Economic Evaluation in Health Care II

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Economic evaluation of costs

Estimating costs: some definitions

Economic terms: opportunity cost

Monetary terms: expenditure to purchase the productive factors for a program or a service or a therapy.

Price/Tariff: monetary value payed for treatments or health technologies, whose evaluation is complex (hospital admission); it includes both direct and indirect costs.

Estimating costs for economic evaluation

Value of the resources used in terms of their opportunity costs

Examples:

- Health care facilities: Hospital services, diagnostic test, pharmaceutical costs, medications
- Health care system/providers: training costs, management costs
- Social Services: Home delivery service, Social support, consultations
- Patients and families: direct costs for medical treatments and assistance, time costs, work time lost, leisure time lost

Types and extent of costs depends on perspective

Estimating costs for economic evaluation

The process of economic costing involves <u>three steps</u>:

1. identifying and describing resource use changes
2. quantifying them in physical units
3. valuing them

Approaches to costing fall into two broad types:

•   macro- or 'top-down' costing

•   micro- or 'bottom-up' costing

These are distinguished largely on the basis of the level of disaggregation at which individual resources are measured and valued.

Economic evaluation of health states and benefits

Outcome measures

Monetary benefits:

Benefits that can be measured in monetary terms

For example:

reduced salary costs because of decrease in number of doctors needed

Productivity gains

Effectiveness measures: e.g. early diagnosis, life years gained

Utility measures:

- Quality Adjusted Life Years (QALYs)
- Disability Adjusted Life Years (DALYs)

Measuring Health: QALY

Length of life: LOL

- Mortality (numbers, rates, etc.)
- Life expectancy
- Life years lost

Quality of life: QOL

- Numerous QoL measures (generic and specific)
- SF-36, EQ-5D, Nottingham Health Profile, Guttman Scale, Rotterdam Symptom Checklist, Hospital Anxiety and Depression scale etc.…

Examples for diseases which are insufficiently capture by LOL measures

Is the life-year gained an adequate generic measure?

Inadequacies of the life-year gained (1)

Treatments for migraine
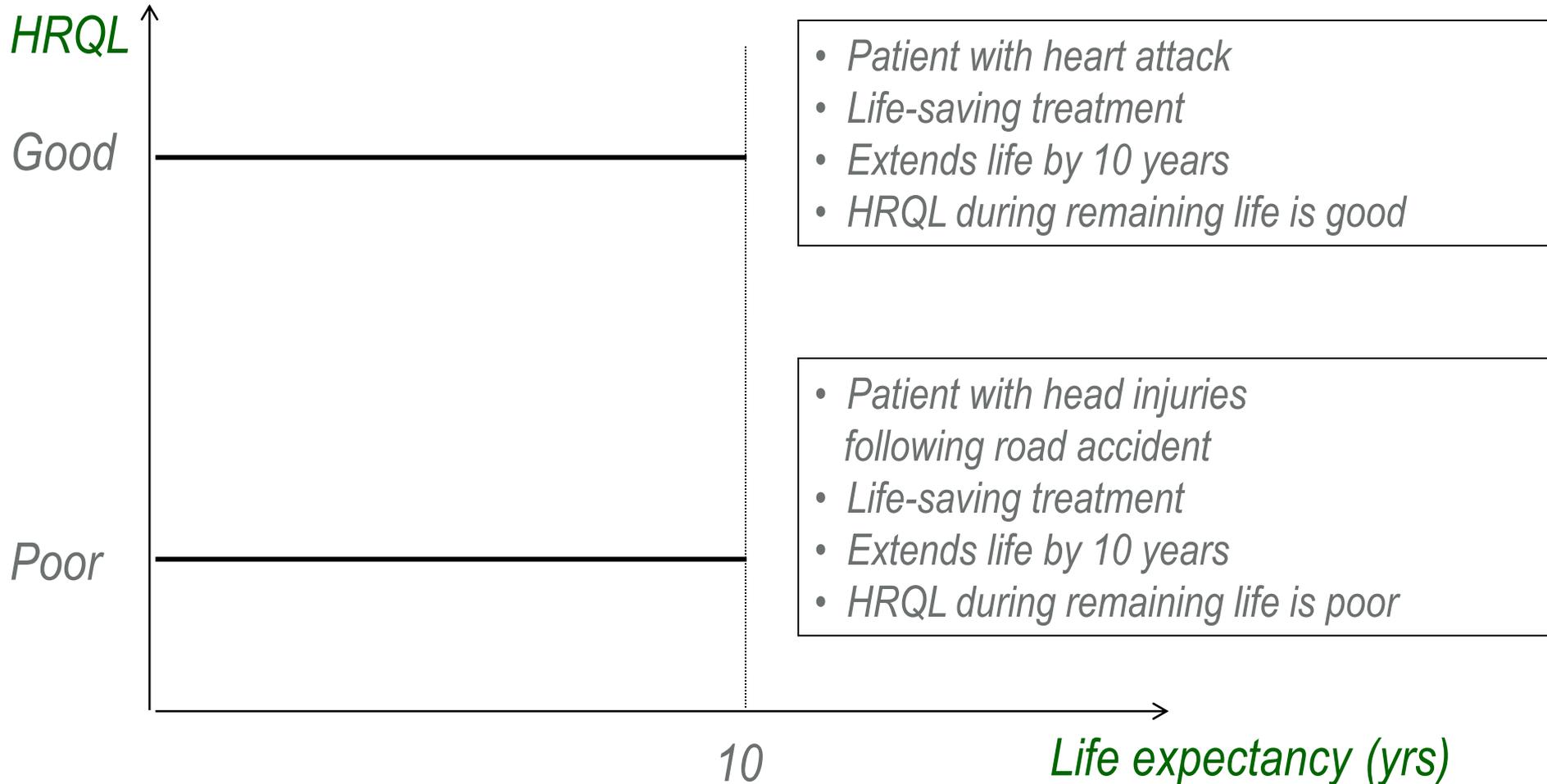
Management of pregnancy

