Cost Benefit, Value of Life, and Health Policy

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Outline

- Cost-benefit analysis
- Converting life years into money: the value of life
- The value of a statistical life
- Value versus affordability: budget impact analysis
- How is cost-effectiveness used in the US and the world?
- The evolving role of cost effectiveness in the US (the quest for "value")

Overview

- We covered **cost studies** early on. A comparison of the costs of two or more interventions. Essentially, the numerator of ICER
- We also covered **cost effectiveness** and **cost utility**: effects or outcomes are either "natural units" or quality-adjusted life years (QALYs)
- I also told you that many people would call both cost-effectiveness analysis
- Today, **cost-benefit analysis**: effects/outcomes are measured in monetary units

Cost-benefit analysis

- In CBA the benefits of an intervention are measured in monetary units
- The summary measure is no longer ICER but rather **Net Social Benefits**

$$NSB_i = B_i - C_i$$

  where i is an intervention and B and C are its "benefits" and costs, respectively
- The decision rule is that the intervention should be implemented if $B_i > C_i$
- Don't get confused: they are still incremental costs. Still a comparison
- Typically, benefits and costs are measured over time so we need to do the usual discounting of **flows**

Net social benefit

$NSB_i = \sum_{t=0}^{n-1} \frac{B_{it}-C_{it}}{(1+r)^t} = \sum_{t=0}^{n-1} \frac{B_{it}}{(1+r)^t} - \sum_{t=0}^{n-1} \frac{C_{it}}{(1+r)^t}$

- In other words, the difference between the present value of benefits and costs
- You could express it in terms of the ratio $\frac{B_i}{C_i}$. If ratio > 1, we should implement project
- All the issues about **perspective**, **time horizon**, and **relevance of costs** for the decision are still valid
- So what is the difference? The difference is that now **we need a way to convert benefits/outcomes into money**

Valuing outcomes

- The conundrum with cost-benefit analysis is that converting outcomes into money is difficult and controversial, which is the reason you won't find many cost-benefit analyses out there
- (But as we saw before and will repeat today: if we use CEA with a QALY threshold, we are indirectly using cost benefit)
- Three methods to transform outcomes into money:
  1. Human capital
  2. **Stated** preferences (aka willingness to pay; WTP)
  3. **Revealed** preferences
- We have been talking about these terms during the semester

Human capital approach

- One way to think of the benefits of an intervention is that it adds more time in better health
- More healthy time allows a person to work more
- Therefore, one way to **valuate** the benefits of an intervention is to calculate the **market value of the time** in better health
- We have seen this idea before: that's how we can valued **productivity changes**
- In the case of CBA, we can extend this idea to value **all the effects** of an intervention

Example

- A vaccination program prevents medical costs associated with the condition
- Contracting the condition could lead to **disability** ("unproductive" time) and early **death** (obviously, can't work)
- We saw that we can value the unproductive time using wages
- We can extend the idea to value life: calculate **average lifetime earnings** of participants and come up with the reduction in earnings had the program not been implemented
- In other words, **average lifetime earnings gained** because of the intervention
- This essentially assigns a monetary value to years of life gained

Problems with the human capital approach

- We already talked about the problems of the human capital approach when we discussed productivity changes
  1. Wages are not a good reflection of the value of earnings
  2. Ethical concerns about using wages (remember the homework about the VA intervention)
- Besides these practical criticisms, the human capital approach is also problematic in theory
- In theory, we would like to know what **resources** would people be **willing to sacrifice** to implement a program because that tells us how people value the program
- With the human capital approach, we measure how much **income is lost due to illness or death**, which is not the same concept
- Using wages is a reasonable approach for tort compensation (for example, malpractice compensation)

Stated preferences (contingent valuation)

- Why not ask people questions to measure the maximum they would be **willing to pay** for an intervention?
- There is theory behind the questions; it's related to demand curves in economics
- Each consumer has a demand curve (resulting from utility maximization)
- A demand curve shows the amount of a product a consumer would buy at different prices
- Market demand is the aggregation of consumers' demand curves
- It also shows how much consumers **value** a good

Stated preferences (contingent valuation)

