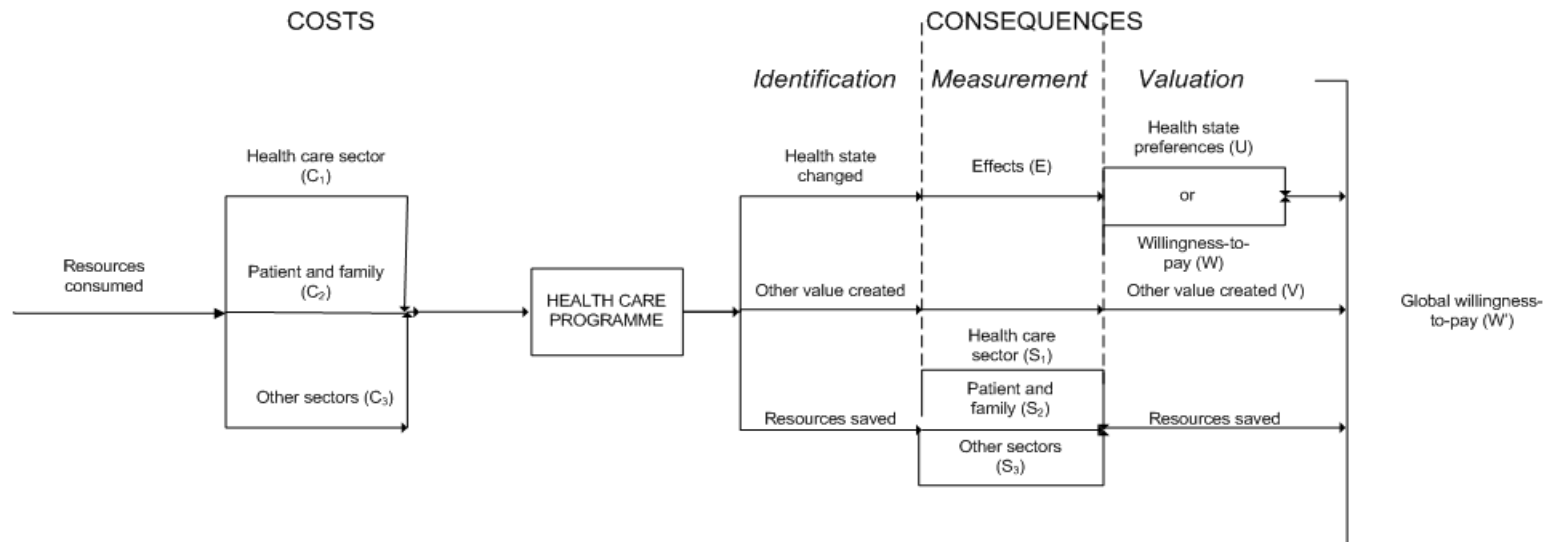


# LECTURE 3

## ESTIMATING BENEFITS, OUTCOMES AND COSTS

# PART1:ESTIMATING COSTS

Cost figures are used in all forms of economic evaluation



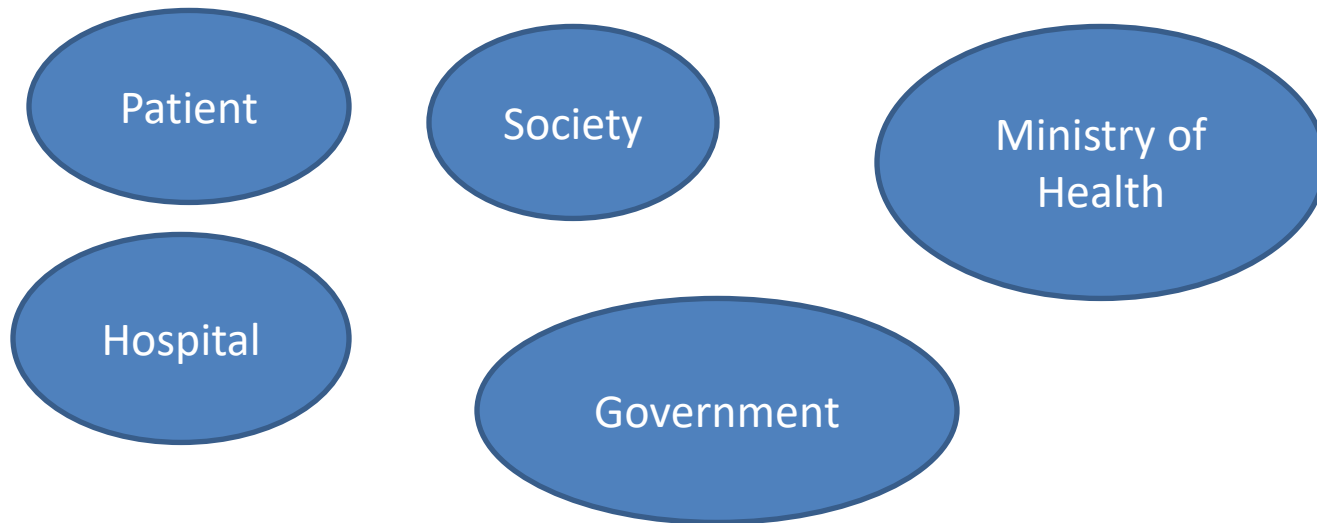
The figure shows the three main categories that can be considered

- Health care resources
- Patient-family resources
- Resource use in other sectors

# Which costs to consider?

The range of costs to be considered depends on the following four points:

- The viewpoint of the analysis : An item may be a cost from one point of view but not a cost from another (e.g. Patients' travel costs)



Different viewpoints can be taken

# The influence of viewpoint

Weisbrod et al. (1980)

Cohort: chronically  
disabled psychiatric  
patients

1. Community-  
treatment  
program

2. Conventional  
treatment  
progressive short-  
term  
hospitalization  
plus aftercare

The implementation of the TCL program has been described in detail.<sup>22</sup> In brief, the program was implemented by a retrained mental-hospital ward staff who were transplanted to the community.<sup>23</sup> Staff coverage was available 24 hours a day, seven days a week. Patient programs were individually tailored and were based primarily on an assessment of the patient's coping-skill deficits and requirements for community living. Most treatment took place in vivo: in patients' homes, neighborhoods, and places of work. More specifically, staff members on-the-scene in patients' homes and neighborhoods taught and assisted them in daily living activities such as laundry upkeep, shopping, cooking, restaurant use, grooming, budgeting, and use of transportation. In addition, patients were given sustained and intensive assistance in finding a job or sheltered workshop, and the staff then continued daily contact with patients and their supervisors or employers to help with on-the-job problem solving. Patients were aided in the constructive use of leisure and the development of effective social skills by the staff, who prodded and supported their involvement in recreation and social activities. Their effort was directed toward taking advantage of patients' strengths rather than focusing on their pathology. Providing support to patients, patients' families, and community members was a key function of the staff. The program was "assertive"; if a patient did not show

# The influence of viewpoint

| Item                    | Programme 1 (\$<br>per annum) | Programme 2<br>(\$ per annum) | Difference<br>(\$ per annum) |
|-------------------------|-------------------------------|-------------------------------|------------------------------|
| COSTS (C)               |                               |                               |                              |
| Primary treatment costs | 4800                          | 3100                          | 1700                         |

| Item                        | Programme 1 (\$<br>per annum) | Programme 2<br>(\$ per annum) | Difference<br>(\$ per annum) |
|-----------------------------|-------------------------------|-------------------------------|------------------------------|
| COSTS (C)                   |                               |                               |                              |
| Primary treatment costs     | 4800                          | 3100                          | 1700                         |
| Other treatment costs       | 1800                          | 2100                          |                              |
| Wider social costs          | 1420                          | 2020                          |                              |
| BENEFITS                    |                               |                               |                              |
| Patient earnings            | 2400                          | 1200                          |                              |
| NET ECONOMIC COSTS<br>(B-C) | 5620                          | 6020                          | 400                          |

Based on Weisbrod et al. (1980) (See also  
<http://www.crd.york.ac.uk/CRDWeb/ShowRecord.asp?AccessionNumber=21995005266>)

# Which costs to consider?

- Have all the alternatives been specified?
  - If so, the common costs to all alternatives need not be considered. Otherwise, consider all the costs!
- Are some costs merely likely to confirm a result that would be obtained by consideration of a narrower range of costs?
  - If so, such costs can be excluded (justification of exclusion should be given)
- Are there any costs which are so small that they are unlikely to make a difference in the results?
  - Such costs can be eliminated (again, justification should be given)

# How should costs be estimated?

Different sources could be used: hospital records, asking patients etc.

| Unit cost            | Unit      | Base-case value | Source             |
|----------------------|-----------|-----------------|--------------------|
| PCI                  | Procedure | £1410.04        | [21]               |
| CABG                 | Procedure | £4902.22        | [21]               |
| Repeat PCI           | Per diem  | £2976           | [21]               |
| Angiogram            | Procedure | £748.25         | [21]               |
| Cardiac ward         | Day       | £157.47         | [21]               |
| Non cardiac ward     | Day       | £244.00         | [21]               |
| CCU                  | Day       | £459.04         | [21]               |
| Outpatient           | Visit     | £59.70          | [21]               |
| Cardiac day case     | Visit     | £108.58         | [21]               |
| Non cardiac day case | Visit     | £182.00         | [21]               |
| Guidewire            | Item      | £61.75          | [21]               |
| Stent                | Item      | £599.01         | [21]               |
| Guiding catheter     | Item      | £37.05          | [21]               |
| Blood                | Unit      | £85.00          | Specific NHS trust |
| Full blood count     | Item      | £4.00           | Specific NHS trust |

| Unit cost    | Unit              | Base-case value | Source |
|--------------|-------------------|-----------------|--------|
| Endoscopy    | Item              | £246.00         | [22]   |
| Tirofiban    | 12.5 mg vial      | £146.11 (+VAT)  | [13]   |
| Eptifibatide | 20 mg vial        | £15.54 (+VAT)   | [13]   |
| Eptifibatide | 75 mg vial        | £48.84 (+VAT)   | [13]   |
| Abciximab    | 10 mg vial        | £280.00 (+VAT)  | [13]   |
| Omeprazole   | 28 tab pack 10 mg | £18.91          | [13]   |



# Issues in costing studies

The following issues commonly arise in costing studies:

- 1. Non-market items**
- 2. Imperfections in markets**
- 3. Time horizon**
- 4. Handling health care costs unrelated to the programme**
- 5. Costs over time: Capital investment**
- 6. Average cost/ marginal cost distinction**
- 7. (Shared) Overhead costs**

# Issues in costing studies

## 1. Non-market items:

Volunteer time, patient/family leisure time

Market wage rates could be used (for volunteer time unskilled labour time might be used)

Leisure time is harder to assess (zero, average earnings, average overtime earnings )

### **Common practice:**

Value lost leisure time at zero in the base case (primary analysis),  
Investigate the impact of other assumptions through the sensitivity analysis

# Issues in costing studies

## 2. Imperfections in markets

Cost refers to the sacrifice (of benefits) made when a given resource is consumed in a programme

Consider other resources, the consumption of which is not adequately reflected in market prices, e.g. Volunteer time, donated clinic space etc.