Treatment of psoriasis

Dental care

Hernia surgery

Drug treatment for epilepsy

HRQL

Good

Poor

10

Life expectancy (yrs)

- *Patient with heart attack*
- *Life-saving treatment*
- *Extends life by 10 years*
- *HRQL during remaining life is good*

- *Patient with head injuries
  following road accident*
- *Life-saving treatment*
- *Extends life by 10 years*
- *HRQL during remaining life is poor*

QALY

QALY: quality adjusted life year

Outcome measure combining two dimensions:

- quality of life (QOL)
- length of life (LOL)

- Values health states over a period of time

  - Perfect health: 1

  - Death: 0

  - Less than perfect health: 'somewhere' between 0 and 1

  - Where 'somewhere' lies is determined by people's preferences (= utility)

  - It is subjective, and differs across cultures and individuals

  - Preferences elicited with questionnaires (e.g. EQ-5D, SF 36)

Calculating health gain using QALYs

- QALYs are additive

  - 1 year in perfect health = ?

  = 1 QALY

  - 2 years with health quality of 0.5 = ?

  = 1 QALY

  - a drug that improves QOL by 0.6 over 10 years = ?

  = 6 QALYs

  - A drug that improves QOL by 0.6 over 10 years for 2 patients = ?

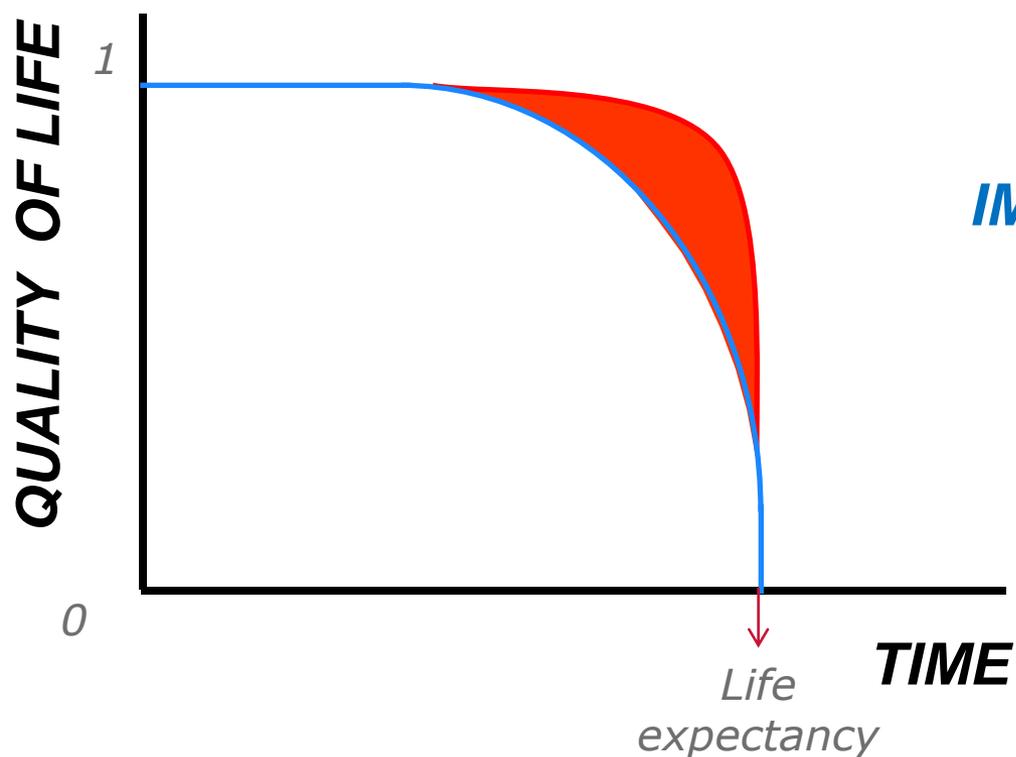 = 12 QALYs

Calculating health gain using QALYs

How to calculate QALYs

1. Draw health state paths
   with and without health care program
2. Calculate duration of each health state over the life span for which QALYs are calculated
3. Apply preference weights associated with each health state, adjusting for the duration of that health state

