Health Economics
Evaluation

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Outline

Cost Effectiveness Analysis vs Cost Benefit Analysis

1. Cost effectiveness analysis: Process of measuring costs and health benefits of various medical treatments, procedures, or therapies.
    1.1 Goal: Compares cost and benefits of different treatments for same disease or condition.
2. Cost-Benefit analysis: Chose between different treatments by creating an explicit tradeoff between money and health.

Source: BHT Chap 14

CEA : Incremental Cost Effectiveness Ratio (ICER)

1. Compare two treatments New(N) and Old(O)
   1.1 Cost of treatment N, $C_N > C_O$, cost of treatment O
      - Expressed in \$. Financial cost and **may** include non-treatment costs like time and travel expenses.

   1.2 Outcomes of treatment N, $E_N > E_O$, outcome of treatment O
      - Expressed in additional years of life.

2. **Incremental Cost-effectiveness Ratio**: Ratio of incremental costs of one treatment over another to the incremental benefits of that treatment.

$$ICER_{N,O} = \frac{C_N - C_O}{E_N - E_O}$$

3. Dominated vs non-dominated treatment
   3.1 If $C_N > C_O$ and $E_N < E_O$, then N is dominated by O. Never use N.

   3.2 If $C_N < C_O$ and $E_N < E_O$ (or $C_N > C_O$ and $E_N > E_O$), then neither is dominated. ICER will be positive.

Source: BHT Chap 14

Example 1: Cost-Effectiveness Analysis

1. Program T: Targetted screening: Screen patients who show signs of COVID19 or are high risk such as elderly.
   1.1 Less expensive, but may miss a few cases.
2. Program U: Universal screening: Test every patient.
   2.1 More expensive, but detect every case.

Programme	Cost per patient($)	Average Life Expectancy
T	51517	21.063
U	51850	21.073

$$ICER_{U,T} = \frac{51850 - 51517}{21.073 - 21.063} = \frac{\$333}{3.65 days} = \$91.23/day$$

3. If switch from Targetted screening to Universal screening, obtain each extra day of life for $91.23
   3.1 If the trade-off is worthwhile, then switch to Universal screening.
4. ICER **does not** say which treatment is optimal.

Example 3: Cost-Effectiveness Analysis

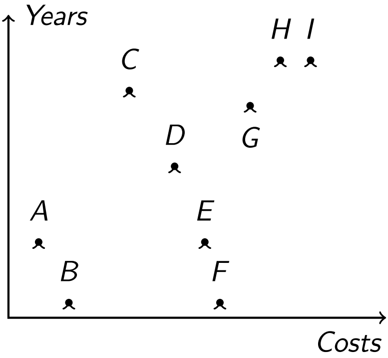
1. Sort the Programmes in ascending order of their cost

Programme	Total cost (TC$)	Life-Expectancy (LE)	Cost per extra life-year (TC/LE)
No treatment	0	0.0	-
Drug A	40,000	1.0	**40,000**
Drug B	80,000	0.2	400,000
Drug C	160,000	3.0	53,333
Drug D	220,000	2.0	110,000
Drug E	260,000	1.0	260,000
Drug F	280,000	0.2	1,400,000
Drug G	320,000	2.8	114,286
Drug H	360,000	3.4	105,882
Drug I	400,000	3.4	117,647

2. Method 1: $TC_A/LE_A = \$40,000$. A is the cheapest treatment.
3. $$ICER_{C,A} = \frac{160,000 - 40,000}{3.0 - 1.0} = \$60,000/year$$

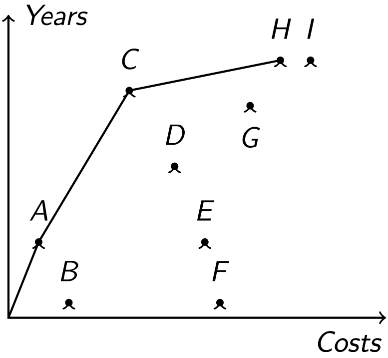
Source: BHT Chap 14

Example 3: Cost-Effectiveness Analysis



1. Graph the various treatment options
2. **Dominated** treatments: If another treatment is both cheaper and more effective.
   2.1 $A \succ B$; A **dominates** B
   2.2 $C \succ D$; C **dominates** D
   2.3 $E \succ F$; E **dominates** F
   2.4 H ? I