# Issues in costing studies

Market prices may not reflect opportunity costs

e.g. Hospital charges may deviate from costs (in case of monopoly or cross-subsidization)

Not always clear when to attempt to adjust market prices. Adjust if

- Lack of adjustment would introduce substantial biases into the study
- There is a clear and objective way of making the adjustments

|             | Standard hospital charges |            | Costs   |            |
|-------------|---------------------------|------------|---------|------------|
| PTCA        | \$8369                    |            | \$5396  |            |
| Atherectomy | \$8391                    |            | \$5726  |            |
| Stent       | \$12670                   | Increasing | \$7828  | Increasing |
| CABG        | \$27739                   |            | \$20927 |            |

(Adjustment by cost-to-charge ratios might be used)

In the case of a third party payer the charges themselves can be used

# Issues in costing studies

## 3. Time horizon

How long a time horizon should be chosen?

The choice should not bias the analysis in favour of one intervention over another

| Follow-up time                 | Agencies considered         |
|--------------------------------|-----------------------------|
| Short term (e.g. to discharge) | Hospital                    |
| Medium term (e.g. to one year) | +Other health care agencies |
| Long term (e.g. to lifetime)   | +Patient, family, friends   |

# Issues in costing studies

## 4. Handling health care costs unrelated to the programme

Consequences of keeping the individuals alive

Open to debate, no agreement about whether to include them

Most argue the need to include future costs for related illnesses,

There are dramatically divergent conclusions about whether future unrelated costs should be included.

Some argue that future nonmedical costs should also be included

Use sensitivity analysis and see how things change under different assumptions!

# Issues in costing studies

## 5. Costs over time: Capital investment

Capital costs: costs to purchase the major capital assets required by the program (e.g. Land, equipment, buildings)

Investment at a single point in time

Used over time, hence wear out (depreciation) occurs in most assets

Land is non-depreciable

Capital cost



```
graph TD; A[Capital cost] --> B[Opportunity cost of tying up funds<br/>Lost opportunity of investing money in<br/>some other venture with positive benefits<br/>Interest rate]; A --> C[Depreciation over time of the asset itself<br/>Different accounting methods can be<br/>used: Straight line, declining balance,<br/>double declining balance];
```



Opportunity cost of tying up funds  
Lost opportunity of investing money in  
some other venture with positive benefits  
Interest rate

Depreciation over time of the asset itself  
Different accounting methods can be  
used: Straight line, declining balance,  
double declining balance

# Issues in costing studies

Annuitize the initial capital cost over the useful life of the asset  
(equivalent annual cost)



# Issues in costing studies

## 6. Average cost/ marginal cost distinction

### Various definitions of cost

Total Cost (TC)

Fixed Cost (FC)

Variable Cost (VC)

Cost function  $(TC)=f(Q)$ , where  $Q$  is the quantity

Average cost  $(AC)=TC/Q$

Marginal cost  $(MC)=d(TC)/dQ$  evaluated at  $x$

The extra cost of producing *one extra* unit of output

Incremental cost(IC)=the difference in cost between the two or more programs compared in the evaluation

The terms 'marginal' and 'incremental' are often used interchangeably in the literature!

# Issues in costing studies

Suppose we want estimate savings from a reduction of one day's stay in the hospital by a program

| Cost (\$) |       |       |
|-----------|-------|-------|
| Day 1     | Day 2 | Day 3 |
| 450       | 500   | 250   |

Average cost of staying one day: \$400

Savings from a one day decrease in stay: \$250

Another issue: one should also investigate whether the freed resources through savings will be usefully deployed!

The choice is problem specific.

# Issues in costing studies

## 7. (Shared) Overhead costs:

The resources which serve many different departments or programmes: Administration, cleaning, power etc.

While costing an individual program one should also consider these shared costs

Various methods are available for a more detailed consideration of costs:

- Direct Allocation
- Step down Allocation
- Step down with iterations
- Simultaneous allocation

# Issues in costing studies: Overhead costs

## Direct Allocation

### Direct Allocation: (Proportional)

- Ignores interaction between overhead departments
- Allocation to final cost centres (FCC)
- Decide on an allocation basis e.g. Paid hours of staff, the area (in m<sup>2</sup>) that the centre uses

Allocation of overhead costs Y to a FCC X = Total cost of Y \* FCC X's share of the allocation basis

# Issues in costing studies: Overhead costs

## Step down Allocation

### Step down allocation

- Partial consideration of interactions between overhead departments (Unlike the direct method, the *step-down method* provides for allocation of a service department's costs to other service departments, as well as to operating departments. )
- Allocate the overhead departments in a stepwise fashion to all of the **remaining** overhead departments and to the FCCs

# Issues in costing studies: Overhead costs

## Step down with iterations

### Step down with iterations

- Full consideration of interaction
- Allocate the overhead departments in a stepwise fashion to all of the **other** overhead departments and to the FCCs

# Issues in costing studies: Overhead costs

## Simultaneous allocation

### Simultaneous allocation

- Full consideration of interaction
- Solve a set of simultaneous linear equations to give the allocations
- Same answer as method (3) with less work

# Issues in costing studies

## **8. Productivity**

Changes in the productive output more often enter into the evaluation as a consequence (will be discussed later in the consequences section)



# Overhead costs example handout

**Table 4.1.** Cost allocation data

|                                            | Annual<br>direct cost <sup>a</sup><br>\$ | Annual units<br>of output <sup>b</sup> | Direct cost<br>per unit<br>\$ | Allocation<br>basis | Annual<br>pd-hrs | Ft <sup>2</sup> | Annual<br>lbs laundry |
|--------------------------------------------|------------------------------------------|----------------------------------------|-------------------------------|---------------------|------------------|-----------------|-----------------------|
| <b>Overhead departments</b>                |                                          |                                        |                               |                     |                  |                 |                       |
| Administration                             | 2,000,000                                |                                        |                               | pd-hrs              | 200 000          | 30 000          | 0                     |
| Housekeeping                               | 1,500,000                                |                                        |                               | ft <sup>2</sup>     | 300 000          | 4 000           | 80 000                |
| Laundry                                    | 1,300,000                                |                                        |                               | lbs                 | 200 000          | 8 000           | 0                     |
| Other                                      | 10,200,000                               |                                        |                               |                     | 300 000          | 158 000         | 120 000               |
| <u>Subtotal</u>                            | <u>15,000,000</u>                        |                                        |                               |                     | <u>1 000 000</u> | <u>200 000</u>  | <u>200 000</u>        |
| <b>Final departments<br/>(Pt. service)</b> |                                          |                                        |                               |                     |                  |                 |                       |
| Laboratory                                 | 4,000,000                                | 8 000 000                              | 0.50/WMU                      |                     | 250 000          | 30 000          | 25 000                |
| NICU                                       | 500,000                                  | 5 000                                  | 100/pt.-day                   |                     | 50 000           | 8 000           | 75 000                |
| Other                                      | 30,500,000                               |                                        |                               |                     | 1 700 000        | 562 000         | 1 200 000             |
| <u>Subtotal</u>                            | <u>35,000,000</u>                        |                                        |                               |                     | <u>2 000 000</u> | <u>600 000</u>  | <u>1 300 000</u>      |
| <b>Hospital total</b>                      | <b>50,000,000</b>                        |                                        |                               |                     | <b>3 000 000</b> | <b>800 000</b>  | <b>1 500 000</b>      |

<sup>a</sup> Direct cost consists of salaries plus supplies. <sup>b</sup> Lab output is in workload measurement units (WMUs) and NICU output is in patient-days.

# Accuracy

How accurate does costing have to be?

- Costing may take considerable time and effort
- The analyst should make the judgement on how accurate cost estimated need to be
- If a cost item is likely to affect the results one may spend some time on making a more precise estimate of that cost

# CAPITAL EXPENDITURES

# Capital Expenditures

- Timing of costs and consequences are usually different.
- (Positive rate of) Time preference: The preference of receiving the benefits earlier and incurring the costs later
- One can usually obtain a positive return with a riskless investment (due to the prevalence of positive rate of time preference)
- Time preference extends beyond money transactions and could extend to goods and services that could not be easily traded
- Significant when we compare programmes with different time profiles

# Capital Expenditures

Significant when we compare programmes with different time profiles

**Example:** Two options for dealing with heart disease

1. Expand funding for coronary artery bypass grafting
2. Conduct a health education campaign to influence diet and lifestyle

We expect option 1 to deliver benefits earlier and would look more attractive if a positive rate of time preference were acknowledged

# Capital Expenditures

Two approaches of comparison that takes differential timing of resource outlays

- Discount future costs to their *present values*
- Express all the costs on an annual basis and obtain an *equivalent annual cost*

# Discount future costs to their present values

$$P = \sum_{n=1}^N F_n (1+r)^{-n}$$

Discount factor

Where  $P$  = present value

$F_n$  = Future cost at year (period)  $n$

$r$  = annual interest (discount) rate

We assumed that the costs occur at the end of each year

If the costs occur at the beginning of each year do not discount year 1 costs!



# Equivalent Annual Cost

- Convenient when most of the costs are easily expressed on an annual recurring basis and it is only the capital costs that differ from year to year
- Capital outlay ( $K$ ) usually at the beginning of the programme
- Find the annual sum  $E$ , which over the period of  $N$  years (the life of the facility) will be equivalent to  $K$  at an interest rate  $r$ .

$$K = \frac{E}{(1+r)} + \frac{E}{(1+r)^2} + \dots + \frac{E}{(1+r)^N}$$

$$K = E \frac{1 - (1+r)^{-N}}{r}$$

Annuity Factor  
 $A(N, r)$

Show this as an exercise!

One can use the Table to obtain the Annuity Factor  
What happens to the formula when the annuity is payable in advance?

# Equivalent annual cost with a resale value

- $S$ =the resale value

$$K - \frac{S}{(1+r)^N} = E * \text{Annuity factor}$$

## Choice of the parameters $r$ , $S$ and $N$

$N$ : Useful life vs. Physical life (better to assume short lives)

$r$ : Interest rate

# Examples

- Calculate the present value of an intervention that costs a total of \$400 with \$200 spent in the first year and \$200 spent in the second year, assuming a discount rate of 5%.
- Calculate the present value of an intervention that costs a total of \$600 with \$200 spent in the first year and \$100 each year of four subsequent years, assuming a discount rate of 5%.

## PART 2

# ESTIMATING BENEFITS AND OUTCOMES

# Benefits and outcomes

- Cost-Effectiveness Analysis (CEA)
  - benefits on one criterion non-monetary scale (measured in natural units e.g. lives lost, cases found, life-years gained)
- Cost-Utility Analysis
  - Estimating health improvement (QALYs or HYE<sub>s</sub>)
  - Quality-Adjusted Life Years (QALYs) & deriving Cost/QALY
  - Using Cost/QALY to set priorities
- (Social) Cost Benefit Analysis (CBA)
  - all criteria common monetary scale

# CEA vs. CUA

Outcomes in CEA are **single**, **programme-specific**, and **unvalued**.

Outcomes in CUA **may be single or multiple**, **general** and incorporate the notion of ***value***.

