CHAPTER 14
HEALTH TECHNOLOGY ASSESSMENT

HTA

- ***Systematic evaluation of properties, effects and/or impacts of health technologies (medicines, medical devices, vaccines) and interventions.***
- ***Approach used to inform policy and decision-making in health care, especially on how best to allocate limited funds to health interventions and technologies.***
- It may be applied to
  - broad public health programmes (such as immunization or screening for cancer)
  - priority setting in health care
  - identifying health interventions that produce the greatest health gain and offer value for money

HTA

- Priority setting
  - **Process of determining how health care resources should be allocated among competing programmes or people**
  - Decisions about
  - General budget allocated to health (%GDP or %of public spending)
  - Which disease to target
  - Who are the beneficiaries
  - Where to direct research
- Who sets priorities?
  - Governments
  - Foundations
  - ONG
  - Private donors

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HTA

- Which objectives
  - Max general population health
  - Reduce health inequalities
  - Universal health coverage
- Criteria for priority setting
  - Cost-effectiveness
  - Poverty reduction
  - Target severe diseases
  - Target the young

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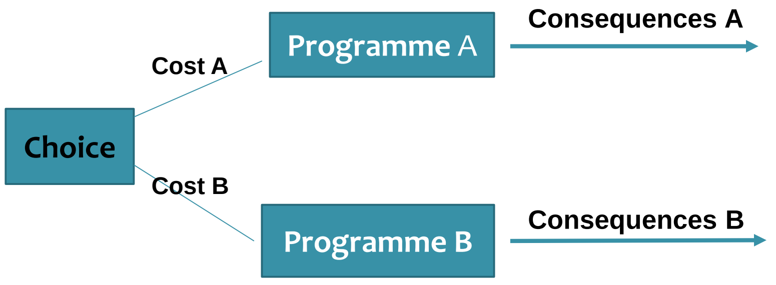
Which intervention are worthwhile

- **Measure the impact of the health problem**
  - Number of cases; number of deaths; amount of disability, pain or suffering; number of people at risk; amount of lost income due to a health problem ….
- **Resouces needed for intervention (costs)**
  - Personel, buildings, equipment, pharmaceuticals, training, information,
- **Outcomes or consequences (benefits)**
  - Measure impact before and after the intervention or
  - Measure impact with and without intervention

An example

- Imagine a community-wide program A to distribute insecticide-treated nets (ITNs) to control malaria.
- What alternatives programmes you might want to compare this against?

An example



HTA

- ***Cost effectiveness analysis*** (compares the costs and benefits of different medical treatments)
- ***Cost-benefit analysis*** (the process of choosing an optimal treatment by creating a tradeoff between money and health)
  - it generates enormous controversy because it involves placing an explicit value on human life.
- These approaches only address one objective: maximizing health (e.g. do not consider equity)

An example: Heart Care Treatment

- Cutler (2007) compares treatments for patients at risk for recurrence of heart attack. The treatment in focus is "revascularization," the use of bypass surgery and/or treatment with stents to improve blood flow to the heart. The study estimates the patient's lifetime costs and benefits. To model the patient's lifetime, he acquired data to permit the study of 17 years into the future following the treatment. He compares improvements to survival for patients admitted to a revascularization-capable hospital and those admitted to a High Volume (assumed to be high quality) hospital but one not having revascularization capability. Cutler calculates the increased life expectancy attributable to each of the two treatments. Revascularization increased life expectancy in this sample by 1.1 years (the sum of the revascularization survival rates) at a cost of approximately $38,000, thus achieving its gains at a rate of **$33,246 for each life year**. The High Volume hospitals increased life expectancy by only 0.06 years, and even though their costs were low, their **costs per life year** saved were **$175,719.** Estimating the value of a human life year to be about $100,000, Cutler concluded that the $33,246 gain from revascularization easily proved cost beneficial

Cost effectiveness analysis

- **Definition:** *the process of measuring the costs and health benefits of various medical treatments, procedures, and therapies.*

Cost effectiveness analysis (CEA) is the less controversial part of HTA, because it is concerned with measuring costs and benefits, not balancing them against each other.

Cost effectiveness analysis

- Often multiple treatments, with varying costs, can be used to treat a given disease.
- In such cases
  - How do patients, hospitals, governments and insurance companies decide which treatments, if any, to provide coverage for?
  - How do patients decide between an expensive and highly effective treatment and a low-cost treatment that is less effective?