Measuring gains from different types of intervention

QUALITY OF LIFE

1

0

TIME

IMPROVED SURVIVAL (INCREASED LENGTH OF LIFE) ONLY

Life expectancy
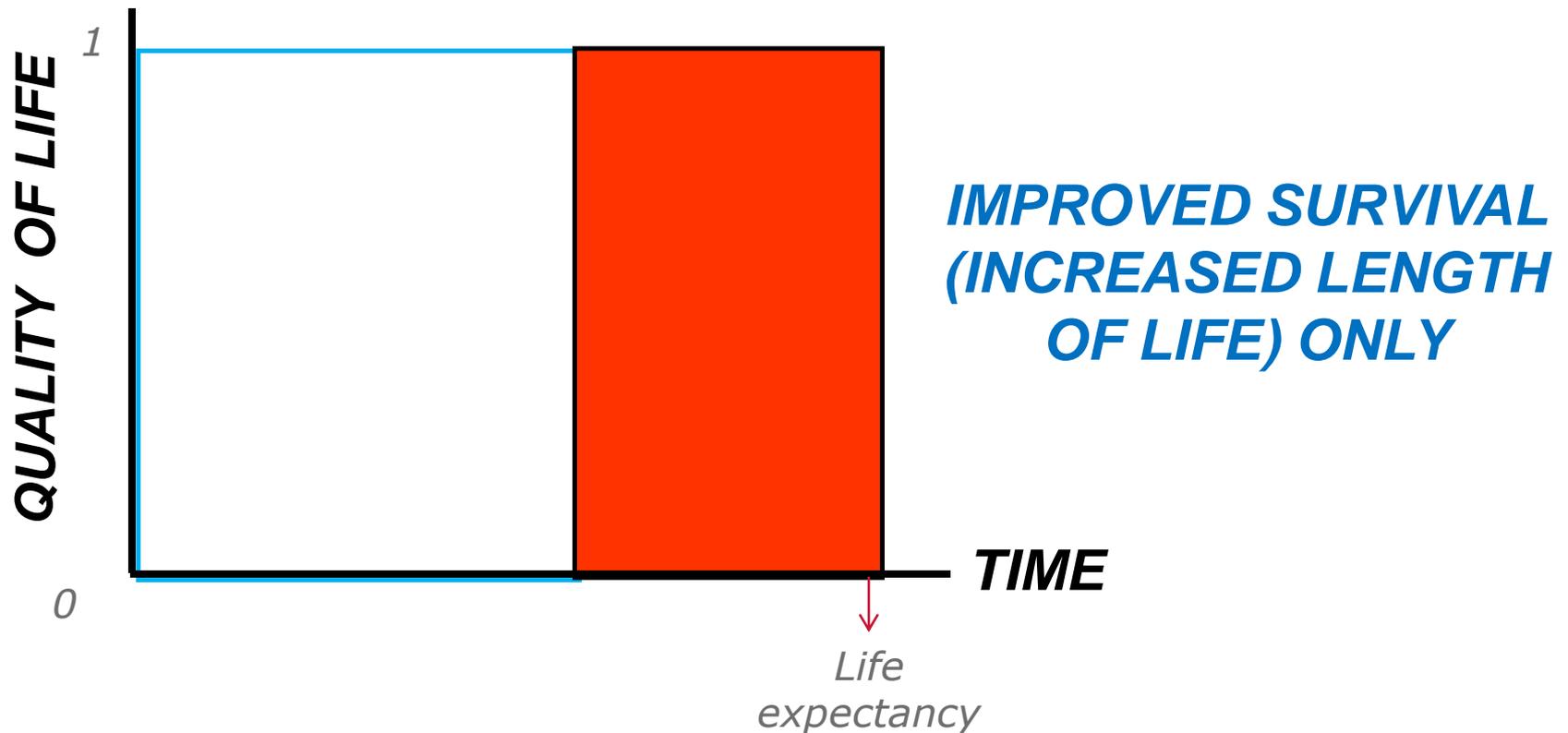
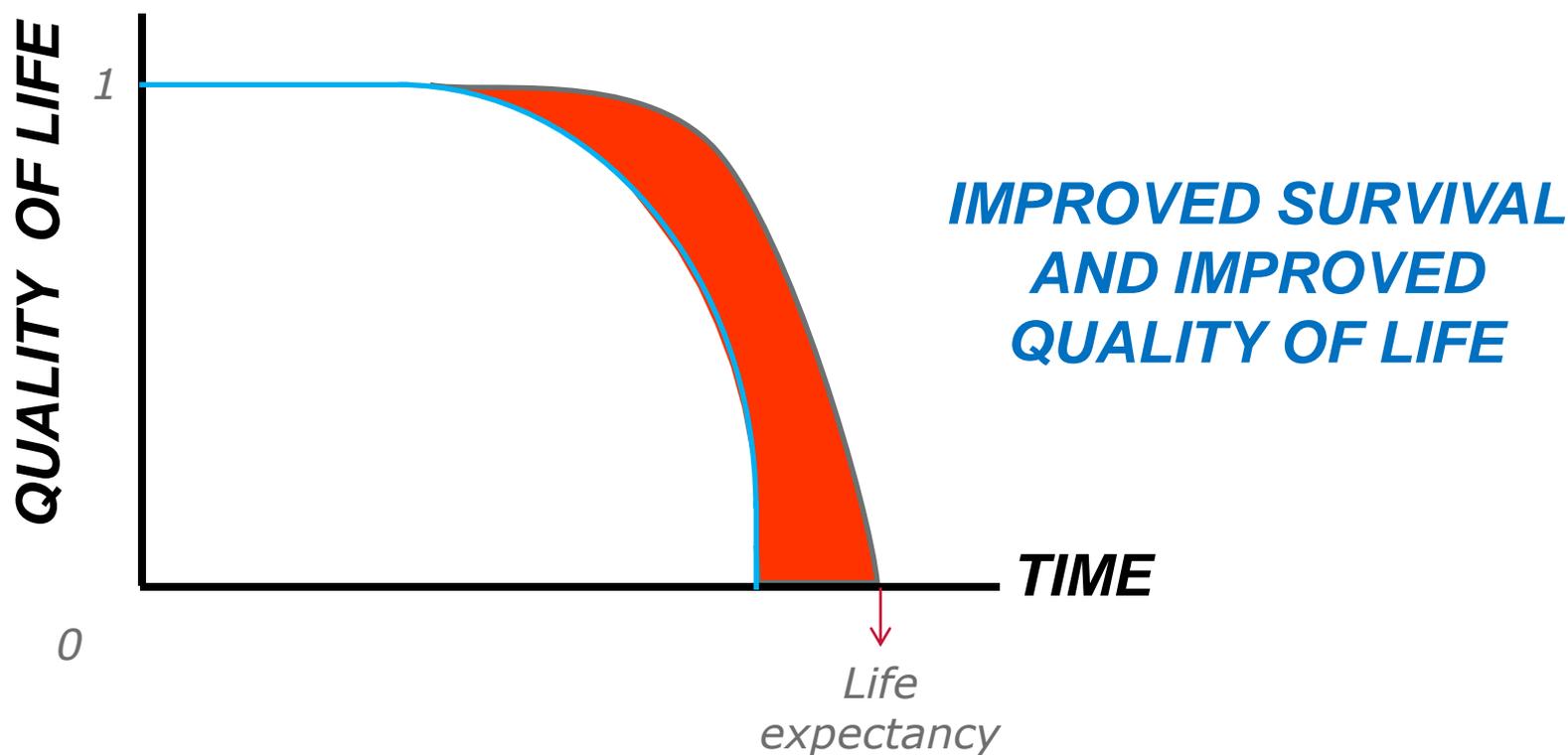## Measuring gains from different types of intervention