CUA is able to incorporate simultaneously both the changes in **the *quantity of life (mortality)*** and the changes **in the *quality of life (morbidity)*** through values or utilities.

*CUA may appear under CEA label in some studies!*

# Utility, value and preference

- Utility and value are different types of preferences.
- Although utility and value might be used interchangeably, *utility* concept is used when *uncertainty is involved* and *value* is used when *uncertainty is not involved*.
- What you get depends on the measurement.
- There are two main approaches to measuring utilities:
  - direct measurement
  - the use of multi-attribute systems.

# Direct Measurement Techniques



# Utility, value and preference

## Direct Measurement

Two important factors here:

- Question framing
- Response method

| Response Method | Question Framing                                                         |                         |
|-----------------|--------------------------------------------------------------------------|-------------------------|
|                 | Certainty (values)                                                       | Uncertainty (utilities) |
| Scaling         | Rating Scale<br>Category scaling<br>Visual Analogue Scale<br>Ratio Scale |                         |
| Choice          | Time trade-off<br>Paired comparison<br>Equivalence<br>Person trade-off   | Standard gamble         |

# Utility, value and preference

## Question framing

- Preference questions on health outcomes: a path from now to death consisting of one or more health states
- Measured preferences may be **ordinal (rank ordered)** or **cardinal (a number is attached to each outcome, an interval scale must be used)**

# Utility, value and preference

## Question framing

- Under **certainty**, the decision maker would be asked:
  - To compare two or more outcomes and to choose between them
  - To scale them

The DM's risk attitude is not captured

- Under **uncertainty**, the DM would be asked to compare alternatives at least one of which contains uncertainty (e.g. standard gamble question)

The DM's risk attitude is captured

# Utility, value and preference

## Response method

The DM can be asked:

- To determine a **strength of preference** and to indicate the results on a numerical scale
- To choose between two alternatives, revealing the preference indirectly (Revealed preference approach, more natural)

# Levels of measurement (Scales of Measure)

**Nominal Scale:** Categorical data

- Colors: red, blue, green

**Ordinal Scale:** Rank order

- Size: small, medium, large

# Levels of measurement

## (Scales of Measure)

- Cardinal Scale: can be interval or ratio
  - **Interval Scale:** e.g. temperature in  $^{\circ}\text{C}$ ,
    - *Ratios of intervals* have a meaning but ratios of scale quantities do not
    - Correct: The gain in temperature in going from  $40^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  is twice as much as the gain in going from  $40^{\circ}\text{C}$  to  $50^{\circ}\text{C}$
    - Incorrect:  $80^{\circ}\text{C}$  is twice as hot as  $40^{\circ}\text{C}$
  - **Ratio Scale:** has an absolute (unambiguous) zero point
    - Both ratios of intervals and ratios of scale quantities have meaning
    - Correct: The gain in length in going from 40 cm to 60 cm is twice as much as the gain in going from 40 cm to 50 cm
    - Correct: 80 cm is twice as long as 40 cm

# Measuring preferences

## Rating scale approach

| Response Method | Question Framing                                                                                     |
|-----------------|------------------------------------------------------------------------------------------------------|
|                 | Certainty (values)                                                                                   |
| Scaling         | <b>Rating Scale</b><br><b>Category scaling</b><br><b>Visual Analogue Scale</b><br><b>Ratio Scale</b> |

Rating scale approach (Tries to obtain an interval scale)

- The simplest of the direct measurement approaches
- Rank the outcomes from most preferred to least preferred
- Place them on a scale such that the **intervals** between placements correspond to the **differences in preferences**

# Measuring preferences

## Rating scale approach

| Response Method | Question Framing                                                                                     |
|-----------------|------------------------------------------------------------------------------------------------------|
|                 | Certainty (values)                                                                                   |
| Scaling         | <b>Rating Scale</b><br><b>Category scaling</b><br><b>Visual Analogue Scale</b><br><b>Ratio Scale</b> |

Variations of scaling approaches: The scale can have

- Numbers (e.g. 0-100) (rating scale)
- Categories (equally spaced, e.g. 0-10) (Category scaling)
- Just consist of a line on a page(Visual Analogue Scaling)



# Rating scale approach

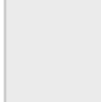
- **Visual Analogue Scaling:** Consists of a single line with anchors representing the best possible health and death (or some alternative worse than death).
- Ask the respondent to place each health state on the line such that the **intervals** between placements reflect **their perceived differences** between the health states

# Neck Pain Visual Analogue Scale

This pain scale is designed to give your physician a subjective measure of the characteristics and quality of your pain. Please choose the number that you feel matches your current pain.

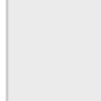
1) Mark your current **neck pain** based on the scale below.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

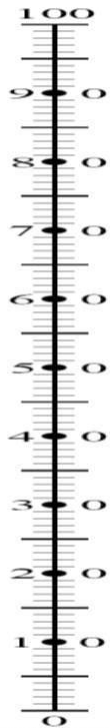
| 0                                                                                 | 1                                                                                 | 2                                                                                 | 3                                                                                  | 4                                                                                   | 5                                                                                   | 6                                                                                   | 7                                                                                   | 8                                                                                   | 9                                                                                   | 10                                                                                  |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |  |  |  |  |  |  |  |  |
| No pain                                                                           | Mild, annoying pain                                                               | Nagging, uncomfortable, troublesome pain                                          | Distressing, miserable pain                                                        | Intense, dreadful, horrible pain                                                    | Worst possible, unbearable, excruciating pain                                       |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |

2) Mark your current **arm pain** based on the scale below.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

| 0                                                                                   | 1                                                                                   | 2                                                                                   | 3                                                                                    | 4                                                                                     | 5                                                                                     | 6                                                                                     | 7                                                                                     | 8                                                                                     | 9                                                                                     | 10                                                                                    |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |  |  |  |  |  |  |  |  |  |
| No pain                                                                             | Mild, annoying pain                                                                 | Nagging, uncomfortable, troublesome pain                                            | Distressing, miserable pain                                                          | Intense, dreadful, horrible pain                                                      | Worst possible, unbearable, excruciating pain                                         |                                                                                       |                                                                                       |                                                                                       |                                                                                       |                                                                                       |

Best  
imaginable  
health state



Worst  
imaginable  
health state

## Utility Score

100 (1.0) —

90 (0.9) —

80 (0.8) —

70 (0.7) —

60 (0.6) —

50 (0.5) —

40 (0.4) —

30 (0.3) —

20 (0.2) —

10 (0.1) —

0 (0.0) —

## Disease State or Condition

— Perfect health

— Mild allergies

— Broken wrist

— Broken leg

— Hospital dialysis (1 year)

— Hospital dialysis (5 years)

— Severe angina

— Coma (1 year)

— Dead

# Rating Scale

## Chronic States

- Described to the subject as irreversible (permanent from the age of onset until death)
- The age of onset and age of death should be the same for all states that are measured together relative to each other in one batch
- Use multiple batches for states with different
- Two additional chronic states are added to each batch as reference states for the scale (Make a guess)
- Ask the subject to select the best and worst health states of the batch
- Then ask him/her to locate the other states on the rating scale

such that the distances between the locations are proportional to his/her preference differences

If death is judged to be the worst state (with a value of 0):

preference value of each of the other states = the scale value of its placement

If death is not judged to be the worst state (with a value of  $d > 0$ ): preference value of the other states =  $(x - d) / (1 - d)$

# Rating Scale

- **Temporary States**

- Described to the subject as lasting for a specified duration of time at the end of which the person gets back to normal health
- States of the same duration and the same age of onset should be batched together for measurement
- Each batch should have an additional state added to it
- Ask the subject to place the best state (what is it?) at the end of the scale and the worst temporary state at the other end
- Again, the remaining temporary states are located on the scale such that the distances between locations are proportional to his/her preference differences
- Sufficient when the programs do not involve mortality

# Rating Scale

- Temporary States

If the programs involve mortality or there is a need to compare the findings to other programs that involve mortality :

the preference values for the temporary states must be **transformed to a 0-1** health preference scale

Redefine the worst temporary state as a chronic state of the same duration and measure its preference value by the method described for chronic states

Transform the values of the other temporary health states accordingly

# Example: Feeling Thermometer

## (A combination of VAS and RS)

- Suppose that there are three chronic health states: A, B and C
- Imagine that you will have to spend the rest of your life in one of these conditions
- I have a device called **feeling thermometer**: a thermometer shaped 0-100 scale on a felt board with 0 labelled “least desirable” and 100 labelled “most desirable”
- I also have these 5 narrow foam sticks pointed at each end labelled respectively: healthy, dead, A, B, C
- Select the most and least desirable states and place them at 100 and 0, respectively

# Example VAS

- Place the other sticks in between them depending on how you feel about spending the rest of your life in each condition
- If you feel the same about two sticks just put them on top of each other
- The distance between the sticks should all be relative to each other
- That is, if you feel that the difference in desirability between healthy and A is twice as great as the difference between A and B, then the spacing between the sticks healthy and A should be twice that between A and B



# Measuring preferences

## Rating scale approach

**The end-of-scale bias:** Participants are reluctant to place health states at the extreme ends of the scale.

**Spacing out bias:** Participants tend to space out the outcomes over the scale regardless of the outcomes

However, the simplicity of the VAS makes it a useful tool  
It is often used as a 'warm up' exercise before other methods

# Measuring preferences (Standard Gamble)

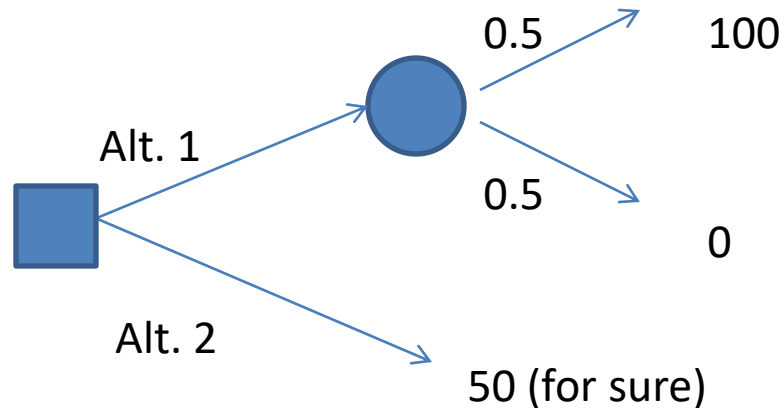
| Response Method | Question Framing           |
|-----------------|----------------------------|
|                 | Uncertainty<br>(utilities) |
| Choice          | Standard gamble            |

Based on the fundamental axioms of utility theory  
introduced by von Neumann and Morgenstern (1944)