Cost effectiveness analysis

- If one treatment is *both* cheaper and more effective than a second treatment, then the second treatment is said to be **dominated** by the first.
  - It is never optimal to use a dominated treatment, because there is always a more effective and cheaper alternative available.

Cost effectiveness analysis

- If neither treatment is dominant, one treatment must be both more expensive and more effective.
  - In such cases, cost-effectiveness analysis is used to help decide whether the extra expenditure is worth it.

Incremental cost-effectiveness ratio (ICER)

- Consider two treatments for the same disease: *A* and *B. A* is both more expensive and more effective than *B*, so neither treatment dominates the other.

- The ***ICER*** of using *A* over *B* is:

$$\mathrm{ICER}_{A,B} = \frac{C_A - C_B}{E_A - E_B} > 0$$

HIV screening

Table 14.1. *Comparison of strategies for HIV screening.*

Treatment strategy	Cost per patient	Average life expectancy
Targeted screening	$51,517	21.063 years
Universal screening	$51,850	21.073 years

Source: Data from Table 3 in Sanders et al. (2005).

$$ICER = \frac{51{,}850 - 51{,}517}{21.073 - 21.063} = 85\$/day$$

Lead poisoning example

- Which treatment strategy is superior?

Table 14.2. *Comparison of two lead poisoning treatments.*

Treatment strategy	Cost of treatment	Prob. of reading disability
Conservative treatment	$786	35.3%
Aggressive treatment	$1,778	21.6%

Source: Data from Table 1 in Glotzer et al. (1995).

Lead poisoning example

$$\text{ICER}_{Agg,\ Cons} = \frac{\$1{,}778 - \$786}{0.353 - 0.216} = \$7{,}241/\text{reading disability}$$

- This ICER provides a price for avoiding a reading disability.
- In some sense, people can avoid a reading disability for an average price of $7,241.
- Note that the ICER does not make a determination about whether this is worth it or not, it is just an empirical fact about costs.

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$$\text{ACER}_T = \frac{C_T}{E_T}$$

Table 14.3. *Various drug therapies for bhtitis.*

Treatment regimen	Total cost (TC)	Life expectancy (LE)	Cost per extra year of life (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

Comparing ICER for A and C → $\frac{160-40}{3-1} = \frac{60\$}{year}$

If one year is worth more than 60 then C is better than A

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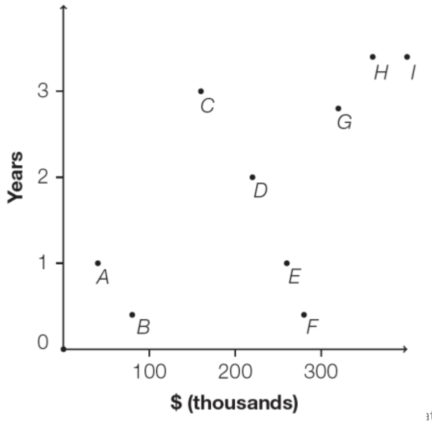
The average cost-effectiveness ratio (ACER)

$$\text{ACER}_T = \frac{C_T}{E_T}$$

- *Q*: So why not just look at the various treatments' ACERs and pick the one with the lowest cost per additional year of life?
- *A*: ACERs typically will not reveal all the potentially cost-effective drugs.

Cost-effectiveness frontier (CEF)

- EX: Consider possible treatment options for the disease "bhtitis": *A, B, C, …, I*



Cost-effectiveness frontier (CEF)

- **Definition:** a subset of treatment strategies for a condition that are not dominated by any other treatment. Any treatment on the CEF is said to be *potentially cost-effective***.**
  - The CEF simplifies comparisons between treatments by allowing analysts to rule out dominated drugs (which should never be used), and focus only on options that potentially cost-effective.