Measuring gains from different types of intervention

QUALITY OF LIFE

TIME

IMPROVED SURVIVAL AT EXPENSE OF DECREASED QUALITY OF LIFE

Life expectancy
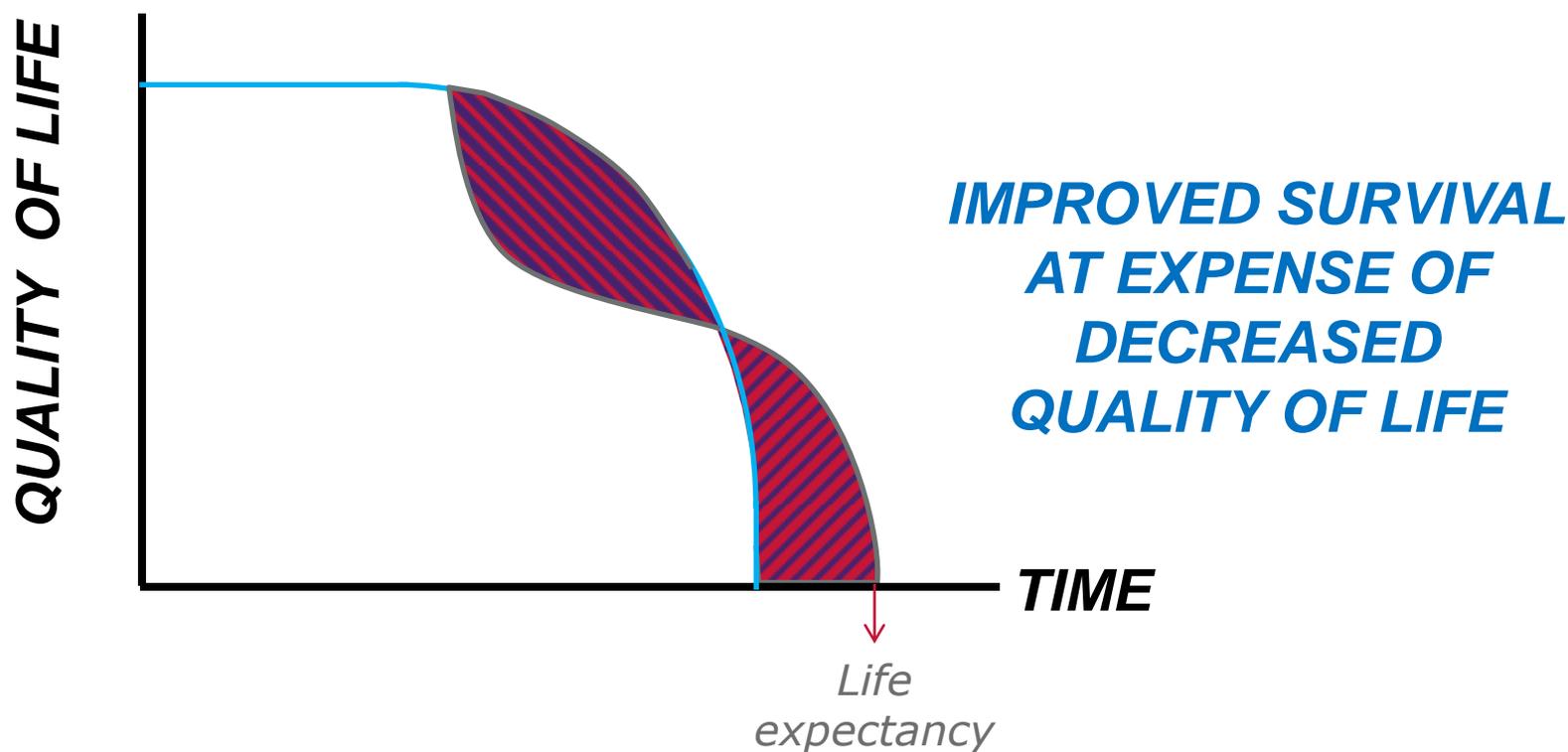
Measuring QALY gains: discrete point calculations