# Utility Theory

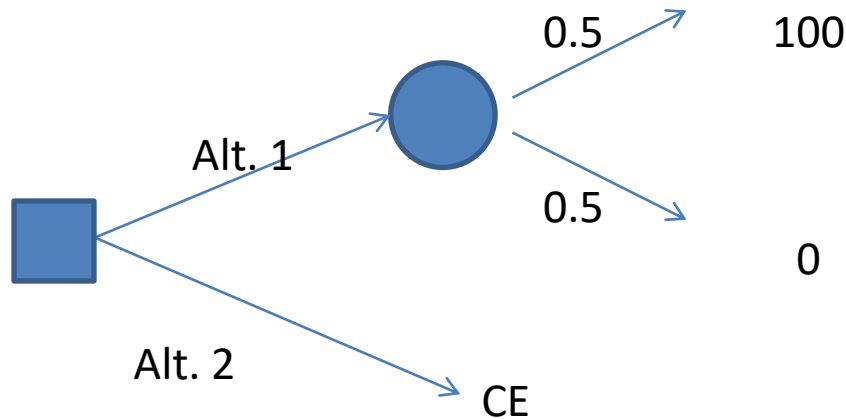
## On Board

# Risk attitude



- Risk averse: Expected value is preferred to the alternative (gamble) itself (Alt. 2 is preferred)
- Risk neutral: Indifference between two
- Risk seeking: Preference for the gamble (Alt 1 is preferred)

# Risk attitude: Finding CE



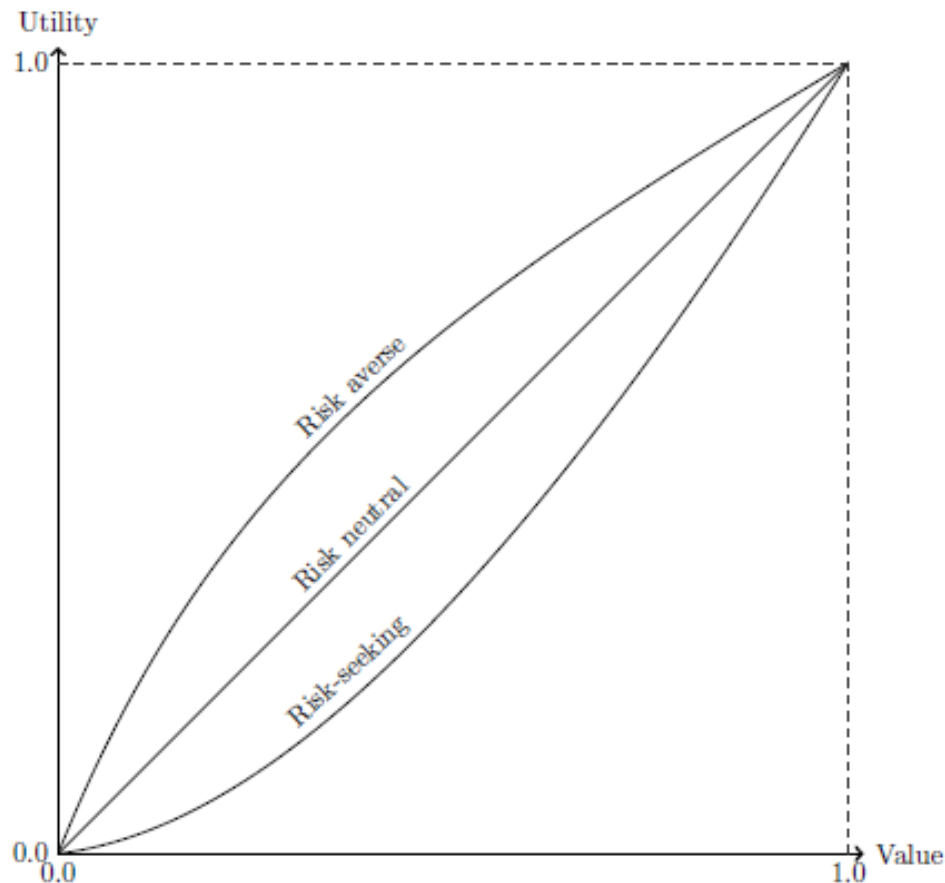
Certainty Equivalent (CE): The lowest amount of money –for certain- that the DM would be willing to accept instead of the gamble

Find the CE value under the following assumptions

$$u(x)=x, \quad u(x)=20+5x, \quad u(x)=x^2$$

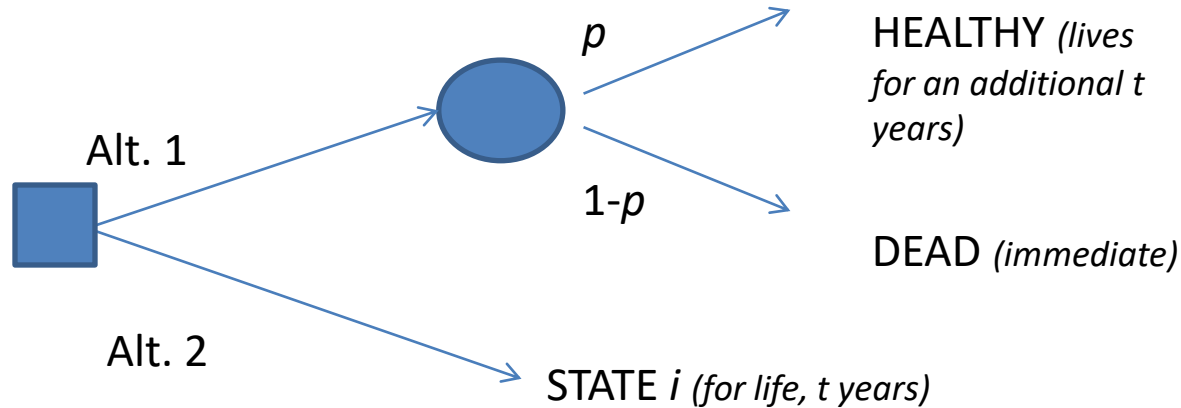
# Risk attitude

- Risk averse:  $CE(\text{lottery}) < EV(\text{lottery})$
- Risk neutral:  $CE(\text{lottery}) = EV(\text{lottery})$
- Risk seeking:  $CE(\text{lottery}) > EV(\text{lottery})$



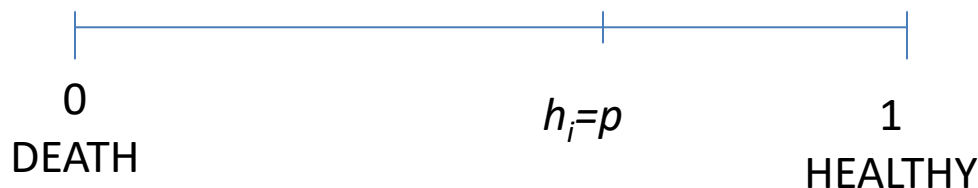
# Standard gamble

For chronic states (Assume that the chronic state (STATE  $i$ ) is preferred to death)



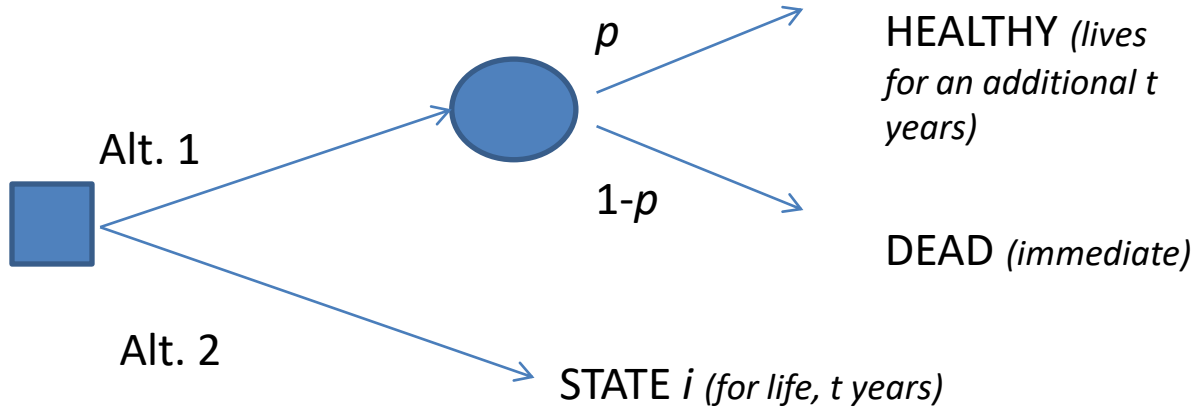
$p$  is varied until the DM is indifferent between the two alternatives  
Use bisection method

| $p$ | $(1-p)$ | Preference              |
|-----|---------|-------------------------|
| 0   | 1       | Sure thing (state $i$ ) |
| 1   | 0       | Gamble                  |
| 0.5 | 0.5     | Gamble                  |
|     |         |                         |
|     |         |                         |
|     |         |                         |



# Standard gamble

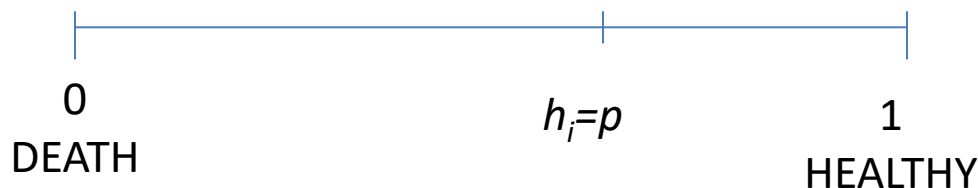
For chronic states (Assume that the chronic state (STATE  $i$ ) is preferred to death)



$p$  is varied until the DM is indifferent between the two alternatives

Use bisection method

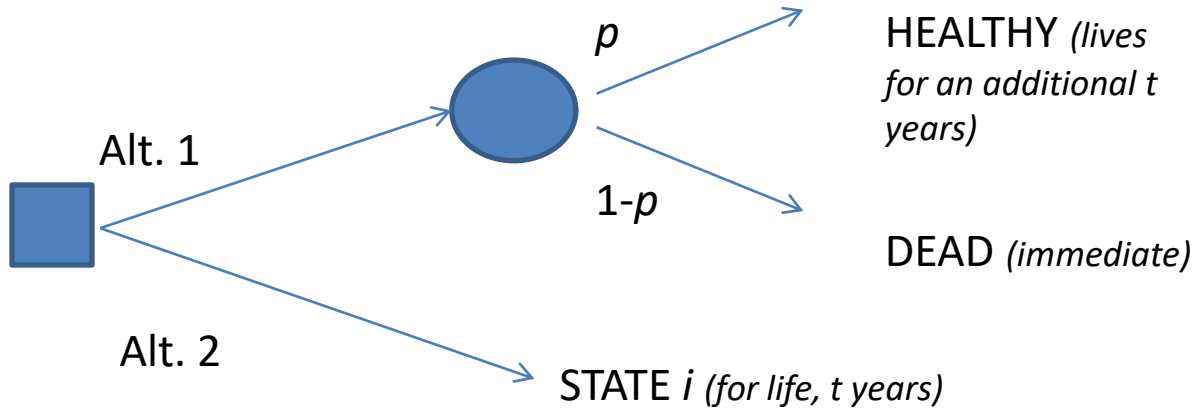
| $p$  | $(1-p)$ | Preference |
|------|---------|------------|
| 0    | 1       | Sure thing |
| 1    | 0       | Gamble     |
| 0.5  | 0.5     | Gamble     |
| 0.25 | 0.75    | Sure thing |
|      |         |            |
|      |         |            |