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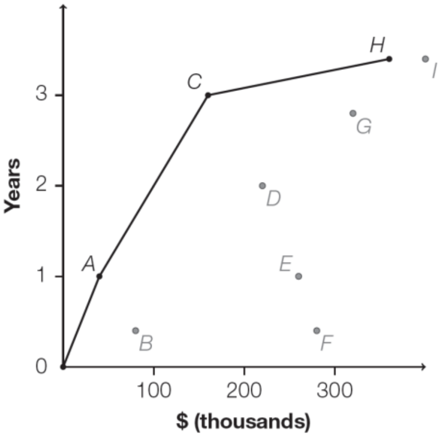
Cost-effectiveness frontier (CEF)

- Connect non-dominated options to form CEF



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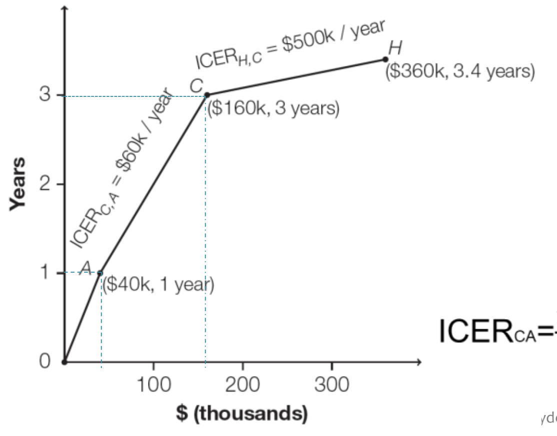
Cost-effectiveness frontier (CEF)

- The slope of the CEF between two points is equal to the inverse of the ICER between the two.



$$ICER_{CA} = \frac{160-40}{3-1} = \frac{60\$}{year}$$

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Which treatment?

- *ACER*$_A$= *40k* $/year
- *ACER*$_C$= *160k* $/year
- *ACER*$_H$= *360k* $/year

- *ICER*$_{0A}$= 40k $/year
- *ICER*$_{AC}$= 60k $/year
- *ICER*$_{CH}$=500k $/year

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Measuring costs

- In order to calculate the ICER, we need to measure the costs of each treatment.
  - not the money costs of resources, but the **opportunity costs**
- Whose perspective?
  - *Society's*: all costs count.
  - *Health care sector*: disregards costs imposed on patients or their families
  - *The patient*: only costs directly borne by patients count.

Which costs count?

- Suppose a complete course of a new lung cancer treatment costs $1,000. Is this the only cost to consider?
- What if…
  - the treatment must be administered in a distant location, or for extended periods of time?
  - the treatment is uncomfortable—or has unwanted side effects?
  - the treatment will lead to adverse health effects in the future? How should future costs be counted? If lung-cancer patients are cured but then go on to have costly heart attacks, should those costs count against the treatment?

Which costs count?

- Direct costs
  - Health-care
  - Non health-care (eg transportation costs)
- Indirect costs
  - Patient and family (work and leisure) time
    - at what value? wage?
- Intangible costs
  - Side effects
    - difficult to measure
- Discounting

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Which costs count?

Table 14.6 The costs of polio classified

Resource	*Type of cost*
Polio vaccine	Direct health care
Salary of physical therapist who treats polio victims	Direct health care
Loss of wages due to polio	Indirect
Loss of wages due to vaccine-induced polio	Indirect
Bus fare for family members visiting child at hospital	Direct non-health care
Pain and suffering following a case of polio	Intangible
Cost of care of siblings to enable mother to take ill child for rehabilitation	Indirect
Time lost taking child to clinic for immunization	Indirect
Salary of nurse who runs immunization clinic	Direct health care
Hospital cost for child with vaccine side-effects	Direct health care

Lorna and Wiseman. Introduction to Health Economics, OUP 2010

How is "effectiveness" measured?

- ***One common measure of effectiveness is increased life expectancy.***
- But how do we account for other health benefits that affect quality of life (e.g. increased mobility and freedom from pain)?
  - The **Quality-Adjusted Life Years** (QALY) approach combines quality of life and life expectancy into a single index.

QALYs

- In a QALY calculation, each year of life receives a quality weight q between 0 and 1 that reflects the quality of that life-year.
- A year lived in perfect health has a quality of weight of q = 1.
- Maybe a year with chronic cough and insomnia is only worth q = 0.5, or a year confined to a wheelchair is only worth q = 0.25.
- Who has the right to make this judgment? We will return to this question

QALEs

- Calculating QALYs requires estimating three pieces of information:
  - the probability P_t of surviving to each year t
  - the quality of life q_t for each year
  - a time-discount rate
- A person's **quality-adjusted life expectancy (QALE)** is the number of additional years he expects to live, weighted by the discounted quality of his life in each of those years (i.e. the sum of his QALYs).