QALYs without treatment (blue)
= 2x0.6 + 8x0.4 = 4.4

QALYs with treatment (blue+red)
= 12x1 = 12

QALYs gained with treatment (red)
= 12 − 4.4 = 7.6
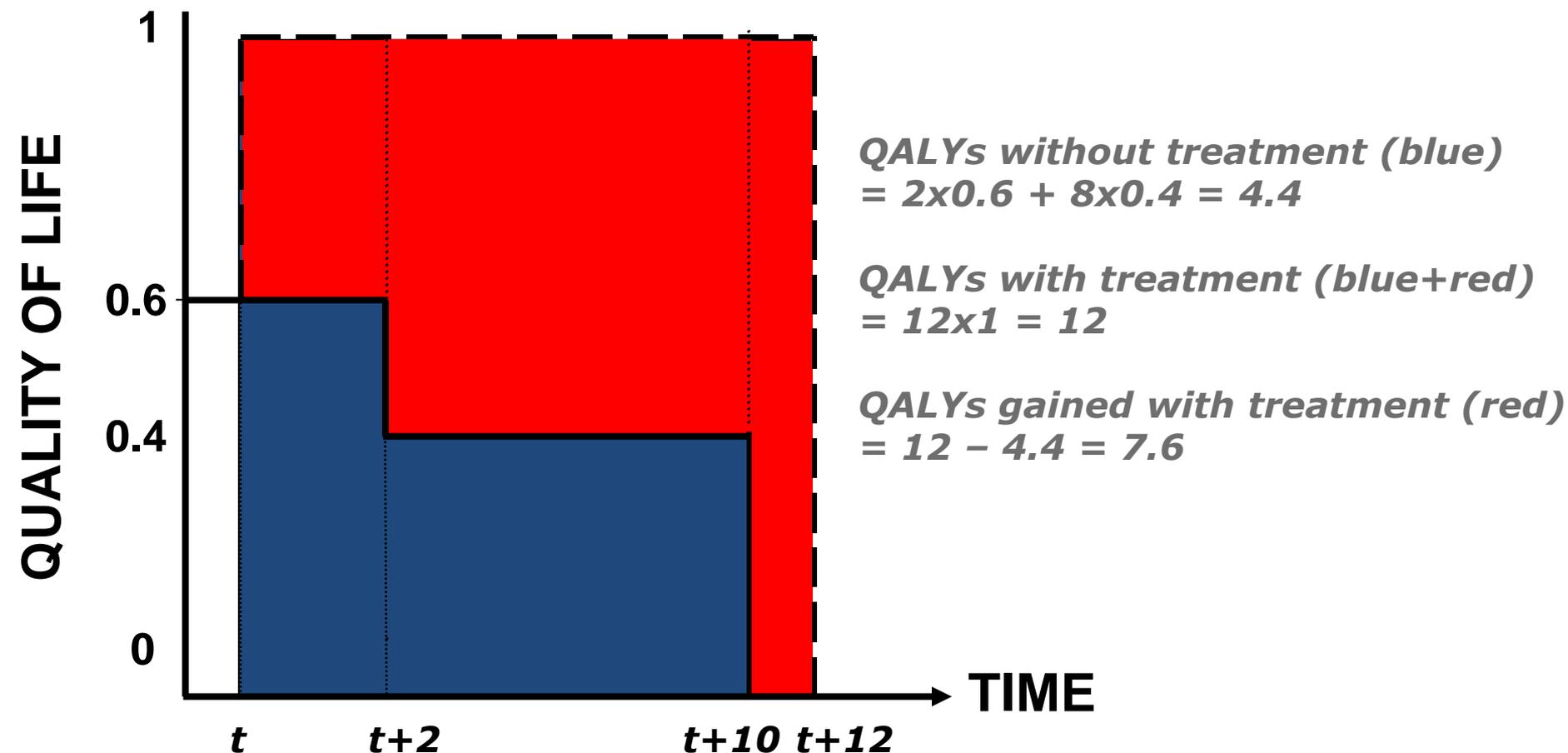
Cost effectiveness league table

Cost per quality-adjusted lifeyear (QALY) of competing therapies

Intervention	Cost per QALY (£)
GP advice to stop smoking	270
Antihypertensive therapy	940
Pacemaker insertion	1100
Hip replacement	1180
Value replacement for aortic stenosis	1410
Coronary artery bypass graft	2090
Kidney transplant	4710
Breast screening	5780
Heart transplant	7840
Hospital haemodialysis	21970

Source: D P Kernick, Introduction to health economics for the medical practitioner. *Postgrad Med J* 2003;79:147–150

Value of health state in QALYs

- Health states values in **QALYs**: subjective
- Function of subjects' individual preferences/utility

Preference Elicitation Techniques
- Standard gamble: *SG*
- Time trade off: TTO
- Visual analogue scale/ Rate Scaling
- Professional judgement

Aggregate preferences in social perspective
- weights for different individuals according to ***Social Welfare Function***

TTO for QALY for states preferred to death

Choice between 2 profiles

    1. Health state: B years, preferred to death (e.g. 20 years with diabetes)

    2. Full health state: A years, A<B (?? years in full health)

Trade-off !

- Vary A until individual is indifferent between profile 1 and 2

- **QALY = LOL * QOL**

- If subject indifferent between two profiles: $LOL_A * QOL_A = LOL_B * QOL_B$

- If state A is full health, then $QOL_A = 1,$ and $QOL_B = LOL_A / LOL_B$

- QOL_B is the quality of life of spending one year with diabetes

TTO for QALY for states preferred to death

Choice between 2 profiles

1. Health state: B years, preferred to death (e.g. 20 years with diabetes)
2. Full health state: A years, A<B (?? years in full health)

Trade-off !

- Vary A until individual is indifferent between profile 1 and 2: say 18 years

- **QALY = LOL * QOL**

- If subject indifferent between two profiles: $LOL_A * QOL_A = LOL_B * QOL_B$

  18 * 1 = 20 * QOL$_B$
  QOL$_B$ = 18/20 = 0.9

  Unknown!

