Introduction to Infectious Disease Modelling and its Applications, LSHTM, 18 - 29 June 2018

Economic evaluation of infectious disease interventions

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Outline

At the end of this session you should:

- Understand the **motivation** for conducting economic evaluations of infectious disease interventions.
- Understand the advantages and limitations of different **methods** of economic evaluations of infectious disease interventions.

Key concepts

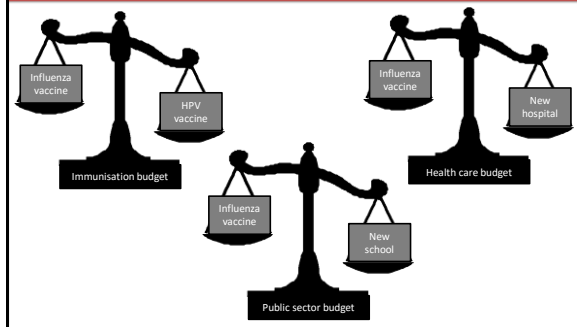
Scarcity

Health care resources (money, staff time, hospital beds etc.) are limited and insufficient to meet all health care demand.

Opportunity cost

The cost of a choice (eg. purchasing a vaccine) is measured in terms of the value of best alternative foregone (eg. using the same money to build a new hospital). This is called the *opportunity cost* of the choice.

Why does economics matter?



Choices like this are being made all the time.
Health economics helps to make the trade-offs explicit.

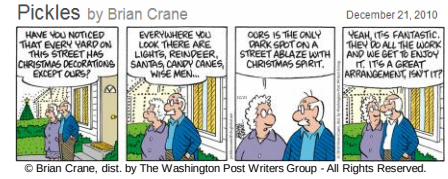
Rationing

Rationing (or **"priority setting"**) is the mechanism we use to allocate scarce resources. Some ways to ration:

- ***Implicit*** – Allocation limited by supply, but the criteria by which decisions are made not explicit (eg. "postcode lottery").
- ***Price*** – Willingness (and ability) to pay determines allocation (eg. auctioning, free market).
- ***Waiting lists*** – Willingness (and ability) to wait determines allocation.
- ***Needs*** – Evaluation of needs (based on explicit criteria such as maximising health or ensuring equity of health gains) determines allocation.

Key concepts

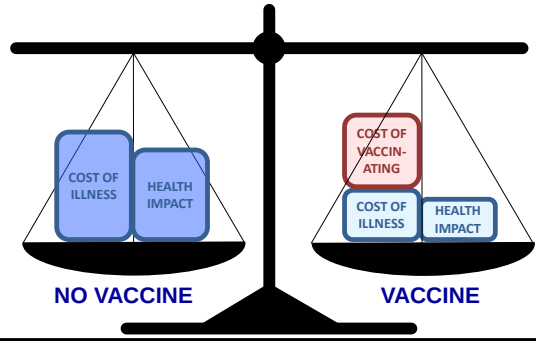
Externalities *are* costs and benefits borne by someone other than the person producing or consuming something.



Consumption of vaccination →
- Other people are protected from disease ("herd protection")
- Other people are happier knowing that someone is protected from disease ("caring externality")
- Vaccine prices may fall for everyone due to economies of scale

Economic evaluations

A (full) economic evaluation compares the incremental costs and consequences of an intervention compared to a comparator



Types of economic evaluation

Type of analysis	Key question	Key assumption
Cost-minimisation	How much does B cost compared to A financially?	A and B have equivalent health benefits, so we should pick the cheapest.
Cost-effectiveness	How much does B cost compared to A per case of flu prevented?	We know how much we want to spend to prevent a flu case.
Cost-utility	How much does B cost compared to A per QALY gained?	We know how much we want to spend to gain a QALY.
Cost-benefit	What is the benefit:cost ratio of B compared to A?	We want to allocate our spending based on individual willingness to pay rather than an external standard.