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

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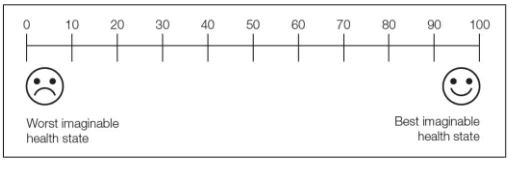
Survey methods: quality weights

- **Visual analogue scale** (VAS) asks respondents to rate health outcomes between 0 (worst) and 100 (best)



- *Pros*: simple to administer and easy for respondents to understand
- *Cons*: does not require respondents to think about tradeoffs between different health states. Thus, results may not reflect the intensity of respondents' preferences.

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Survey methods: quality weights

- **Standard Gamble (SG)**: For health condition *H*, respondents choose between having *H* with certainty or a gamble with probability *p* of full health and probability (1- *p)* of death. The point of indifference between these two options is used as the quality weight *q* of health condition *H.*

•*Pros*: reflects intensity of preferences better than VAS.
•*Cons*: this approach may be affected by risk aversion, and people often respond in counterintuitive ways to such uncertain gambles.

Survey methods: quality weights

- **Time trade-off** (TTO): respondents choose between 1) living for *t* years with a health state *H* before dying, and 2) living for a shorter amount of time Ŧ in full health before dying. The quality weight *q* of health state *H* is the ratio Ŧ*/t (with Ŧ* representing the point of indifference between the two options).

•*Pros*: Reflects intensity of preferences better than VAS.
•*Cons*: may be biased if Ŧ* is a function of age

Weight estimates

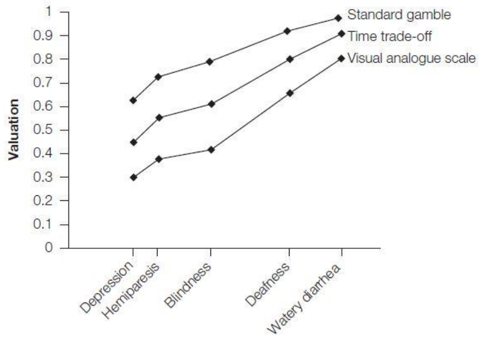

Figure 14.5. *Average quality weight estimates for five conditions under three different estimation methods.*

Source: Data from Salomon and Murray (2004).

EQ-5D

- based on a questionnaire with five questions with pre-scored value set, derived by one or several of the direct methods. Each combination of the responses can be assigned a weight using specific value sets. The British value set, which is commonly used, has been developed by using TTO and VAS in a sample of the British general public.
- https://euroqol.org/

Whose opinion matters in QALY surveys?

- Healthy survey respondents may be unequipped to imagine the quality of life in health states they have not experienced.
- Expert panels are unlikely to ably represent patients' preferences.
- People who have lived with a condition for decades tend to understate the suffering that healthy people would feel if they suddenly developed a condition (e.g. blindness).

Cost-benefit analysis (CBA)

- **Definition:** Cost-benefit analysis (CBA) is the process of choosing an optimal treatment among all potentially cost-effective ones, *given a certain monetary value for each unit of health effect*.
  - This optimal treatment is then termed **cost-effective** for a person or agency with that valuation.

Cost-benefit analysis (CBA)

Example: Let us assume that we values each QALY at $**100,000**

Treatment	Cost	Value of QUALY	B-C
A	40	**100**	60
C	160	3x**100**=300	**140**
H	360	3.4x**100**	-20

The treatment with highest net value is C

and if the value of a QALY is 35,000? And 50,000?

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Cost-benefit analysis (CBA)

Example: Let us assume that we values each QALY at $**50,000**

Treatment	Cost	Value of QUALY	B-C
A	40	**50**	**10**
C	160	3x50=150	-10
H	360	3.4x**50**= 170	-190

The treatment with highest net value is A

and if the value of a QALY is 550,000?

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Cost-benefit analysis (CBA)

Example: Let us assume that we values each QALY at **$550,000**

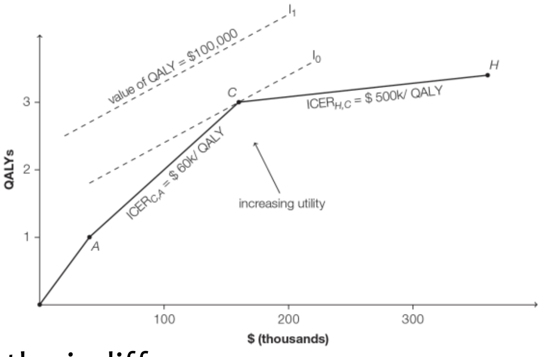
Treatment	Cost	Value of QUALY	B-C
A	40	**550**	510
C	160	3x**550**=1650	1490
H	360	3.4x**550**=1870	**1510**

The treatment with highest net value is H

Cost-benefit analysis (CBA)

- When we place a monetary value on each QALY, we implicitly create a set of indifference curves that can be plotted with the CEF (why?)
-
- As a result, his indifference curves slope such that he is indifferent between one additional QALY and $100,000.