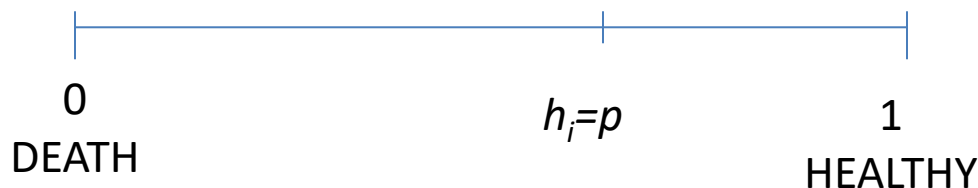
# Standard gamble

For chronic states (Assume that the chronic state (STATE  $i$ ) is preferred to death)



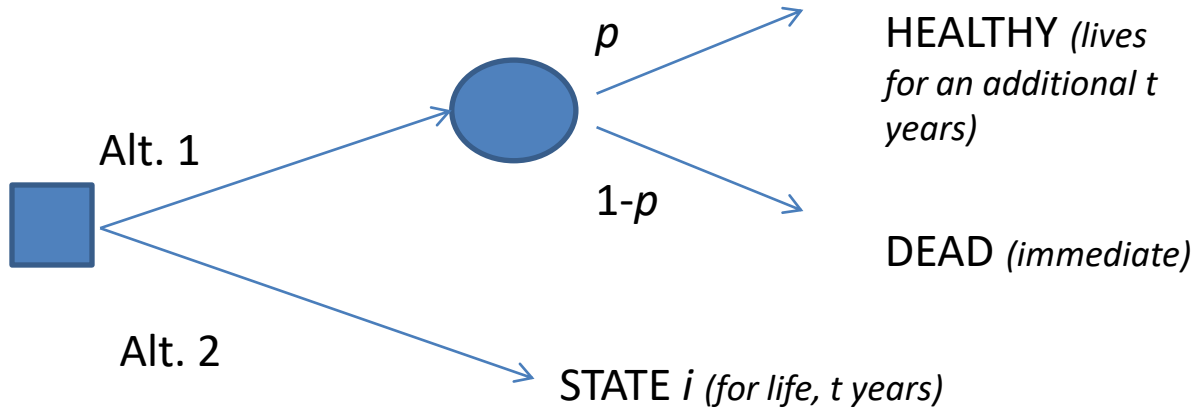
$p$  is varied until the DM is **indifferent** between the two alternatives  
Use bisection method

| $p$  | $(1-p)$ | Preference |
|------|---------|------------|
| 0    | 1       | Sure thing |
| 1    | 0       | Gamble     |
| 0.5  | 0.5     | Gamble     |
| 0.25 | 0.75    | Sure thing |
| 0.38 | 0.62    | Gamble     |
|      |         |            |



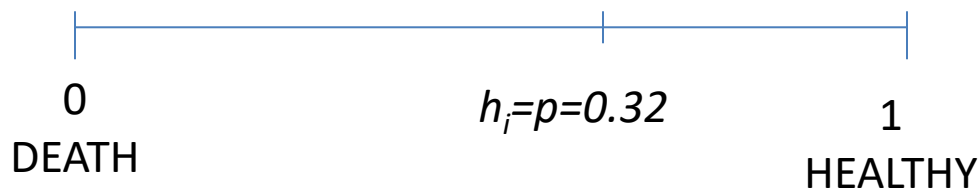
# Standard gamble

For chronic states (Assume that the chronic state (STATE  $i$ ) is preferred to death)



$p$  is varied until the DM is indifferent between the two alternatives  
Use bisection method

| $p$  | $(1-p)$ | Preference |
|------|---------|------------|
| 0    | 1       | Sure thing |
| 1    | 0       | Gamble     |
| 0.5  | 0.5     | Gamble     |
| 0.25 | 0.75    | Sure thing |
| 0.38 | 0.62    | Gamble     |
| 0.32 | 0.68    | Can't tell |

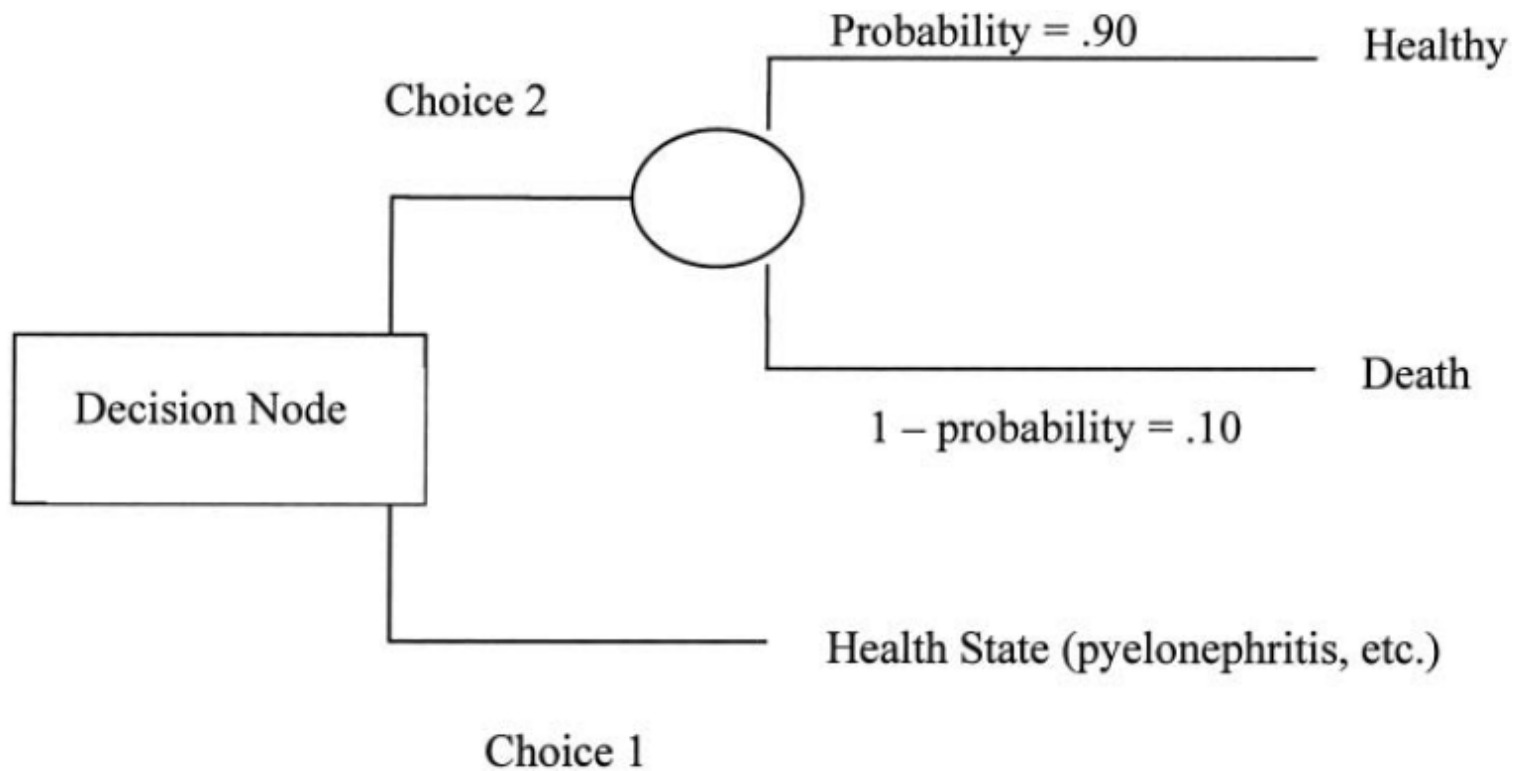


**Choose one of these options**

Admitted to a long-term hospital as an inpatient with comorbid conditions

Take the outcome from a spin on this wheel

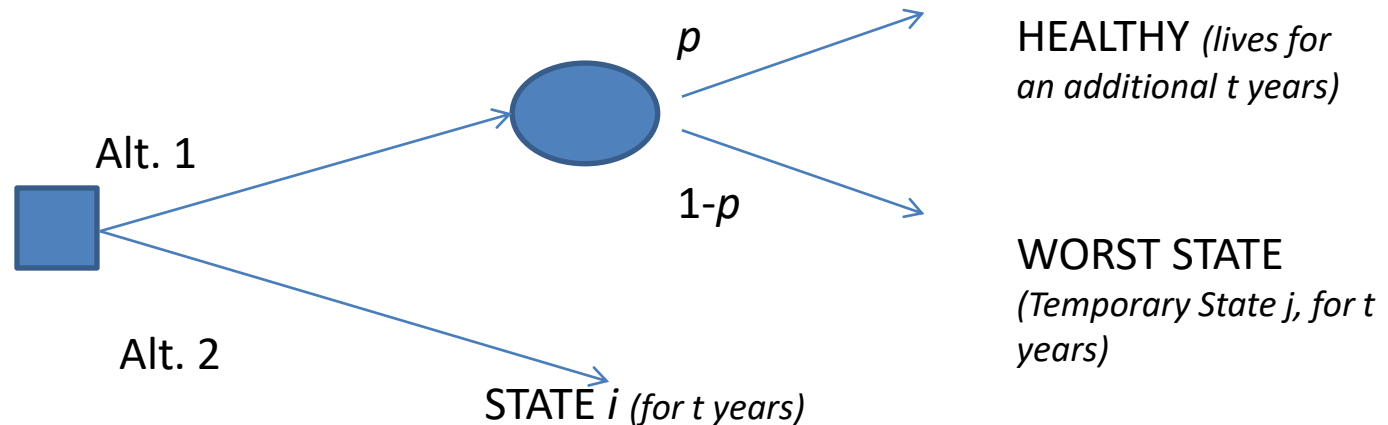




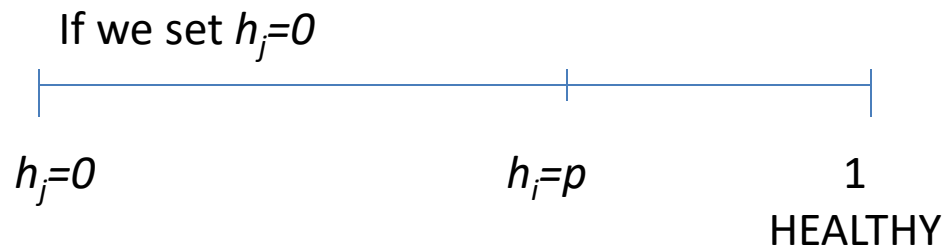
# Standard gamble

## For temporary health states

All states must last for the same duration followed by a common state, i.e. healthy