Example 3: Cost-Effectiveness Analysis



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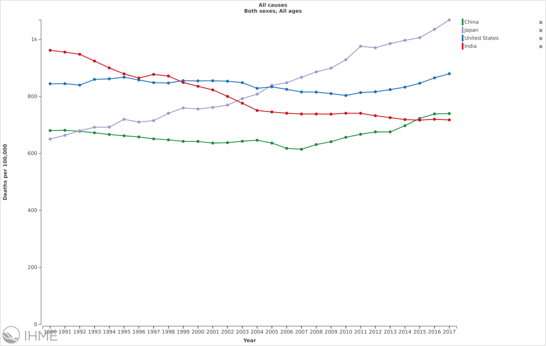
    2.4 H ? I
3. Connect points that are *not* dominated $\Rightarrow$ **Cost-effectiveness frontier**
4. Slope of line between two points: inverse of ICER
   $ICER_{C,A} = \$60k/year$
   $ICER_{H,C} = \$500k/year$

Measuring Costs

1. Perspective: Patient, Payer
2. Hypothetical “social planner” and patient.
3. Social planner: include *all* costs borne by society.
   3.1 Direct costs: Paid by patient and insurer, govt.
   3.2 Indirect costs: Time off from work, care-giver’s wages
   3.3 Monopoly Profits(?): If P>MC. Only include MC.
4. Patient: Direct cost
5. Divergence between patient and social planner:
   5.1 Moral hazard due to insurance coverage;
   5.2 Positive or negative externality.

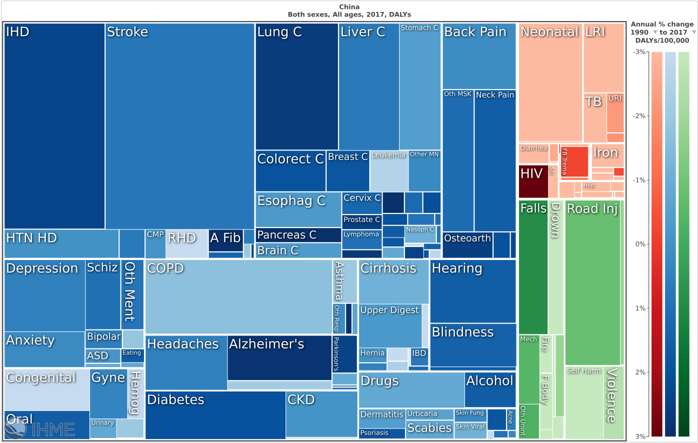
Source: BHT Chap 14

Measurement of Health Status



1. Most basic measure of health - Mortality based indicators
2. Life-Expectancy - Years expected to live based on current mortality patterns
   2.1 E.g. Life-expectancy at birth: How long a new born is expected to live given current mortality and morbidity patterns in the country.
3. Mortality - Infant mortality, all-cause mortality, disease-specific mortality

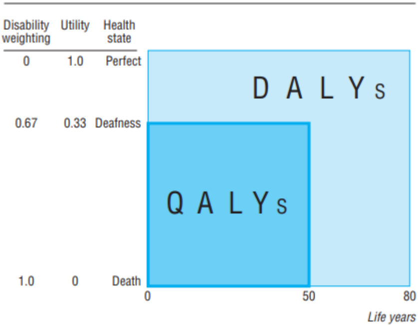
Measurement of Health Status



1. Although mortality based indicators are useful, they ignore the burden of:
2. Chronic diseases (non-communicable diseases)
3. Injuries
4. Disabilities

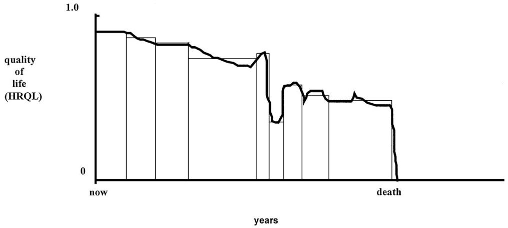
Measurement of Health Status

1. **Health Adjusted Life Years (HALY)**:
   1.1 Population health summary measure: mortality and morbidity.
2. Disease Adjusted Life Years (DALY)
   2.1 DALYs are a measure of a health gap (a "bad" to be minimized)
   2.2 Number of Years of Life *lost* to disability, morbidity, or mortality.
3. Quality Adjusted Life Years (QALY)
   3.1 QALYs are a measure of health expectancy (a "good" to be maximized).
   3.2 Dual benefit of saving life - adding to years to life, adding quality of life.