TTO for QALY for states preferred to death

- If state A is full health, then $QOL_A = 1$, and $QOL_B = LOL_A / LOL_B$

- QOL_B is the quality of life of spending one year with diabetes

Standard gamble

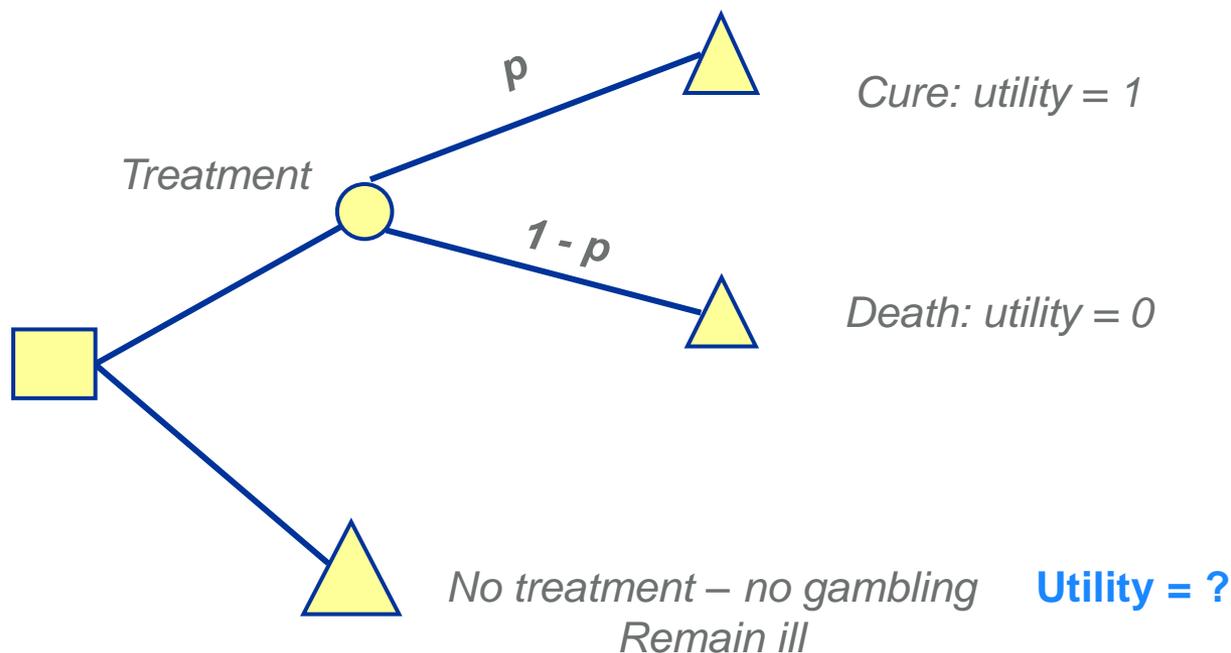Two alternatives

- A: two possible outcomes:
    » Return to the state of perfect health for t years (with probability p)
    » Immediate death (with probability 1-p)

- B: one outcome:
    » Maintain a given condition for t years.

- What probability *p* would make the individual indifferent between A & B?

That probability is the utility index we are looking for!

The standard gamble

p

Cure: utility = 1

Treatment

1 - p

Death: utility = 0

No treatment – no gambling **Utility = ?**
Remain ill

Probability is varied until person is indifferent between options:
P*U(cure)+(1-p)*U(death) = U(no treatment)

U(no treatment)=p

Visual analogue scale

Place various health states on a scale

- Desirability
- Meaningful distances

0.0	0.5	1.0

No quality of life   *Perfect health*

The health states

- Currently experiencing or hypothetical
- For most individuals
    - » Perfect health: assessed to be 'most desirable'
    - » Death 'least desirable'
    - » Most other states will be somewhere in between

EQ-5D

Most studies use existing instruments like EuroQoL Group *EQ- 5D*:

- Consider a particular health situation
    - » **5 attributes**: *mobility, self-care, usual activities, pain and discomfort, anxiety and depression*
    - » **3 levels**
    - » **3^5 = 243 possible health states** + "unconscious" + "dead"

- Quantification based on TTO
    - » 3000 people (UK)

- Moving to new scale with **5 levels** and **3125 health states**

Mobility

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

Self-Care

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

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

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

Pain/Discomfort

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

Anxiety/Depression

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

E.g. of health state: broken arm   2 2 2 3 1

Mobility

I have no problems in walking about   q   1
I have some problems in walking about   q   **2**
I am confined to bed   q   3

Self-Care

I have no problems with self-care   q   1
I have some problems washing or dressing myself   q   **2**
I am unable to wash or dress myself   q   3

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

I have no problems with performing my usual activities   q   1
I have some problems with performing my usual activities   q   **2**
I am unable to perform my usual activities   q   3

Pain/Discomfort

I have no pain or discomfort   ❑   1
I have moderate pain or discomfort   ❑   2
I have extreme pain or discomfort   ❑   **3**

Anxiety/Depression

I am not anxious or depressed   ❑   **1**
I am moderately anxious or depressed   ❑   2
I am extremely anxious or depressed   ❑   3