$$h_i = p \cdot 1 + (1-p) \cdot h_j$$

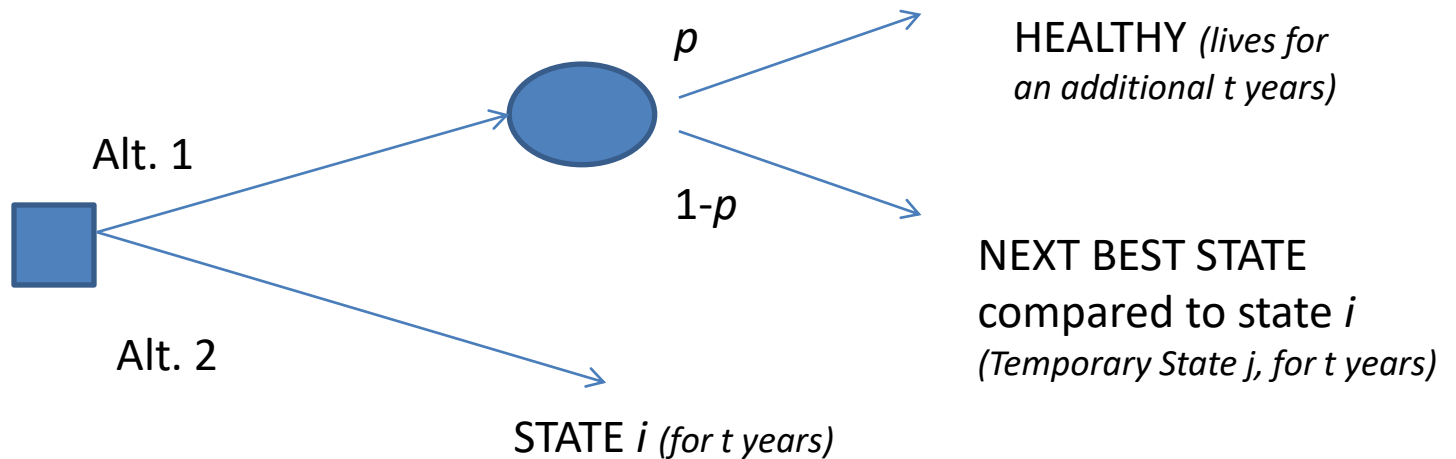


How can we convert this to a 0-1 **death- healthy** scale?

How can we convert this to a 0-1 death- healthy scale?

- Find the value of  $h_j$  first on a 0-1 death-healthy scale
- Redefine the worst of the temporary states (state  $j$ ) as a short duration chronic state for time  $t$  followed by death measured on the 0-1 scale by the technique used for chronic states
- Then  $h_i = p * 1 + (1-p) * h_j$

## A Variation:



$$h_i = p * 1 + (1-p) * h_j$$

$h$  values for the states have to be solved in sequence, starting with the worst state

# Time Trade-off

| Response Method | Question Framing<br>Certainty (values)                                        |
|-----------------|-------------------------------------------------------------------------------|
| Choice          | <b>Time trade-off</b><br>Paired comparison<br>Equivalence<br>Person trade-off |

Developed by Torrance et al. (1972)

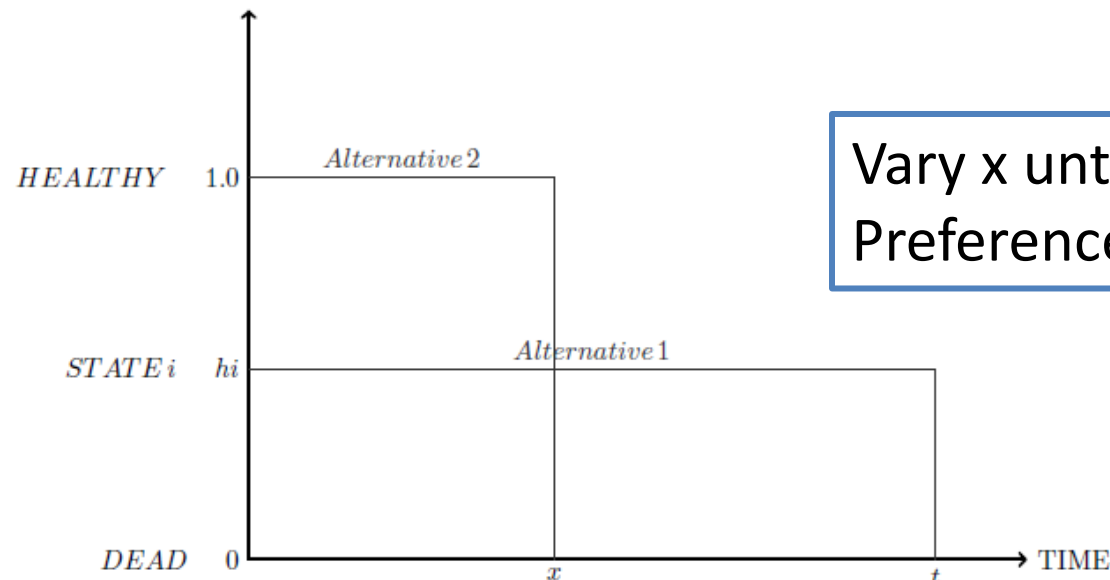


# Time Trade-off

For a chronic state better than death

The subject is offered two options:

- State  $i$  for time  $t$  (life expectancy of an individual with the chronic condition followed by death)
- Healthy for time  $x < t$  followed by death



Vary  $x$  until the respondent is indifferent  
Preference score for state  $i = h_i = x/t$

# Example

**Choose one of these options**

20 years with  
blindness in one eye

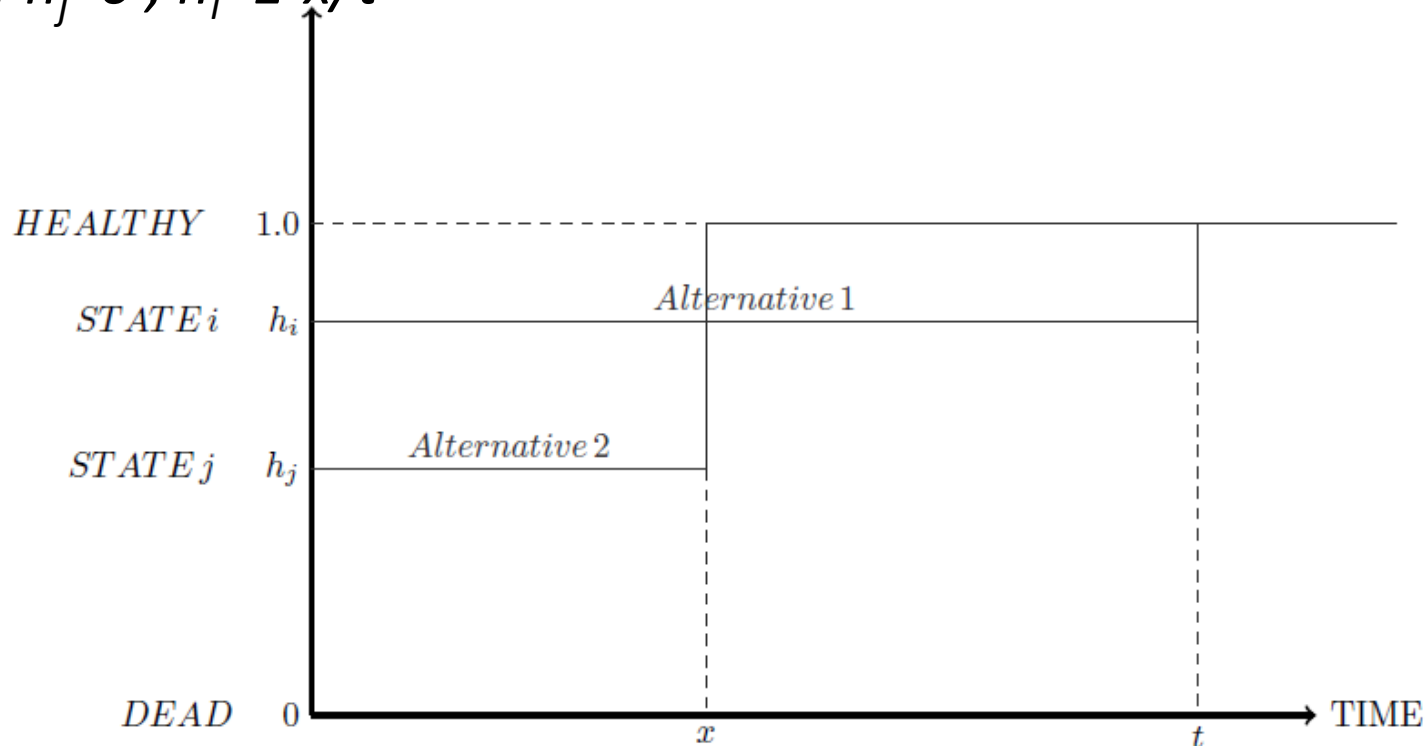
17 years with  
perfect health

| Option 1                           | Option 2                     | Choice      |
|------------------------------------|------------------------------|-------------|
| 20 years with blindness in one eye | 10 years with perfect health | 1           |
| 20 years with blindness in one eye | 15 years with perfect health | 1           |
| 20 years with blindness in one eye | 17 years with perfect health | Indifferent |
|                                    |                              |             |

# Time Trade-off

For a temporary state

- Temporary state  $i$  for time  $t$  (the duration of the temporary state), followed by healthy
- Temporary state  $j$  (worst state) for  $x < t$  followed by healthy
- Vary  $x$  until the respondent is indifferent
- Preference score for state  $i = h_i = 1 - (1 - h_j)x/t$
- If  $h_j = 0$ ,  $h_i = 1 - x/t$



- Transforming to the 0-1 dead healthy scale

Find the value of  $h_j$  first on a 0-1 death-healthy scale

Redefine the worst of the temporary states (state  $j$ ) as a short duration chronic state

And measured by the method for chronic states

# Other methods

- Ratio scale
- **Equivalence (Person trade-off):** Find  $x$  such that:

$x$  patients in the designated state of health have their lives extended by one year

=

100 healthy patients have their lives extended by 1 year

# Multi Attribute Health Status Classification Systems

# MA health status classification systems

Measuring preferences for health outcome can be time-consuming and complex

An alternative is using pre-scored multi-attribute health status classification systems

- Quality of Well Being (QWB)
- Health Utilities Index (HUI)
- EuroQol (EQ-5D)
- The underlying theory is multi-attribute utility theory

# Three main health status classification systems

## **1. Quality of Well Being (QWB)**

(Kaplan and Anderson 1988)

Classifies patients according to four attributes

1. Mobility

2. Physical activity

3. Social activity

4. Symptom-problem Complex (in case of more than one symptom/complex take the most undesirable one)

The scoring function is based on category scaling measurement hence the scores are values

Respondents asked to rate a single day in various states on scale between 0 and 1.