Source: Gold et al 2002, NCCID Project No 211, Figure from Arnesen and Nord, BMJ 319 (1999)

QALYs



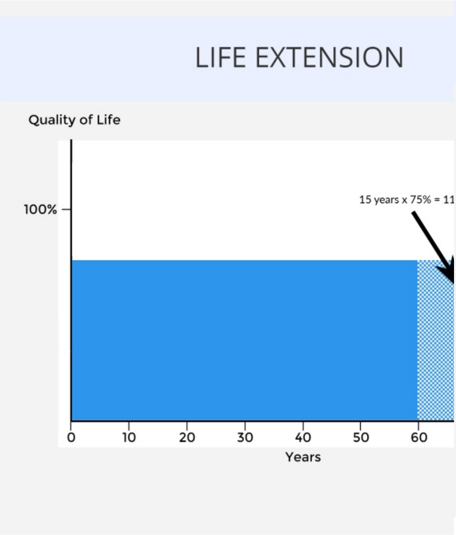
1. QALYs: QALYs is weighted sum of quality weights, q, and duration lived with that quality weight, t (area below life path)
   1.1 Assign **health state** at each point, **assign quality weight** to each health state.
      - **quality weight,** q_t: 1 for Prefect health $\rightarrow$ 0 for death
      - Each year gets weight somewhere between 0 and 1: health utility
   1.2 Area of rectangle = Time-spent in state X Score for state
      - E.g. q = 0.5 $\times$ t =2 is same as q=0.25 $\times$ t=4 is same as q=1 $\times$ t =1
2. Calculating QALE

$$QALE = \sum_{t=t_0}^{Z} \delta^{t-t_0} q_t P_t$$

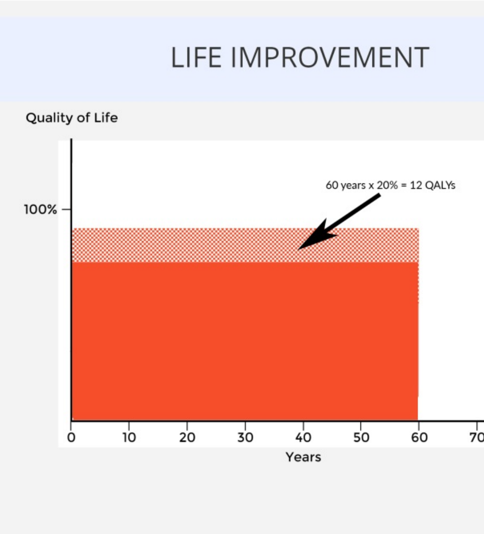
   2.1 P_t: Pb of surviving to next year,t and δ: time-discounting factor: $\approx$ 3-5%

Source: Gold et al 2002, NCCID Project No 211, BHT Chap 14

QALYs - Dual Use



This graph illustrates how QALYs are calculated when **mortality** is affected: patient's life is extended by 15 years, while his quality of life is unchanged.



This graph illustrates how QALYs are calculated when **morbidity** is affected: the life of the patient is improved by 20% over 60 years.

Source: https://www.melissacalixte.com/ideas/qalys

Issues with QALYs

1. Scale of 0 (Death) and 1 (Perfect):
2. Some illnesses are worse than death?
3. Definition of perfect health varies by culture, country, time-period.
4. QALYs are not sensitive enough - small range of 0 to 1.
5. If QALYs are same, then how do you compare intervention A vs intervention B?
6. Chronic diseases with same health states cant be compared.
7. Hardly any weight on emotional or mental health and its effect on quality.

Source: Gold et al 2002, NCCID Project No 211

Disease Adjusted Life Years (DALYs)

1. Origin in 1993 by the World Bank
2. Aim: To quantify the **burden of diseases and disability** and to **set priorities for resource allocation**.
3. Idea of Burden: A **gap** between country's current population health and a hypothetical ideal (where everyone reaches maximum life-expectancy in perfect health).
4. Idea of Burden: Assumes that **time** lived with disease is important.
5. Resource allocation: Shift from mortality based decision making to **non-fatal health outcomes**.
   5.1 Measure magnitude of premature deaths and non-fatal health outcomes due to **proximate causes** (diseases, injuries) and to **distal causes** (poor water and sanitation, smoking, socio-economic inequality)
6. Use: For cost-effectiveness analysis of interventions
   6.1 Reductions in DALYs are used to measure benefits of interventions.

Source: Gold et al 2002, NCCID Project No 211

Steps for DALYs

1. DALYs measure total length of time spent with illness
2. DALYs = Years of life lost due to premature mortality (**YLL**) + Years of life lived with disability (**YLD**)
3. **YLL** = N (number of deaths at age x) x L (standard of life expectancy at age x in years)
4. **YLD** = I (number of incident cases) x L (average duration of the case until remission or death in years) x DW (disability weight)
5. Disability weights: HRQL are assigned to health outcomes: 0 = perfect health, 1 = death.
6. Discounting
   6.1 Age discounting: adults had higher weights - net contributors to society, young and old lower weights.
   6.2 Time discounting: Future life saved, discounted at 3%.