Cost-effectiveness analysis

Incremental cost-effectiveness ratio = Incremental costs / Incremental health gains

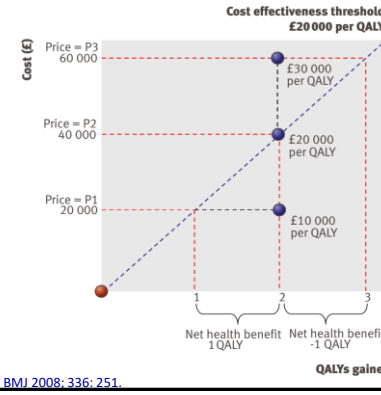
= (INTERVENTION COSTS + ECONOMIC BURDEN) − ECONOMIC BURDEN

= HEALTH BURDEN − HEALTH BURDEN

NO INTERVENTION INTERVENTION

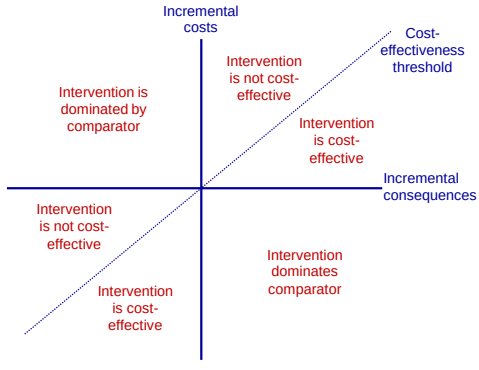
Measured in quantities like:
episodes of disease prevented
life years gained
QALYs gained
DALYs averted

Cost effectiveness thresholds



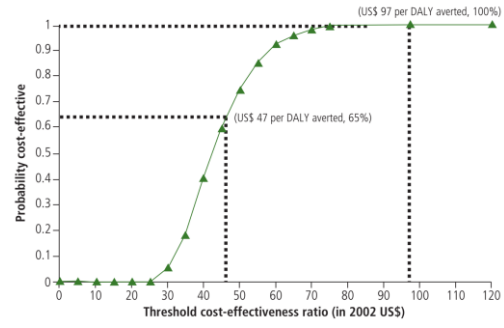
Claxton *et al*. BMJ 2008; 336: 251.

The cost-effectiveness plane



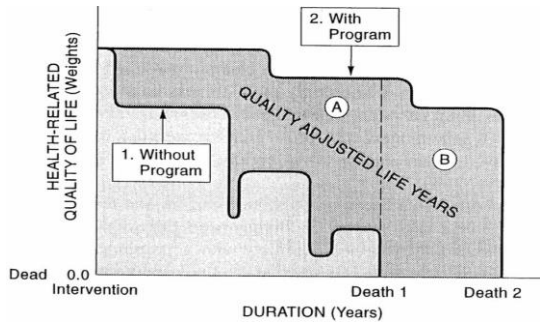
The cost-effectiveness acceptability curve

Infant hepatitis B vaccination in the Gambia



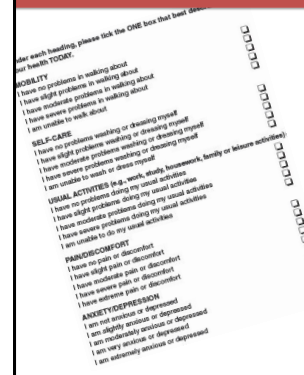
Kim et al. Bull WHO 2007; 85:833.

Measuring benefits: QALYs



Gold *et al*. Cost-effectiveness in health and medicine. OUP, 1996.

Generic instructions to measure QALYs



Dimension	Level	Coefficient (England)
Constant		1.003
Mobility	Slight	0.057
	Moderate	0.075
	Severe	0.208
	Unable	0.255
Self-care	Slight	0.058
	Moderate	0.083
	Severe	0.176
	Unable	0.208
Usual activities	Slight	0.048
	Moderate	0.067
	Severe	0.165
	Unable	0.165
Pain/discomfort	Slight	0.059
	Moderate	0.080
	Severe	0.245
	Unable	0.298
Anxiety/depression	Slight	0.073
	Moderate	0.099
	Severe	0.282
	Unable	0.282

