Exercise 1 ...

- *Once you have calculated the **QALYs** for drugs **Y** and **X**,*
- *You can now **determine** the **incremental** difference in the **costs** and **outcomes**, or incremental cost utility ratio (**ICUR**).*

Suppose, The **ICUR** in this example is ETB **80,000:1**,

*how do you **interpret** this **ICUR**????*

Exercise 1 ...

ETB 80,000:1, ICUR means that

You would have to spend an *additional 80,000* ETB *for drug Y*
over drug X *to achieve one additional QALY.*

How do you see this cost? Is it excess of the benefit gained?

Exercise 2

Suppose, a patient suffer from disease 'X' and has been receiving Drug therapy 'A' which has a survival benefits of 10 years. If the patients is left untreated, the patient will only live for 5 years. Estimated utility value (relative to 'perfect health') with drug therapy 'A' and without therapy is 0.7 and 0.5 respectively. The cost incurred by the patient with drug therapy 'A' and without therapy A is 18,000ETB and 4,000ETB respectively.

Calculate QALY with and without treatment?

Calculate ICUR and interpret your result?

Exercise 3

- Suppose you are a ward pharmacist of oncology clinic at hospital X in Ethiopia. In your hospital you have been using Drug A as a standard of care and now, the new chemo drug is to be considered for procurement by the hospital. Both chemo drugs prolong life and both cause side effects which reduce QOL. Your standard chemo (Drug A) prolongs life by 1 year and reduces QoL of your patients by 35% due to its side effects. The new chemo prolongs life by 1.5 years at an estimated utility value of 0.5.

You are requested to perform a PE analysis which is CUA.

Calculate the QALYs for each chemo drug??

Exercise 3...

Standard chemo (Drug A)

- Life expectancy = 1year
- Utility values = $1 - 0.35 = 0.65$
- QALYs = $1 \times 0.65 = 0.65$ years
 - The new treatment is expected to add 0.65 quality-adjusted life-years to your patient's life.

New chemo

- Life expectancy = 1.5 years
- Utility value = 0.5
- QALYs = $1.5 \times 0.5 = 0.75$ years
 - The new treatment is expected to add 0.75 quality-adjusted life-years to our patient's life.

Exercise 3...

- Suppose a full course of treatment costs of both chemos are as follows,
 - 1,200 ETB for standard Chemo
 - 1,500 ETB for new Chemo
- **Calculate ICUR?**
- **Interpret your result?**

Exercise 3...

- **ICUR** =
$$\frac{\text{cost of new chemo} - \text{cost of standard chemo}}{\text{QALYs of new chemo} - \text{QALYs of standard chemo}}$$
$$= \frac{1,500\text{ETB} - 1,200\text{ETB}}{0.75 - 0.65} = 3,000 \text{ per QALYs}$$

Interpretation:

On average, it costs us **3,000 ETB** to add *one year of perfect health* onto the life of your patient.

So is this considered cost-effective?

Exercise 3...

Suppose, *Ethiopia's* per capita **GDP** is **400 USD**?

So, can the new chemo be considered as **cost-effective**?

Based on **WHO** recommendation.

Exercise 3...

- WHO recommendation is $< 3x$ per capita GDP of ICER to judge whether a given drug therapy or health technology is CE or not.
 - So, as for this case your ICUR is 3,000 Per QALYs
 - And the per capita GDP is $400 \times 20 = 8,000$

From this date the new chemo may be considered CE
but at a higher price.

Exercise 4

Assume, Drug therapy 'X' increases one's life expectancy by 2 years, but causes adverse effects or inconvenience, such that one's QoL or utility are decreased by 25%.

Calculate QALYs with treatment?

Exercise 5

| Duration | Health State | Weight |
|----------|---|--------|
| 3 months | Hospital Dialysis | .62 |
| 3 months | Home confinement for TB | .68 |
| 8 years | Home Dialysis | .65 |
| 8 years | Mastectomy for breast CA | .48 |

1. Sketch the QALY diagram and determine how **many QALY** are gained if a person achieves an eight year life extension on home dialysis under assumption of no discounting and 5% discounting

Exercise 5

2. Sketch the QALY diagram and determine how many QALY are gained if a person achieves a ***three month*** life extension on ***hospital dialysis***
- a. No discounting b. Discounting rate of 5%

Exercise 5

3. Assume a breast cancer patient will become symptomatic, have a mastectomy and live additional six years. By screening you can detect the breast cancer one year earlier and add two years to the patients life(now she lives nine years from the mastectomy instead of six) Sketch the QALY diagram and determine how many QALY are gained by screening