no problems with performing my usual activities

No pain or discomfort

I have no problems with self-care

Not anxious, nor depressed

Mobility	Self care	Usual acts	Pain & dis	Depres'n
1	1	1	1	1
2	1	1	1	1
3	3	3	3	3

TTO

Mobility

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

Health state	Score	Health state	Score	Health state	Score	Health state	Score
1 1 1 1 1	1.00	1 2 1 3 2	0.09	1 3 2 2 3	0.04	2 1 3 2 1	0.36
1 1 1 1 2	0.85	1 2 1 3 3	-0.08	1 3 2 3 1	0.01	2 1 3 2 2	0.29
1 1 1 1 3	0.41	1 2 2 1 1	0.78	1 3 2 3 2	-0.06	2 1 3 2 3	0.13
1 1 1 2 1	0.80	1 2 2 1 2	0.71	1 3 2 3 3	-0.22	2 1 3 3 1	0.10
1 1 1 2 2	0.73	1 2 2 1 3	0.27	1 3 3 1 1	0.34	2 1 3 3 2	0.03
1 1 1 2 3	0.29	1 2 2 2 1	0.66	1 3 3 1 2	0.27	2 1 3 3 3	-0.13
1 1 1 3 1	0.26	1 2 2 2 2	0.59	1 3 3 1 3	0.11	2 2 1 1 1	0.75
1 1 1 3 2	0.19	1 2 2 2 3	0.15	1 3 3 2 1	0.22	2 2 1 1 2	0.68
1 1 1 3 3	0.03	1 2 2 3 1	0.12	1 3 3 2 2	0.15	2 2 1 1 3	0.24
1 1 2 1 1	0.88	1 2 2 3 2	0.05	1 3 3 2 3	-0.02	2 2 1 2 1	0.62
1 1 2 1 2	0.81	1 2 2 3 3	-0.11	1 3 3 3 1	-0.04	2 2 1 2 2	0.55
1 1 2 1 3	0.38	1 2 3 1 1	0.45	1 3 3 3 2	-0.11	2 2 1 2 3	0.12
1 1 2 2 1	0.76	1 2 3 1 2	0.38	1 3 3 3 3	-0.28	2 2 1 3 1	0.09
1 1 2 2 2	0.69	1 2 3 1 3	0.22	2 1 1 1 1	0.85	2 2 1 3 2	0.02
1 1 2 2 3	0.25	1 2 3 2 1	0.33	2 1 1 1 2	0.78	2 2 1 3 3	-0.14
1 1 2 3 1	0.23	1 2 3 2 2	0.26	2 1 1 1 3	0.35	2 2 2 1 1	0.71
1 1 2 3 2	0.16	1 2 3 2 3	0.09	2 1 1 2 1	0.73	2 2 2 1 2	0.64
1 1 2 3 3	-0.01	1 2 3 3 1	0.07	2 1 1 2 2	0.66	2 2 2 1 3	0.21
1 1 3 1 1	0.56	1 2 3 3 2	0.00	2 1 1 2 3	0.22	2 2 2 2 1	0.59
1 1 3 1 2	0.49	1 2 3 3 3	-0.17	2 1 1 3 1	0.20	2 2 2 2 2	0.52
1 1 3 1 3	0.32	1 3 1 1 1	0.44	2 1 1 3 2	0.12	2 2 2 2 3	0.08
1 1 3 2 1	0.43	1 3 1 1 2	0.37	2 1 1 3 3	-0.04	2 2 2 3 1	0.06
1 1 3 2 2	0.36	1 3 1 1 3	0.20	2 1 2 1 1	0.81	2 2 2 3 2	-0.02
1 1 3 2 3	0.20	1 3 1 2 1	0.31	2 1 2 1 2	0.74	2 2 2 3 3	-0.18
1 1 3 3 1	0.17	1 3 1 2 2	0.24	2 1 2 1 3	0.31	2 2 3 1 1	0.38
1 1 3 3 2	0.10	1 3 1 2 3	0.08	2 1 2 2 1	0.69	2 2 3 1 2	0.31
1 1 3 3 3	-0.07	1 3 1 3 1	0.05	2 1 2 2 2	0.62	2 2 3 1 3	0.15
1 2 1 1 1	0.82	1 3 1 3 2	-0.02	2 1 2 2 3	0.19	2 2 3 2 1	0.26
1 2 1 1 2	0.74	1 3 1 3 3	-0.19	2 1 2 3 1	0.16	2 2 3 2 2	0.19
1 2 1 1 3	0.31	1 3 2 1 1	0.40	2 1 2 3 2	0.09	2 2 3 2 3	0.02
1 2 1 2 1	0.69	1 3 2 1 2	0.33	2 1 2 3 3	-0.08	2 2 3 3 1	0.00
1 2 1 2 2	0.62	1 3 2 1 3	0.16	2 1 3 1 1	0.49	2 2 3 3 2	-0.07
1 2 1 2 3	0.19	1 3 2 2 1	0.28	2 1 3 1 2	0.42	2 2 3 3 3	-0.24
1 2 1 3 1	0.16	1 3 2 2 2	0.21	2 1 3 1 3	0.25	2 3 1 1 1	0.37
2 3 1 1 2	0.30	3 1 1 1 2	0.27	3 2 1 1 2	0.16	3 3 1 1 2	0.05
2 3 1 1 3	0.13	3 1 1 1 3	0.10	3 2 1 1 3	0.00	3 3 1 1 3	-0.11
2 3 1 2 1	0.24	3 1 1 2 1	0.21	3 2 1 2 1	0.11	3 3 1 2 1	0.00
2 3 1 2 2	0.17	3 1 1 2 2	0.14	3 2 1 2 2	0.04	3 3 1 2 2	-0.07
2 3 1 2 3	0.01	3 1 1 2 3	-0.02	3 2 1 2 3	-0.13	3 3 1 2 3	-0.24
2 3 1 3 1	-0.02	3 1 1 3 1	-0.05	3 2 1 3 1	-0.15	3 3 1 3 1	-0.26
2 3 1 3 2	-0.09	3 1 1 3 2	-0.12	3 2 1 3 2	-0.22	3 3 1 3 2	-0.33
2 3 1 3 3	-0.25	3 1 1 3 3	-0.29	3 2 1 3 3	-0.39	3 3 1 3 3	-0.50
2 3 2 1 1	0.33	3 1 2 1 1	0.30	3 2 2 1 1	0.20	3 3 2 1 1	0.09
2 3 2 1 2	0.26	3 1 2 1 2	0.23	3 2 2 1 2	0.13	3 3 2 1 2	0.02
2 3 2 1 3	0.10	3 1 2 1 3	0.06	3 2 2 1 3	-0.04	3 3 2 1 3	-0.15
2 3 2 2 1	0.21	3 1 2 2 1	0.18	3 2 2 2 1	0.07	3 3 2 2 1	-0.04
2 3 2 2 2	0.14	3 1 2 2 2	0.11	3 2 2 2 2	0.00	3 3 2 2 2	-0.11

QALYs for HIV patients

Avg EQ 5D weights	No ART	ART
Stage 1 (no ART)	0.8	0.8
Stage 2	0.7	0.875
Stage 3	0.5	0.75
Stage 4	-0.1	0.625
Death (ART failure)	-0.1	0.01

Quality adjusted life-years of HIV patients
Robberstad B and Olsen J.A. "The health related quality of life of people living with HIV/AIDS in sub-Saharan Africa – a literature review and focus group study". Cost Effectiveness and Resource Allocation 2010, 8:5

Health Utilities Index (HUI)

EQ-5D

Quality of Well Being Scale (QWB)

Australian Quality of Life Instrument (AQoL)

SF-6D

Disability Adjusted Life Years (*DALYs*)

- **WHO** and World Bank
- Measure of population ill-health
- Relatively easily measured in a wide variety of countries

DALYs

- time that people live with a **disability**
- with the time that they lose to premature **mortality**
- Disability: in a *(0,1)* scale; *0* perfect health, *1* maximum disability severity

Disability Adjusted Life Years (*DALYs*)

- Mortality: compared to the maximum life expectancy
- Aim: reduce *DALYs*

Values of health states

- Are not elicited according to subjective preferences
- But valuated by international experts in public health

Discounting

Discounting

- Alternatives differ with respect to their timing
- Lower weight to costs and outcomes in the future
  - discounted compared to those which occur in the present
- Weights yearly costs and benefits using a discount rate and sums them to form a present value.