http://www.euroqol.org/eq-5d-products/eq-5d-5l.html

Generic instruments to measure QALYs

Example:
Quality of life of tuberculosis patients at diagnosis and follow-up

	Diagnosis				Follow-up				
	Some problems		Unable to/ extreme		Some problems		Unable to/ extreme		
	n	%	*n*	%	*n*	%	*n*	%	*P* value*
EQ5D									
Mobility	19	32	1	2	11	22	0	0	0.096
Self-care	7	12	2	3	1	2	1	2	0.025
Usual activities	23	39	4	7	11	22	3	6	0.138
Pain/discomfort	34	57	5	8	20	41	2	4	0.012
Anxiety/depression	22	37	4	7	13	26	2	4	0.227

Kruijshaar *et al*. Int J Tuberc Lung Dis 14:296.

	A	B	C	D	E	F	G	H	I	J
1	**EQ-5D tariff**									
2							**TB at diagnosis: Kruijshaar 2010**			
3		**Coefficients**					**Proportion**		**Proportion x coefficient**	
4	**Dimension**	**None**	**Some**	**Unable/extreme**			**Some**	**Unable/extreme**		
5	Mobility	0	0.069	0.314			32%	2%	0.02836	
6	Self-care	0	0.104	0.214			12%	3%	0.0189	
7	Usual activity	0	0.036	0.094			39%	7%	0.02062	
8	Pain/discomfort	0	0.123	0.386			57%	8%	0.10099	
9	Anxiety/depression	0	0.071	0.236			37%	7%	0.04279	
10	Constant	0.081							0.081	
11	N3 (at least 1 extreme)	0.269						24%	0.065528	
12								Total	0.358188	
13								1-Total	0.641812	

Discounting

Imagine a world with no inflation…

If I owe you £1000, would you rather I paid you back today or in 10 years time?

Economists call this change in the value of money over time "discounting" …

Discounting

Discounting formula

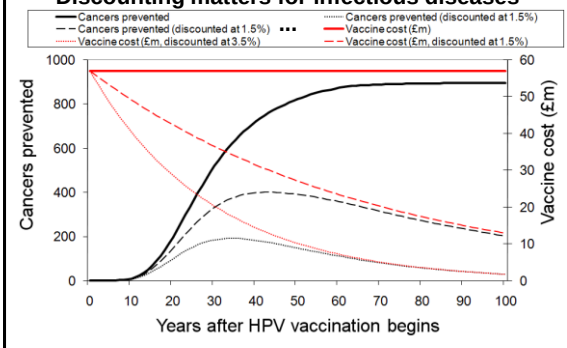
$$Y_n = \frac{X_n}{(1+r)^n}$$

Y_n = discounted value in year n
X_n = undiscounted value in year n
r = discount rate

Country	Discount rate: costs	Discount rate: effects
Mexico	5%	5%
Netherlands	4%	1.5%
Thailand	3%	3%
South Africa	5%	5%
UK	3.5%	3.5%
USA	3% (unofficial)	3% (unofficial)

Discounting

Discounting matters for infectious diseases



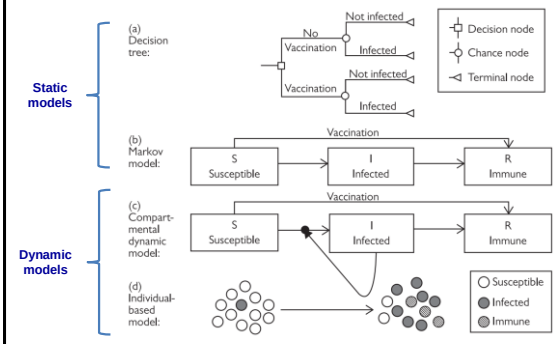
See Jit and Mibei. Vaccine 2015; 33:3788 for more discussion on discounting and vaccines.