- Why can we measure consumers' *value* from demand curves? A **little bit** of econ theory:
- I like wild mushrooms (e.g. morel or chanterelle) so I would pay up to $30 for a pound (in special occasions). When you can actually find them in Colorado they are about $16 per pound (Costco sometimes have them for a lot less)
- Economists would say that I gained $14 in "value." I was willing to pay $30 per pound but the market price was less. Economists call this **consumer surplus**
- Same idea in contingent valuation/stated preferences. We would like to know the max people would be willing to pay (WTP) for an intervention so we can compare it to the cost of the intervention
- One way of thinking about contingent valuation is that it is an attempt to **create a market for the intervention**

Stated preferences (contingent valuation)

- A practical example about valuing life (Drummond et al, 2005)
- "Suppose you buy a new car... You can choose an option that reduces the risk of death in case of an accident. The next few questions will ask about how much extra you would be prepared to pay for different types of safety features. You must bear in mind **how much you personally can afford**."
- Additional information: car without added safety feature: 10 in 100,000 risk of death. With feature, 5 in 100,000, so a reduction of 5 in 100,000
- Note the target of the question: how much are you willing to pay for the safety feature that will reduce **your** risk of death *given your income constraints*?
- We could ask that question to a representative sample of people. Suppose that on average the stated willingness to pay for the feature is $200

Stated preferences (contingent valuation)

- People would be willing to pay an additional \$200 for a reduction of 5 deaths in 100,000
- That implies $\frac{\$200}{(5/100{,}000)} = \$4,0000,000$ per life
- (Another way: \$200 per 5 deaths averted, so \$40 per life. But it was out of 100,000 population, so we need to multiply by 100,000)
- This is per life saved or death averted since we are dividing $\frac{\$}{deathssaved}$
- This is a fairly simple example but you get the idea: **we ask people to tell us about trade offs so we can imply the value they place on certain outcomes**; in this case, life
- WTP could be used to value other outcomes
- **As you can probably guess, there are many problems with stated preferences**

Problems with WTP

- Some of them:
  1. Many ways to ask questions; comparability is difficult
  2. Who should answer the question? Society or the participants?
  3. WTP depends on income; it raises ethical concerns
  4. The biggest one: **talk is cheap**
- We want to know what people would pay, **not what they say they would pay**
- Most of us **overestimate** what we would be willing to pay when asked
- Economists are very skeptical about asking people about hypotheticals
- Instead, what about if we do the same using actual behavior? Enter **revealed preferences**

Revealed preferences

- Revealed preferences uses actual choices to figure out valuations
- In other words, instead asking people what they would do in a given situation, **we imply value by studying what people actually did**
- Revealed preferences are limited to valuations of benefits that are **salient** (it will become clear in a couple of slides)
- For this reason, revealed preferences studies are often used to value life years gained and not other intermediate outcomes like reductions in blood pressure or cases detected

Revealed preferences

- It all started with Adam Smith in 1776 so to speak:

  The wages of labour vary with the easy or hardship, the cleanliness or dirtiness, the honourableness or dishonourableness of the employment
- In other words, for people to do a job, wages need to compensate for risk
- As usual, we are thinking about a more or less competitive market – ruling out gangsters, slavery, imperfect information... Do NFL players really know the true risk of death? Has the market adjusted so first responders dealing with COVID-19 get additional hazard pay? **NO**
- **General approach**: use data on wages and risks while controlling for worker and job characteristics
- There are many studies that have used this type of analysis; it includes **hedonic pricing or hedonic valuation** (how much are people willing to pay to avoid noise or pollution?)

The value of a statistical life

- In spite of problems, plenty of studies offer some guide as to the value of life
- When applied to valuing life, the revealed preference approach is called the **value of a statistical life**. The statistical approach can be a bit complicated but the logic is fairly simple
- Often, a regression is estimated, making wages a function of person characteristics (P), job characteristics (J), fatality risk (p), non-fatal death risk (q), and compensation for the risk (WC)

  $E[wage_i] = \beta_0 + \beta_1' \mathbf{P} + \beta_2' \mathbf{J} + \beta_3 p + \beta_4 q + \beta_5 WC$
- Note that **P** and **J** are a group (vector) of variables. We mostly care about β_3
- Holding job factors, personal factors, non-fatal injuries, and compensation **constant**, *how much more on average do people get paid for a change in the fatality risk associated with the job?*