- Future costs and benefits should be discounted
  - » Example: discount rate is 3.5%

2012   *2014*
£5000   £5000

$$\frac{5000}{(1+0.035)^2} = 4668.53$$

The importance of the comparator

Choice of comparator and cost effectiveness

Table 1. cost effectiveness analysis including Drug B

intervention	QALYs	Δ QALYs	Cost (£000)	Δ cost	Cost/QALY gained
Palliative care	0.4	0.4	1	1	2.5
Drug A	0.6	0.2 (0.6-0.4)	2	1 (=2-1)	5 (=1/0.2)
Drug B	0.7	0.1	10	8	80
Drug C	0.8	0.1	13	3	30

Table 2. cost effectiveness analysis excluding Drug B

intervention	QALYs	Δ QALYs	Cost (£000)	Δ cost	Cost/QALY gained
Palliative care	0.4	0.4	1	1	2.5
Drug A	0.6	0.2	2	1	5
Drug C	0.8	0.2	·13	11	55

Choice of comparator and cost effectiveness

In this case:

Omitting Drug B as a comparator for Drug C increases the ICER (= reduces cost-effectiveness) of Drug C

Using Drug B as the comparator could mean that we attribute spurious cost effectiveness to Drug C (if Drug B is the wrong comparator)

The choice of comparator influences the estimated cost-effectiveness of an intervention

In other words: any drug can be made to look cost-effective by evaluating it against a drug that has nearly as high costs and much lower benefits

Important: any new intervention should to be compared to standard of care

Key Terms

Key Terms

Economic evaluation: comparison of two or more alternative courses of action in terms of both their costs and their consequences; economists usually distinguish several types of economic evaluation differing in how consequences are measured

Cost Benefit Analysis: an economic evaluation that expresses both costs and outcomes of an intervention in monetary terms. Benefits are valued in monetary terms using valuations of peoples' observed or stated preferences using, for example, the willingness-to-pay approach.

Cost Effectiveness Analysis: an economic study design in which consequences of different interventions are measured using a single outcome, usually in 'natural' units (for example, life-years gained, deaths avoided, heart attacks avoided, cases detected). Alternative interventions are then compared in terms of cost per unit of effectiveness.

Cost Utility Analysis: type of cost-effectiveness analysis in which benefits are expressed as the number of life years saved adjusted to account for loss of quality from morbidity of the health outcome or side effects from the intervention. The most common measure in *CUA* is the *quality-adjusted life year (QALY)*

Key Terms

Cost effectiveness Threshold: A subjective threshold used to determine if the intervention studied is cost-effective and/or should be adopted. Typical cost-effectiveness thresholds are $50,000/QALY, $100,000/QALY in the USA and £20,000-30,000/QALY in the UK.

Cost Effectiveness Plane: diagrammatic way of comparing technologies or treatment alternatives. A four-quadrant diagram of cost difference plotted against effect difference yields: quadrant I, where the intervention is more effective and more costly than the comparator ; quadrant II, where the intervention is more effective and less costly than the comparator; quadrant III, where the intervention is less effective and less costly than the comparator; and quadrant IV, where the intervention is less effective and more costly than the comparator.

Comparator

The standard intervention against which the intervention under appraisal is compared. The comparator can be no intervention, for example, best supportive care.

Key Terms

Outcome: the measure of the possible results that may stem from exposure to a preventive or therapeutic intervention. Outcome measures may be intermediate endpoints or they can be final endpoints.

Effectiveness: Clinical effectiveness.

Health-related quality of life (HRQL): a combination of an individual's physical, mental and social well-being; not merely the absence of disease.

Quality Adjusted Life Years: an index of survival that is adjusted to account for the patient's quality of life during this time. QALYs have the advantage of incorporating changes in both quantity (longevity/mortality) and quality (morbidity, psychological, functional, social, and other factors) of life. Used to measure benefits in cost–utility analysis.

Disability Adjusted Life Years: a standard measure for comparing health outcomes for various health conditions; years of potential life lost due to premature mortality and the years of productive life lost due to disability

Key Terms

Life-years gained

Average years of life gained per person as a result of the intervention.

Net Present Value: the difference between the present value of cash inflows and the present value of cash outflows.

Incremental Cost Effectiveness Ratio: the difference in the mean costs in the population of interest divided by the differences in the mean outcomes in the population of interest.

Dominance: an intervention is dominated if it has higher costs and lower outcomes than an alternative intervention.

Key Terms

Discounting: costs and perhaps benefits incurred today have a higher value than costs and benefits occurring in the future. Discounting health benefits reflects individual preference for benefits to be experienced in the present rather than the future. Discounting costs reflects individual preference for costs to be experienced in the future rather than the present.

Monetary Net Benefit: the benefit of an option in monetary units, minus its total cost in monetary units

Health Net Benefit- the benefit of an option in health units, minus its total cost in health units

Key Terms

Standard gamble

A method used to measure utility (for example, health states) where the individual is asked to make a trade-off between having a chronic disease (the state being valued) for a certain period of time, and a gamble with good health for the same period and death. The chances of ending up in good health are varied until the individual is indifferent between the certain and uncertain choices.

Time trade-off

A method used to measure utility (for example, health states). The utility value is measured by finding the point at which the respondent cannot choose between two scenarios. For chronic illness, the choice is between the illness for a period of time and perfect health for a shorter time, both followed by death. For short-term illness, the choice is between the illness for a period of time and a worse health state for a shorter time, both followed by the same specified outcome.

DALYs Formula

The solution of the definite integral from the age of onset a to $a+L$ is the duration of disability or time lost due to premature mortality provides the DALY formula for an individual:

$$-\left[\frac{DCe^{-\beta a}}{(\beta+r)^2}\left[e^{-(\beta+r)(L)}(1+(\beta+r)(L+a))-(1+(\beta+r)a)\right]\right]$$

where D is disability weight (or 1 for premature mortality), r is the discount rate, C is the age-weighting correcting constant, β is the parameter from the age-weighting function, a is the age of onset, and L is the duration of disability or time lost due to premature mortality. This formula can be conveniently written in a spreadsheet cell to facilitate calculation of DALYs. In the specific form used for calculating DALYs, r equals 0.03, β equals 0.04 and C equals 0.16243.