**TABLE 1. Quality of Well-Being Scale elements and calculating formulas**

| Step no.                             | Step definition                                                                                                                                                                                                                                                                                                                                                                                             | Weight |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| <i>Mobility Scale (MOB)</i>          |                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| 5                                    | No limitations for health reasons                                                                                                                                                                                                                                                                                                                                                                           | -.000  |
| 4                                    | Did not drive a car, health related (younger than 16); did not ride in a car as usual for age, and/or did not use public transportation, health related; or had or would have used more help than usual for age to use public transportation, health related                                                                                                                                                | -.062  |
| 2                                    | In hospital, health related                                                                                                                                                                                                                                                                                                                                                                                 | -.090  |
| <i>Physical Activity Scale (PAC)</i> |                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| 4                                    | No limitations for health reasons                                                                                                                                                                                                                                                                                                                                                                           | -.000  |
| 3                                    | In wheelchair, moved or controlled movement of wheelchair without help from someone else; or had trouble or did not try to lift, stoop, bend over, or use stairs or inclines, health related, and/or limped, used a cane, crutches or walker, health related; and/or had any other physical limitation in walking, or did not try to walk as far or as fast as others the same age are able, health related | -.060  |
| 1                                    | In wheelchair, did not move or control the movement of wheelchair without help from someone else, or in bed, chair, or couch for most or all of the day, health related                                                                                                                                                                                                                                     | -.077  |
| <i>Social Activity Scale (SAC)</i>   |                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| 5                                    | No limitations for health reasons                                                                                                                                                                                                                                                                                                                                                                           | -.000  |
| 4                                    | Limited in other role activity, health related                                                                                                                                                                                                                                                                                                                                                              | -.061  |
| 3                                    | Limited in major (primary) role activity, health related                                                                                                                                                                                                                                                                                                                                                    | -.061  |
| 2                                    | Performed no major role activity, health related, but did perform self-care activities                                                                                                                                                                                                                                                                                                                      | -.061  |
| 1                                    | Performed no major role activity, health related, and did not perform or had more help than usual in performance of one or more self-care activities, health related                                                                                                                                                                                                                                        | -.106  |

**TABLE 2.** *List of Quality of Well-Being Scale symptom/problem complexes (CPX) with calculating weights for QWB scale, version 6B*

| CPX no. | CPX description                                                                                                                                                                                   | Weights |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 1       | Death (not on respondent's card)                                                                                                                                                                  | -.727   |
| 2       | Loss of consciousness such as seizure (fits), fainting, or coma (out cold or knocked out)                                                                                                         | -.407   |
| 3       | Burn over large areas of face, body, arms, or legs                                                                                                                                                | -.367   |
| 4       | Pain, bleeding, itching, or discharge (drainage) from sexual organs—does not include normal menstrual (monthly) bleeding                                                                          | -.349   |
| 5       | Trouble learning, remembering, or thinking clearly                                                                                                                                                | -.340   |
| 6       | Any combination of one or more hands, feet, arms, or legs either missing, deformed (crooked), paralyzed (unable to move) or broken —includes wearing artificial limbs or braces                   | -.333   |
| 7       | Pain, stiffness, weakness, numbness, or other discomfort in chest, stomach (including hernia or rupture), side, neck, back, hips, or any joints of hands, feet, arms or legs                      | -.299   |
| 8       | Pain, burning, bleeding, itching, or other difficulty with rectum, bowel movements, or urination (passing water)                                                                                  | -.292   |
| 9       | Sick or upset stomach, vomiting or loose bowel movements, with or without fever, chills, or aching all over                                                                                       | -.290   |
| 10      | General tiredness, weakness, or weight loss                                                                                                                                                       | -.259   |
| 11      | Cough, wheezing, or shortness of breath <i>with or without</i> fever, chills, or aching all over                                                                                                  | -.257   |
| 12      | Spells of feeling upset, being depressed, or of crying                                                                                                                                            | -.257   |
| 13      | Headache, or dizziness, or ringing in ears, or spells of feeling hot, or nervous, or shaky                                                                                                        | -.244   |
| 14      | Burning or itching rash on large areas of face, body, arms, or legs                                                                                                                               | -.240   |
| 15      | Trouble talking, such as lisp, stuttering, hoarseness, or inability to speak                                                                                                                      | -.237   |
| 16      | Pain or discomfort in one or both eyes (such as burning or itching) or any trouble seeing after correction                                                                                        | -.230   |
| 17      | Overweight or underweight for age and height of skin defect of face, body, arms or legs, such as scars, pimples, warts, bruises, or changes in color                                              | -.186   |
| 18      | Pain in ear, tooth, jaw, throat, lips, tongue; missing or crooked permanent teeth—includes wearing bridges or false teeth; stuffy, runny nose; any trouble hearing—includes wearing a hearing aid | -.170   |
| 19      | Taking medication or staying on a prescribed diet for health reasons                                                                                                                              | -.144   |
| 20      | Wore eyeglasses or contact lenses                                                                                                                                                                 | -.101   |
| 21      | Breathing smog or unpleasant air                                                                                                                                                                  | -.101   |
| 22      | No symptoms or problem (not on respondent's card)                                                                                                                                                 | -.000   |
| 23      | Standard symptom/problem (not on respondent's card)                                                                                                                                               | -.257   |
| 24      | Trouble sleeping                                                                                                                                                                                  | -.257   |
| 25      | Intoxication                                                                                                                                                                                      | -.257   |
| 26      | Problems with sexual interest or performance                                                                                                                                                      | -.257   |
| 27      | Excessive worry or anxiety                                                                                                                                                                        | -.257   |

\* CPX 24-27 are assigned standard weights until empirical weights can be derived in new studies.

# Scoring function

## *Calculating Formulas:*

Formula 1: Point-in-time Well-being score for an individual (W):

$$W = 1 + (CPXwt) + (MOBwt) + (PACwt) + (SACwt)$$

where wt is the preference-weighted measure for each factor and CPX is symptom/problem complex. For example, the W score for a person with the following description profile may be calculated for one day as follows:

| QWB Element | Description                                                                               | Weight |
|-------------|-------------------------------------------------------------------------------------------|--------|
| CPX-11      | Cough, wheezing, or shortness of breath, with or without fever, chill, or aching all over | -.257  |
| MOB-5       | No limitations                                                                            | -.000  |
| PAC-1       | In bed, chair, or couch for most or all of the day, health related                        | -.077  |
| SAC-2       | Performed no major role activity, health related, but did perform self-care activities    | -.061  |

$$W = 1 + (-.257) + (-.000) + (-.077) + (-.061) = .605$$

Formula 2: General Health Policy Model Formula for Well-Years (WY) as an output measure:

$$WY = [\text{No. of persons} \times (CPXwt + MOBwt + PACwt + SACwt)] \times \text{time}$$

# EuroQol (EQ-5D)

EuroQol Group: A consortium of investigators in Europe

“Established in 1987, the EuroQol Group first met to test the feasibility of jointly developing a standardized non disease specific instrument for describing and valuing health-related quality of life.”\*

**Five attributes** each with three levels (no problem, some problems, major problems)

- Mobility,
- Self-care
- Usual activity
- Pain/discomfort
- Anxiety/depression

Preferences for the scoring function were measured with the time trade-off method on a random sample of 3000 adults in the UK

Score on a 0-1 scale

\*<http://www.euroqol.org/>

# EuroQol classification system

## Mobility

1. No problems walking about
2. Some problems walking about
3. Confined to bed

## Self-Care

1. No problems with self-care
2. Some problems washing or dressing self
3. Unable to wash or dress self

### Usual Activities

1. No problems with performing usual activities (e.g. work, study, housework, family or leisure activities)
2. Some problems with performing usual activities
3. Unable to perform usual activities

### Pain/Discomfort

1. No pain or discomfort
2. Moderate pain or discomfort
3. Extreme pain or discomfort

### Anxiety/Depression

1. Not anxious or depressed
2. Moderately anxious or depressed
3. Extremely anxious or depressed

# EuroQol classification system

For convenience each composite health state has a five digit code number relating to the relevant level of each dimension, with the dimensions always listed in the order given above.

For example: 11223 means

- 1 No problems walking about
- 1 No problems with self care
- 2 Some problems with performing usual activities
- 2 Moderate pain or discomfort
- 3 Extremely anxious or depressed

# EuroQol scoring formula

| DIMENSION                                | COEFFICIENT    |
|------------------------------------------|----------------|
| Constant (a)                             | 0.081          |
| Mobility<br>level 2<br>level 3           | 0.069<br>0.314 |
| Self-care<br>level 2<br>level 3          | 0.104<br>0.214 |
| Usual activity<br>level 2<br>level 3     | 0.036<br>0.094 |
| Pain/discomfort<br>level 2<br>level 3    | 0.123<br>0.386 |
| Anxiety/depression<br>level 2<br>level 3 | 0.071<br>0.236 |
| N3                                       | 0.269          |
| adjusted $r^2$                           | 0.46           |

Subtract the relevant coefficients from 1.  
Constant term: Any dysfunction at all  
N3: if any dimension is at level 3

Example: Consider the state 11223



# Health utilities index (HUI)

- There are 3 systems HUI1;HUI2 and HUI3
- Each system consists of a health status classification system and one or more scoring formulae
- In all cases the scores are preference-based, interval scaled, and on the 0-1 scale
- Scores derived from preferences of members of the general public
- Each version is based on the previous one

| <b><u>Attribute</u></b> | <b><u>Level</u></b> | <b><u>Description*</u></b>                                                                                                      |
|-------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| <b>Sensation</b>        | 1                   | Able to see, hear, and speak normally for age.                                                                                  |
|                         | 2                   | Requires equipment to see or hear or speak.                                                                                     |
|                         | 3                   | Sees, hears, or speaks with limitations even with equipment.                                                                    |
|                         | 4                   | Blind, deaf, or mute.                                                                                                           |
| <b>Mobility</b>         | 1                   | Able to walk, bend, lift, jump, and run normally for age.                                                                       |
|                         | 2                   | Walks, bends, lifts, jumps, or runs with some limitations but does not require help.                                            |
|                         | 3                   | Requires mechanical equipment (such as canes, crutches, braces, or wheelchair) to walk or get around independently.             |
|                         | 4                   | Requires the help of another person to walk or get around and requires mechanical equipment as well.                            |
|                         | 5                   | Unable to control or use arms and legs.                                                                                         |
| <b>Emotion</b>          | 1                   | Generally happy and free from worry.                                                                                            |
|                         | 2                   | Occasionally fretful, angry, irritable, anxious, depressed, or suffering "night terrors".                                       |
|                         | 3                   | Often fretful, angry, irritable, anxious, depressed, or suffering "night terrors".                                              |
|                         | 4                   | Almost always fretful, angry, irritable, anxious, depressed.                                                                    |
|                         | 5                   | Extremely fretful, angry, irritable, anxious, or depressed usually requiring hospitalisation or psychiatric institutional care. |

|                  |   |                                                                                                                                  |
|------------------|---|----------------------------------------------------------------------------------------------------------------------------------|
| <b>Cognition</b> | 1 | Learns and remembers school work normally for age.                                                                               |
|                  | 2 | Learns and remembers school work more slowly than classmates as judged by parents and/or teachers.                               |
|                  | 3 | Learns and remembers very slowly and usually requires special educational assistance.                                            |
|                  | 4 | Unable to learn and remember.                                                                                                    |
| <b>Self-Care</b> | 1 | Eats, bathes, dresses, and uses the toilet normally for age.                                                                     |
|                  | 2 | Eats, bathes, dresses, or uses the toilet independently with difficulty.                                                         |
|                  | 3 | Requires mechanical equipment to eat, bathe, dress, or use the toilet independently.                                             |
|                  | 4 | Requires the help of another person to eat, bathe, dress, or use the toilet.                                                     |
| <b>Pain</b>      | 1 | Free of pain and discomfort.                                                                                                     |
|                  | 2 | Occasional pain. Discomfort relieved by non-prescription drugs or self-control activity without disruption of normal activities. |
|                  | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities.                            |
|                  | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief.                  |
|                  | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities.                                               |
| <b>Fertility</b> | 1 | Able to have children with a fertile spouse.                                                                                     |
|                  | 2 | Difficulty in having children with a fertile spouse.                                                                             |
|                  | 3 | Unable to have children with a fertile spouse.                                                                                   |