The value of a statistical life

- Note that the regression approach is parallel to stated preferences. A similar stated preference question: How much more money do you need in order to accept a job that will increase your chances of dying by X in 1000,000?
- Wide range of estimates. Range of about $3 to $7 million with older data. The most current accepted value is $9 to $10 mill
- See Viscusi and Aldy (2003) for a comprehensive review
- As you probably suspect, WTP (stated preferences) estimates are a lot **higher than revealed preference estimates**
- Talk is cheap. We all care about safety and extending life but have competing priorities and constraints

Problems with revealed preferences

- Valuations vary widely and are **context** (e.g. unemployment, sample) and **job** specific. The numbers above are averages of several professions
- Hard to differentiate one aspect of the job versus another. Wage depends on risk, but also on comfort and other attributes, which are controlled for in the regression, albeit imperfectly
- In other words, there are factors that could explain wages, other than risk, that are not accounted for the in the model, including imperfect information and other factors like bargain power of workers. Think for a second about a farmer or a miner in Bolivia
- Then again, **we are talking about trade-offs**. How much do we trade-off to increase live (alternatively, avoid death)? **That should depend on income and opportunities**
- But the statistical value of life is used the governments to decide if something is worth doing. Why not use it for health interventions?

What is the state of CBA?

- Given the difficulties of valuing outcomes, CBA is not often used in economic evaluations
- This is true for **final outcomes** like death, even more complicated to value **intermediate outcomes** like blood pressure decreases, cases detected, depression reductions
- A lot of ethical concerns about valuing outcomes in terms of money
- Not just my opinion

What is the state of CBA?

- "The major disadvantage of the benefit-cost framework is the requirement that human lives and quality of life be valued in monetary units. Many decision-makers find this difficulty or unethical or do not trust analyses that depend upon such valuations." (Weinstein and Fienberg, 1980)
- "To be trained in medicine, nursing or one of the other "sharp end" disciplines and then be faced with some hard-nosed cold-blooded economist placing money values on human life and suffering is anathema to many." (Mooney, 1992)
- "[Cost-benefit analysis is] an approach whose difficulty lies in its intrinsic favoring of programs and diseases of the affluent over those of the poor." (Gold et al, 1996)

Connection between CUA/CEA and cost-benefit

- BUT... **Is CBA really that different from CEA?**
- Remember, we compare ICERs to some threshold (or ICERs of other interventions), which traditionally is measured in terms of years of life gained or quality-adjusted life years (QALY)
- Current accepted thresholds are $100,000 to $200,000 per QALY
- But the threshold **is also the maximum WTP per unit of life or QALY** so in fact we are valuing life years. It's implicitly the value of one year of life adjusted for quality
- To many economists, the difference between CBA and CEA is that **CBA makes this valuation explicit**, while CEA hides behind the vague idea of thresholds
- Regardless, **CBA is not often used in health care and many of the studies that claim to use CBA do not value benefits**

Thresholds and the statistical value of life

- Can we come up with a threshold using the statistical value of life? Yep. Let's use the current $10 million number
- That's not per year but that's the value of a life regardless of age. Life expectancy in the US is about 78 years, so $\frac{\$10 mill}{78} = \$128,205$ per year
- We need to adjust for quality. The average EQ-5D is about 0.8. So $\$128,205 * 0.8 = \$102,564$ per QALY
- **Does it look familiar?** Yes, of course, that's close to the current threshold

Thresholds and the statistical value of life

- Another way. I find it problematic that \$10 mill is the value of an entire life. Revealed preference studies use data from people in the labor market who are of average age. How I value the rest of my life now is different than my valuation at 15. I had major (major!) world-changing plans. That could affect labor choices
- The median age in the USA is about 37. Life expectancy is 78. So the rest of life is 41 years. So $\frac{\$10 mill}{41} = \$243,902$
- Now, quality of life after 37 has to be less than 0.8, the entire life. Using Medical Expenditure Panel Survey (MEPS) data, the average is about 0.7. So the adjusted value is $243,902 * 0.7 = 170,731$ per QALY
- Looks familiar? Again, that's within the accepted \$100K to \$200K for the ICER
- **Disclaimer**: the previous slide is the most accepted way to think about this

The coronavirus and the value of a statistical life

- We can use the statistical value of life to think about whether the economic cost of inducing the economy into a comma is worth it compared to the lives saved
- But, I'm **NOT** going there mostly because I think it's a false choice and there is so much uncertainty about the different scenarios
- In any case, most calculations suggests that yes, it is worth it, but at some point it won't
- That's based on the idea that our actions reveal how we trade off money to accept the risk of dying