Source: Gold et al 2002, NCCID Project No 211

DALYs and their issues

1. Life-expectancy:
   1.1 Length of life lost due to disease or disability;
   1.2 Males (80) and Females (82.5) based LE in Japan for females;
   1.3 Should same LE be used for males and females? (Alcohol, Tobacco, Occupation, Child-bearing)

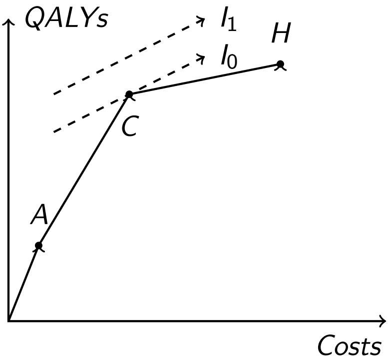
2. Disability weights
   2.1 Coping/Adaptation problem: Weight closer to 1 at time of injury, closer to 0 after adaptation.
      - Pre-adapted weight - prevention and rehabilitation more cost-effective than life extension
      - Post-adaptive weight - Life-extension more cost-effective.

   2.2 Different preferences for trade-off between quantity and quality of life for *others* vs for *oneself*

DALYs and their issues

1. Discounting future DALYs
   1.1 Utility maximizing individuals do not discount own health if expect their life to be better in future.
   1.2 Even if discount for self, how to decide discount rate for social preferences?
2. Age-Weighting: 2 identical patients, age 22 and age 2.
   2.1 Principle of reducing duration of life-lost: save 2 year old.
   2.2 Population surveys: Save young adults over young children.
   2.3 Age-dependent preference: life lived at different ages is valued differently.
       - Human capital model: Productive life over unproductive life. Different incomes/education.
       - Interdependence model: Net contributors of care to others (elders, children). Income vs Volunteering.
       - Survey (1993): Age 10 $\succ$ Age 5 $\succ$ Age 35 $\succ$ Age 60 $\succ$ Age 70
3. Co-morbidities. DALYs do not consider co-morbidities.
   3.1 Poorer societies with higher burden of co-morbidity will have lower DALYs than richer societies.

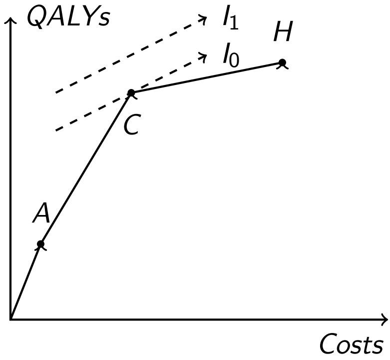
Cost-Benefit Analysis



1. CEA ranks the treatments (eliminates dominated)
2. CBA process of choosing optimal treatment among CE ones by assigning monetary value to health benefits.
3. Assigning monetary value ≈ indifference curve
   3.1 E.g. Assume value QALY at \$100,000
   3.2 Slope of indifference curve: indifferent between one additional QALY and \$100,000

Source: BHT Chap 14

Cost-Benefit Analysis



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   1.1 Assigning monetary value $\approx$ indifference curve
   1.2 E.g. Assume value QALY at \$100,000
   1.3 Slope of indifference curve: indifferent between one additional QALY and \$100,000

1. Tangency point: C
   1.1 Takes 3 additional QALYs at C for only \$160,000 (valuation is \$100,000 for 1 QALY)
   1.2 Forego 0.4 QALYs at H which costs \$200,000 more than C.
   1.3 H might be chosen if value additional QALYs at \$200,000/0.4 = \$500,000
   1.4 Recall $ICER_{H,C} = \$500,000/QALY > \$100,000$(value for one QALY)
   1.5 Insurance: 10% co-insurance: $Cost_C = \$16,000$, $Cost_H = \$36,000 \rightarrow ICER_{H,C} = \$20,000/0.4 = \$50,000$

Value of Statistical Life

1. Labor Market Decision
    1.1 Either work for *safe* job or *risky* job
    1.2 Difference in risk and risk-premium
    1.3 Job with 1% higher risk for \$50,000 risk-premium: VSL = \$50,000/0.01 = \$5 million
    1.4 VSL Range (USA): \$5-\$12 million.
2. Product Purchase Decision
    2.1 How much are people willing to pay to purchase products that reduce risk.
    2.2 Price of bike-helmet vs. reduction in risk of head-injury.
    2.3 VSL Range: \$2.6 million for children 5-9; 2.6 million 10-14; \$4 million for adults 20-59
3. Government Policy
    3.1 Federal Aviation Administration: \$2.5 million
    3.2 Food and Drug Administration: \$5.3-6.8 million

Source: BHT Chap 14