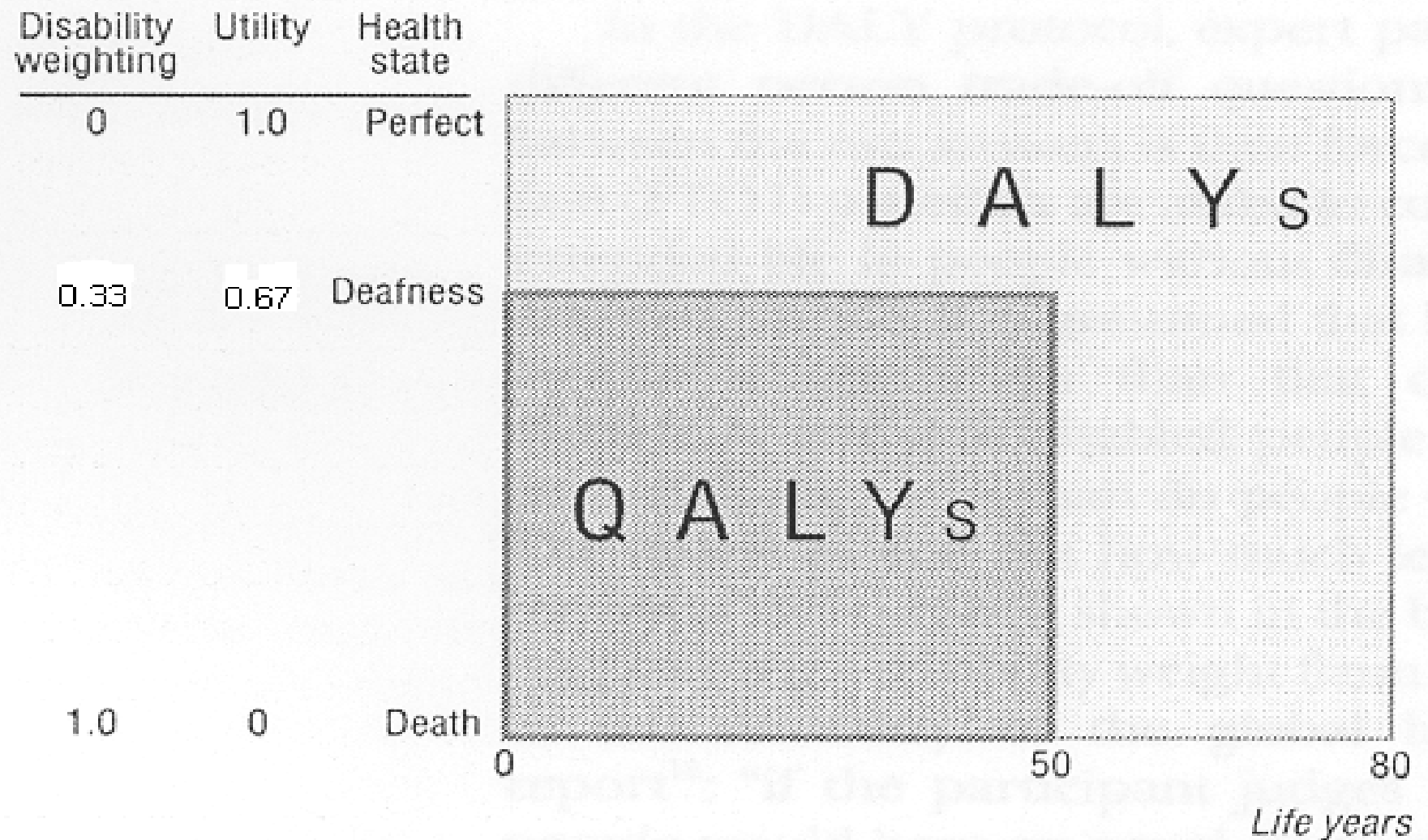
a. Assuming no discounting

b. Assuming 5% discount rate

Example 6

Presbyopia affects most people at age 40 years. It does not affect life expectancy but diminish visual functions. After vision declines at age 40, it does not (hypothetically) decline more with advancing age. There is a new surgical procedure for this condition that restore vision to normal with no complication and costs \$ 10,000. Life expectancy at age 40 in the general population is assumed to be 42 years and time trade off yields a utility value of 0.999 for presbyopia. Calculate the number of QALY with intervention and without intervention

QALY versus DALY



3. Methods of Measuring Preference

- Example: EQ-5D (EuroQol 5 dimensions; n=245)
- Health state 1:
 - no problems walking about; no problems with self care; no problems performing usual activities; no pain or discomfort; not anxious or depressed
- Health state 2:
 - no problems walking about; no problems with self care; some problems performing usual activities; no pain or discomfort; extremely anxious or depressed

3. Methods of Measuring Preference

Quality of well Being (QWB)

- Classifies patients according to four attributes
 - Mobility
 - Physical Activity
 - Social Activity
 - Symptom Problem Complex

Euro Qol(EQ 5D)

- Five attributes
 - Mobility
 - Self Care
 - Usual Activity
 - Pain/ Discomfort
 - Anxiety/depression

Summary

Situations where QALYs should be used or might be useful

- There is no expected effect of the intervention on mortality: physical, social and psychological wellbeing are the expected effects of the intervention
- Both morbidity and mortality are affected by the intervention and a common metrics is desired
- Interventions with a range of different outcomes will be compared

Summary

Situations where QALYs may not be useful or should not be used

- When only intermediate outcome data can be obtained and these outcomes cannot be converted into QALYs
- When obtaining utility measure is too expensive or too difficult
- When incorporating utility measures would not change conclusions