Switching gears: **Budget impact analysis**

- Suppose that there is a new intervention that is considered cost-effective. The ICER, compared to usual care is about $45,000 per QALY, which would be considered cost effective by any standard
- The recommendation is to implement the intervention because it has good "value"
- The next logical question should be: **can we actually afford it**?
- Make sure you understand the difference between the **value** question and the **affordability** question. Not the same
- Remember the fancy restaurant example: I think that a $300 meal at the best seafood restaurant in NYC is good value and worth it. I'm yet to visit any such restaurant

Budget impact analysis

- Remember, to get ICERs we compare the new intervention to something else –the old intervention, usual care, the best available alternative drug, etc
- ICER is the ratio of incremental costs to incremental effectiveness: $\frac{C_2 - C_2}{E_2 - E_1}$
- Nowhere in the calculation of ICER we took into account the actual **number of people that would be affected by the program**
- Clearly, affordability depends on the number of people affected by a program and the **cost of the new intervention**, not *incremental cost over incremental effects*
- You can get a low ICER if the incremental effectiveness is large –but the price of the new intervention could be very, very high

Budget impact analysis

- **Definition 1**: BIA measures expected changes in the expenditure of a health care system after the adoption of a new technology (or intervention or drug, ect)
- **Definition 2**: An economic assessment that estimates the **financial consequences** of a new technology (or intervention or drug, ect)
- It is usually done **in addition** to a CEA/CUA study
- The relevant question for a BIA study is the **affordability** of the program, not the "value" of the new intervention

Key components of BIA

- **Perspective**: A payer perspective–the payer can be the government, of course: Medicare, Medicaid, the VA
- **Time horizon**: Usually shorter than CEA/CUA (1-3 years)
- BIA does incorporate the **number of people affected by the intervention** (**this is a crucial element**) and the cost of the new intervention, not just incremental costs

  Not so easy to measure: need to come up with estimates of uptake, insurance restrictions, and other features of the health care system. Hard to estimate how the new intervention will change current practice. If a new drug, would everybody start using the new drug? Half? What's the copay going to be?
- **Discounting**: Usually not (but could take into account inflation)
- **Sensitivity analysis**: Of course, always important

The Affordable Care Act and CEA

- Expanded access to insurance
  1. **Mandate** to have insurance (or pay penalty)
  2. Eliminate **pre-existing** conditions
  3. Create a **market** for health insurance that does not depend on work
  4. Provide **subsidies** and **expand** Medicaid
- When the bill was debated, talk of "death panels" motivated congress to **explicitly forbid the use of cost-effectiveness** analysis in **government** programs
- Explicitly forbade the use of ICER and thresholds
- Instead, funding was provided for **comparative effectiveness research**

So why do CEA?

- We should at least attempt to collect evidence on incremental costs and benefits
- **Even if you do not believe in government intervention**, why not let patients and doctors talk about costs versus benefits?
- At the end, we **all pay** for health care in one way or another
- We pay for care of others through **taxes** and **insurance premiums**

Not just about rationing

- CEA is not about **rationing or denying coverage**
- It can be used to provide *incentives* through co-payments; insurance companies do this
- Increase the co-pay of low-value interventions (reduce the co-pay of high-value interventions)
- This is the rationale behind **value-based insurance design** (VBID), which has been shown to reduce costs
- Pharmacy formularies take CEA into account
- At the very least, what about using CEA to eliminate waste (no value treatments)?