Cost-benefit analysis (CBA)



1) Plot the indifference curves
2) Find the tangency point
3) With these indifference curves, the cost-effective treatment is Drug C.

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Cost-benefit analysis (CBA)

- If costs and benefits last for T years, we have to discount then and compute the Net Present Value of a treatment:
- $$NPV = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t}$$
- r is the discount rate
- $\sum_{t=0}^{T} \frac{B_t}{(1+r)^t}$ is the value of QALE

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Estimating the value of life

- QALE is the sum of QALY
- How much is a QALY worth?
- Value of life estimates rely primarily on three sources:
  - human capital, labor market choices, product purchase decisions, and government policies.

Estimating the value of life

- You may think life cannot be valued economically or has an infinite value. Consider the following example:
  - There is a suitcase across a busy street with a million dollars in it.
  - If you cross the busy street to get the suitcase, there is a 1% chance you will be struck by a bus and killed.
  - Do you risk it?
  - If you answer yes, your life cannot be worth more than $100 million to you ($1 million divided by 0.01).

Human capital

- Quantify the loss of a person's marginal productivity as result of ill health – i.e the marginal loss in economic output that results from a person not being able to work.
- The monetary value of lost productivity due to ill health is computed at the 'market price' of labour (wage).
- An example …
- Limits

Using the labor market to reveal VSL

- In order to attract workers to more hazardous jobs, high-risk employers offer additional wages ("risk premiums"), which supplement the wages workers would earn in comparable, but lower-risk jobs.
- If researchers know both the risk premium for a job and the difference in risks, then they can estimate how much a worker values his life.
  - Example: A worker who would take a job with a 1% higher fatal injury risk for $50,000 more in wages has a VSL of $50,000 ÷ 0.01 = $5 million.

Using purchase decisions to reveal VSL

- Example: Jenkins et al. (2001) used price data for children's bike helmets to estimate their VSLs.
  - The decision to wear a helmet indicates a judgment that the risk reduction of head trauma from bike accidents is worth the cost of buying helmets.
  - Researchers used the prices of helmets to estimate a lower bound for the value of risk reduction and use that to calculate a lower bound for the VSL of helmet-wearers.
  - Other purchasing decisions: smoke detectors, safe cars vs unsafe cars.

Using government policies to reveal VSL

- Example: In 1972, a U.S. law guaranteed kidney dialysis to all patients under 65 with end-stage renal disease for free.
  - Kidney dialysis costs approximately $50,000 per QALY.
  - The passage of this amendment suggests that a QALY is worth at least $50,000 to American taxpayers.

Conclusion

- Health systems/Insurers can neither cover every single new technology, nor refuse to cover all new procedures
- *selective* about which procedures to cover
  - HTA is a tool that many insurers and national health systems use to make these coverage decisions

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Killing COVID-19

https://www.youtube.com/watch?v=xTxWa7wWATg

Some simple maths and economics

Stephen Wright
Professor of Economics
Birkbeck College
University of London

Killing COVID-19 via herd immunity

- Estimates of mortality rate from COVID-19 typically in range 0.5% to 1%
- If we rely purely on herd immunity almost everyone catches COVID-19
- So globally around 35-70 million people would die
- A pandemic is a classic externality
- **Governments are willing to spend money to save lives**
- **But how much?**

What would we pay to avoid the death toll from herd immunity? A crude calculation for the UK

- The UK's National Health Service currently authorises spending £20,000 to £30,000 to save a single "quality-adjusted life year" (QALY)
- UK population≈ 67 million
- With mortality rates of 0.5% to 1%, achieving herd immunity would cost 335,000 to 670,000 lives in UK, mostly the elderly.
- Each death implies c. 15 lost QALYs, assume £25k per QALY
- ➔ On usual rules NHS would spend up to £125bns to £250bns (5.7% to 11.4% of GDP) to prevent these deaths
- In simple logistical terms, hospital services would be overwhelmed by so many deaths over such a short period.