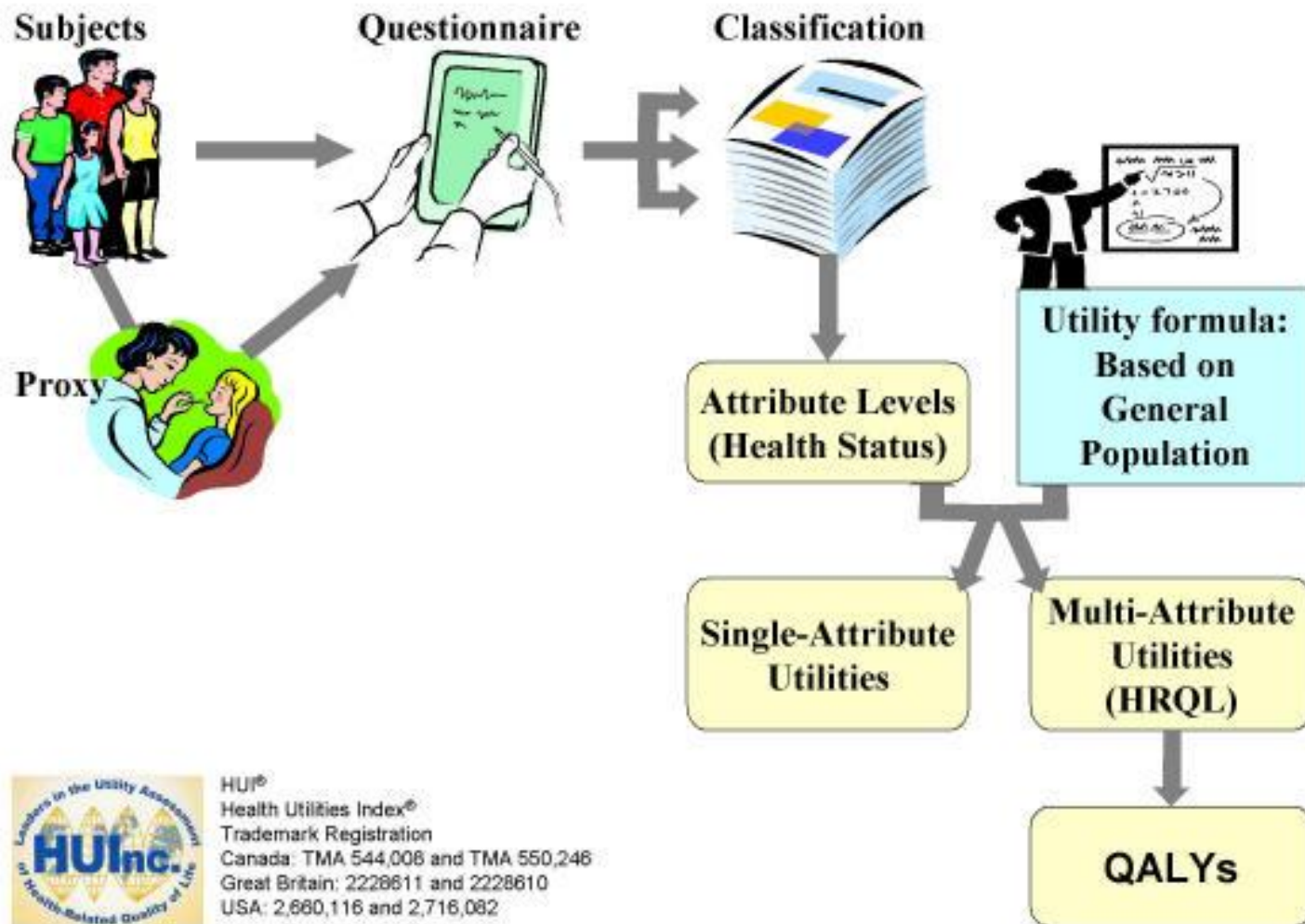
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# HUI2 scoring formula

| Sensation | Mobility | Emotion | Cognition | Self-Care | Pain   | Fertility |
|-----------|----------|---------|-----------|-----------|--------|-----------|
| x1 b1     | x2 b2    | x3 b3   | x4 b4     | x5 b5     | x6 b6  | x7 b7     |
| 1 1.00    | 1 1.00   | 1 1.00  | 1 1.00    | 1 1.00    | 1 1.00 | 1 1.00    |
| 2 0.95    | 2 0.97   | 2 0.93  | 2 0.95    | 2 0.97    | 2 0.97 | 2 0.97    |
| 3 0.86    | 3 0.84   | 3 0.81  | 3 0.88    | 3 0.91    | 3 0.85 | 3 0.88    |
| 4 0.61    | 4 0.73   | 4 0.70  | 4 0.65    | 4 0.80    | 4 0.64 |           |
|           | 5 0.58   | 5 0.53  |           |           | 5 0.38 |           |

$$u=1.06(b1xb2xb3xb4xb5xb6xb7)-0.06$$

# Health Utilities Index (HUI®) Components



- Disease-specific instruments

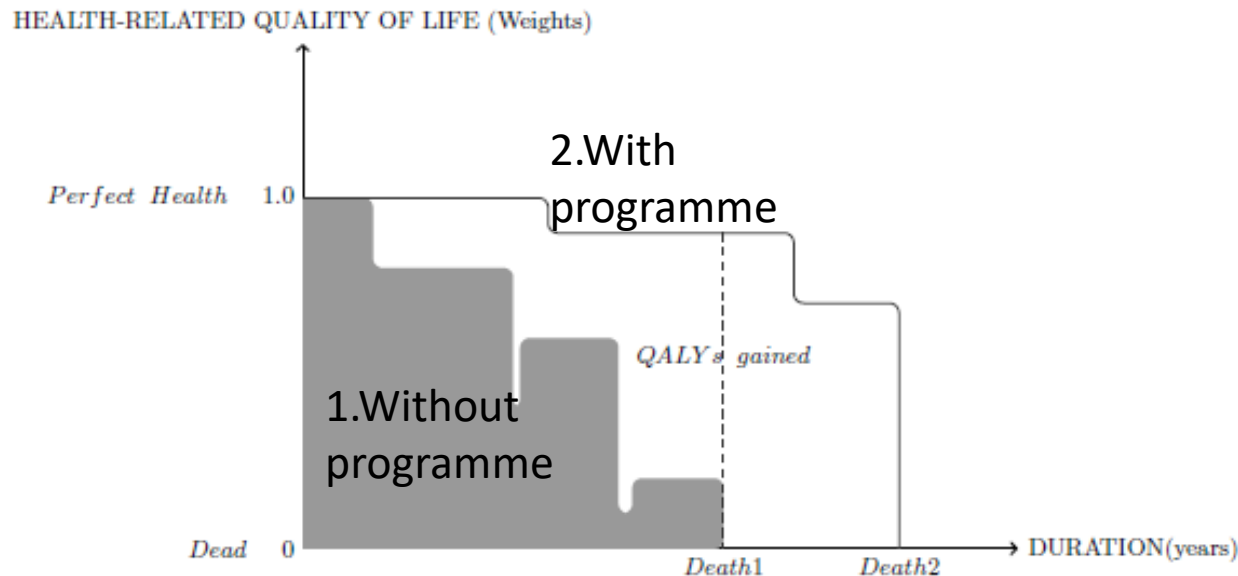
QUALITY ADJUSTED LIFE YEARS

# Quality adjusted life years

Many studies conducting CUA report results in terms of Cost/ QALY gained

First introduced by Klarman and colleagues (1968)

Captures gains from **reduced morbidity** (quality gains) and **reduced mortality** (quantity gains), and combined these into a single measure



Incremental QALY=the area under path 2- the area under path 1

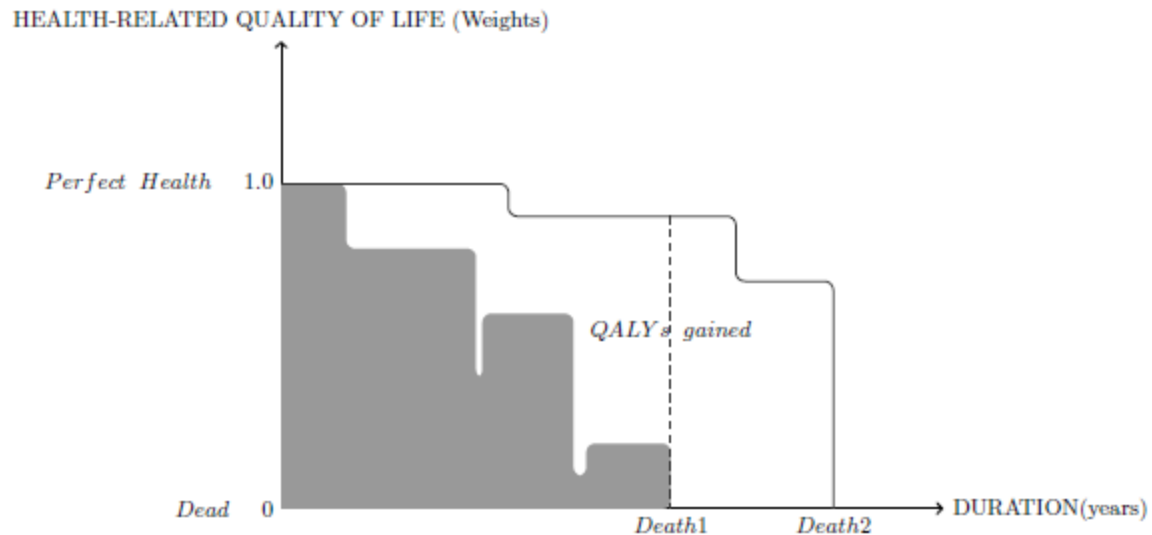


# Quality adjusted life years

- To operationalize the QALY concept, we need quality weights, which must be
  - Based on preferences
  - Anchored on perfect health and death (death=0, perfect health=1)
  - Measured on an *interval scale*
- All QALYs are not the same: weights may be based on
  - *Gamble utility measurements*
  - *Time trade-off value measurements*
  - *Visual analogue scale value measurements*
  - *Estimates by physicians or researchers*
  - *Or preference weighted systems such as HUI, QWB or EuroQol-5D*

On patients, on the general public or on some other group
- *Other names for QALYs:*
  - Years of Healthy Life (YHL)
  - Health-Adjusted Person Years (HAPY)
  - Health-Adjusted Life Expectancy (HALE)

# Quality adjusted life years



Incremental QALY (without discounting)=the area under path 2- the area under path 1

With discounting (similar to discounting on costs)

# Examples

On Board