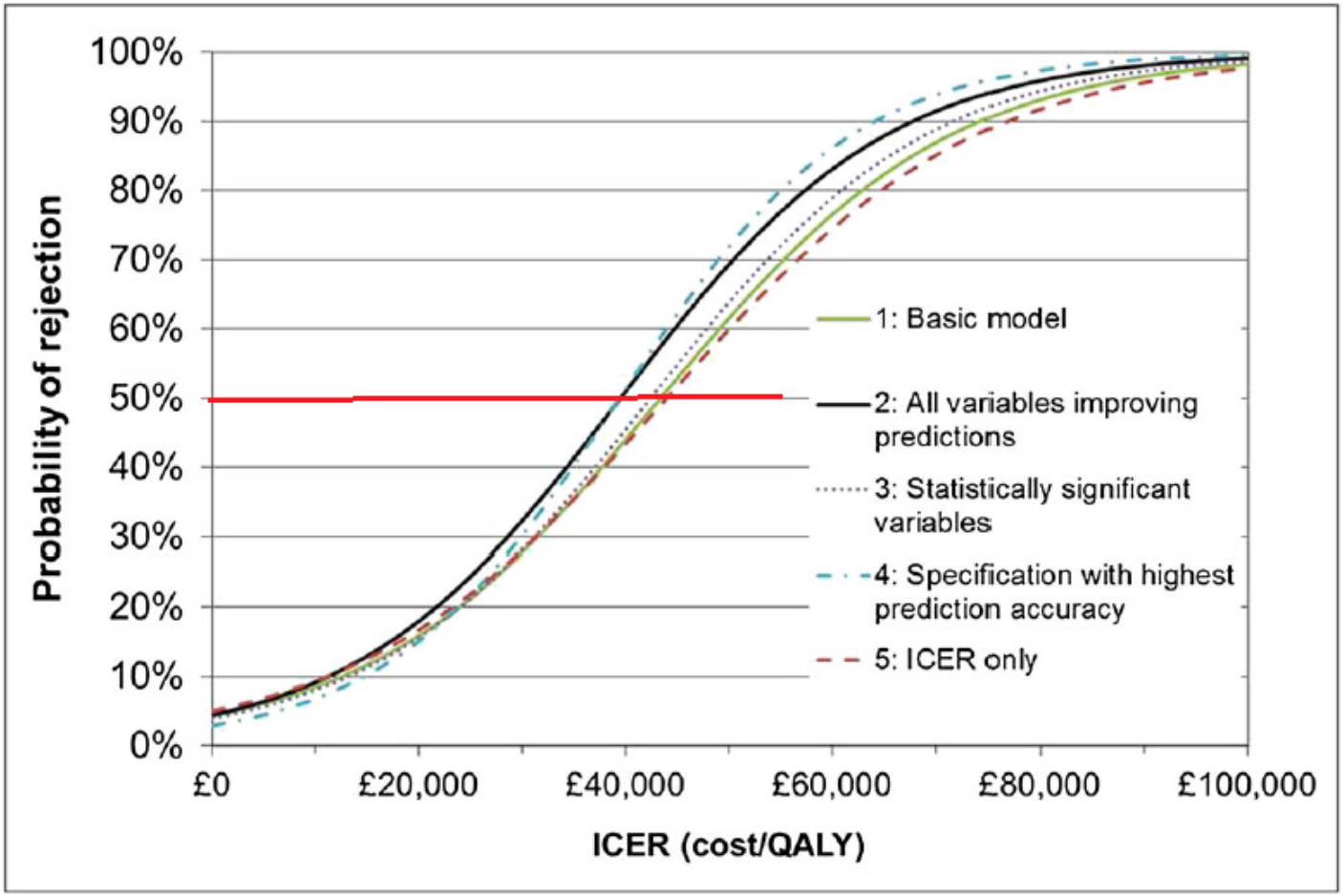
View from the other side

- CEA is used many countries in ways that (currently) would be politically impossible to implement in the US
- In the UK, the National Center for Health and Care Excellence (NICE) uses CEA in coverage decisions
- So, yes, **rationing**. They do have people who die because they are denied coverage...
- BUT: the ICER is not the only factor that is considered, although is an important one

How does NICE decide?

- NICE has rigorous **guidelines** to conduct CEA (much like FDA regulations for clinical trials)
- An ICER below £20,000 is considered cost-effective and, most of the time, accepted for coverage
- A new technology with an ICER over £20,000 is not considered cost effective but it **could be** approved for use
- Other factors considered are: uncertainty of ICER, innovation, non-health outcomes, end-of-life considerations, stakeholders perspectives on quality of life gains, age (don't mess up with children's health)
- In other words, there is room for **judgment** and consideration of the **limitations** of CEA
- Dankin et al (2015) analyzed ICER decisions

Probability of rejection by ICER



- "We estimate that the ICER at which the probability switches from more-likely-to accept to more-likely-to-reject is between £39,000 and £44,000"