Economic evaluations of infectious diseases

Pathogen-host interactions	• Interventions may have complex interactions with the pathogen and with host immunity.
Ecological externalities	• Beneficial or detrimental impact on individuals not receiving the intervention (herd immunity, type replacement).
Time horizon	• Interventions may have long-term implications (eradication, accumulation of susceptibles).
Economic scope	• Epidemic (cholera, dengue) or emerging (pandemic flu, Ebola, Zika) infections have a wide macroeconomic impact.

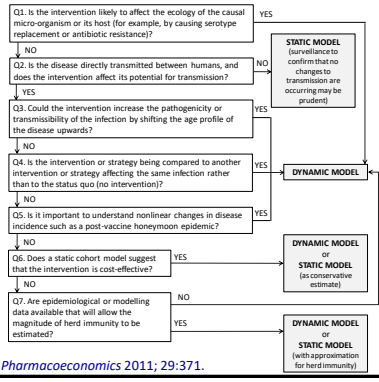
Adapted from Beutels et al. Lancet Infect Dis 2008; 8:727

Models of infectious diseases



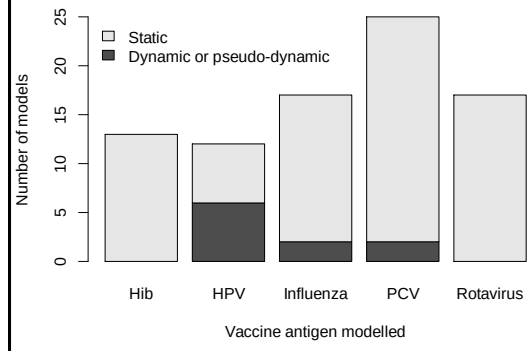
Jit and White. Chapter 17: Economic analysis of interventions against infectious diseases. In: Oxford Specialist Handbook of Infectious Disease Epidemiology. OUP: Oxford, 2015.

Static or dynamic?



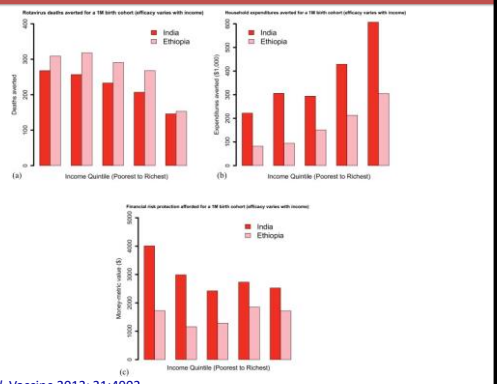
Jit and Brisson. *Pharmacoeconomics* 2011; 29:371.

Economic models of vaccination in the literature



From a review of reviews published in 2007-2014 (Jit and Mibei. Vaccine 2015;33:3788)

Equity: impact by income quintile



Verguet *et al.* Vaccine 2013; 31:4902

Concluding messages

1. Health economic evaluation is used to ensure that resource allocation decisions are made on explicit, evidence-based and needs-based criteria.
2. Economic evaluation of infectious diseases is a specialised field which requires analysts familiar with both health economics as well as the special epidemiological features of infectious diseases.
3. It is important to understand the assumptions and limitations behind different types of economic models as these can have a large impact on model results.

Further reading

General text on economic evaluation:

Drummond MF, Sculpher MJ, Claxton K, Stoddard DL, Torrance GW. (2015). Methods for the economic evaluation of health care programmes. 4th edition. OUP.

Economic evaluations of infectious disease interventions:

Beutels P, Scuffham PA, MacIntyre CR. Funding of drugs: do vaccines warrant a different approach? Lancet Infect Dis 2008; 8:727.

Brisson M, Edmunds WJ. Economic evaluation of vaccination programs: the impact of herd immunity. Med Decis Making. 2003 Jan-Feb;23(1):76-82.

Jit M, Brisson M. Modelling the Epidemiology of Infectious Diseases for Decision Analysis: A Primer. Pharmacoeconomics 2011; 29:371.

Jit M, White PG. Chapter 17: Economic analysis of interventions against infectious diseases. In: Oxford Specialist Handbook of Infectious Disease Epidemiology. OUP: Oxford, 2015.