CEA around the world

Country	HTA Entity	Scope of HTA
United Kingdom	National Institute for Health and Care Excellence (NICE)	Drugs, devices, diagnostics, interventional procedures, clinical and public health interventions, service delivery, social care, pay-for-performance schemes, human resources and staffing norms
Australia	Pharmaceutical Benefits Advisory Commission (PBAC)	Drugs and vaccines
Germany	German Institute for Quality and Efficiency in Healthcare (IQWiG)	Drugs, devices, surgical procedures, quality control interventions, diagnostic tests, clinical practice guidelines of disease management programs, lay information for patients
Canada	Canadian Agency for Drugs and Technologies in Health (CADTH)	Health care technologies
France	French High Health Authority (HAS)	Drugs, devices, surgical procedures, and diagnostic tests; clinical guidelines for disease management; public health guidance on disease prevention and health care system organization, accreditation, and QA of providers
Sweden	Swedish Council on Technology Assessment in Health Care (SBU)	Health care technologies

Sources: Chalkidou and Anderson. Comparative Effectiveness Research: International Experiences and Implications for the U.S., 2009; [23] Sorenson and Chalkidou. Reflections on the Evolution of Health Technology Assessment in Europe, 2012; [7]

- From Fairbrother et al (2014); HTA= Health technology assessment

In the US?

- Insurance companies use CEA for **formulary decisions**. Also, they need CEA for approval in Europe
- More and more medical societies are coming up with "value" recommendations
- ICERs almost always show up in these recommendations but not the only factor
- **Recall**: value in CEA is $\frac{\Delta Costs}{\Delta Outcomes}$. Often, outcome is QALY
- See Neumann (2015)

Neumann (2015)

Summary of Therapy Value Frameworks.*

Organization	Factors Considered	Description
American College of Cardiology–American Heart Association (ACC–AHA)	Clinical benefit vs. risks Magnitude of net benefit Precision of estimate based on quality of evidence Value (cost-effectiveness)	Magnitude of treatment effect ranges from class I ("benefit [greatly exceeds] risk," "procedure or treatment is useful or effective") to class III ("no benefit, or harm," "procedure or treatment is not useful or effective and may be harmful"). Precision of treatment effect ranges from level A ("data derived from multiple randomized trials or meta-analyses") to level C ("only consensus opinion of experts, case studies, or standard of care"). Value corresponds to cost-effectiveness thresholds (high: less than $50,000 per QALY; intermediate: $50,000 to $100,000 per QALY; low: more than $150,000 per QALY). The framework lists the clinical benefit and value designations without combining them.
American Society of Clinical Oncology (ASCO)	Clinical benefit Overall survival Progression-free survival Response rate Toxicity Bonus factors Palliation Time off all treatment Cost per month	A therapy can be awarded up to 130 points. Clinical benefit (≤80 points) reflects end point and magnitude of benefit, with preference given to evidence on overall survival if available. Toxicity (±20 points) reflects the rate of grade 3 to 5 toxic effects with treatment relative to standard of care. Bonus point score reflects palliation (10 points if therapy improves symptoms) and increased time off all treatment (≤20 points). The framework doesn't combine each drug's point score and cost.
Institute for Clinical and Economic Review (ICER)	Incremental cost-effectiveness plus care value components Comparative clinical effectiveness Other benefits and disadvantages Contextual considerations Budget impact	Cost-effectiveness ratio must not exceed a threshold ranging from $100,000 to $150,000 per QALY. Selection of final threshold is based on: (a) comparative clinical effectiveness, reflecting "judgments of the health benefit magnitude" and "strength of a body of evidence"; (b) other benefits and disadvantages, including such outcomes as factors influencing adherence or return to work; and (c) contextual considerations, including "ethical, legal, or other issues" (e.g., high burden of illness, availability of alternative treatments). Budget impact is acceptable if a drug's introduction is compatible with an annual health care budget increase of GDP growth plus 1%. ICER reverse-engineers a "value-based price benchmark" that independently satisfies both the cost-effectiveness and budget-impact criteria (see text).

Summary

- Although CBA is not used much in health interventions, it's similar to CEA with a decision threshold
- CEA is about comparing incremental cost with incremental benefits/outcomes. Are the additional benefits worth the additional costs?
- The statement above is different from affordability, thus the need for a **budget impact analysis**
- CEA is not just about rationing; it can be used to set **incentives**
- It can also be used to **inform** patients and doctors. As patients, do we want to contribute to waste?