UK-China Health and Economy Partnership
中英健康医疗与经济合作项目

Introduction to the Economic Evaluation of Tests

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Learning Objectives

Health economics aims to ensure that new interventions (drugs, tests) are funded only if the expected benefits are greater than the opportunity cost of spending.

Economic evaluation (EE) is the comparative analysis of alternative courses of action in terms of both their costs and health outcomes.

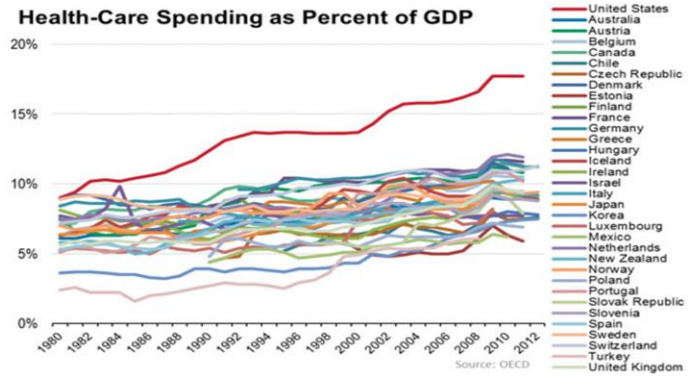
Decision trees and **markov cohort models** are often used to evaluate cost-effectiveness of tests.

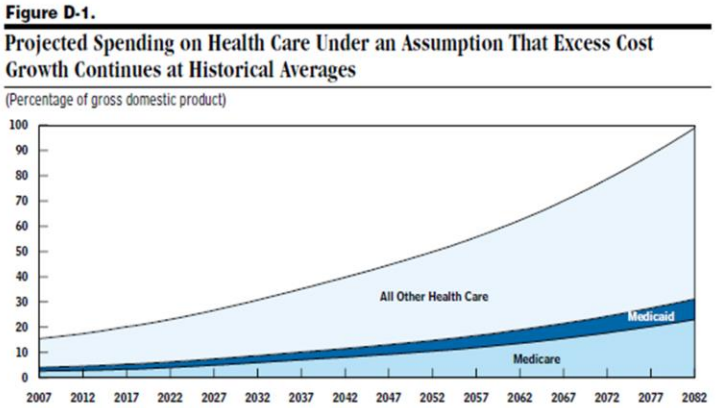
Why are Tests / Screening different and how can we fit them into existing models

Underlying Problem

- Infinite demand for healthcare.
- There is a finite amount of resources with which to provide healthcare

- This is the 'classic' rationale for economics – the science of scarcity
  - A scientific approach to maximising 'outcomes' given limited resources
  - Still means difficult decisions need to be made, but makes them explicit
  - ***A pragmatic approach to making better decisions!***





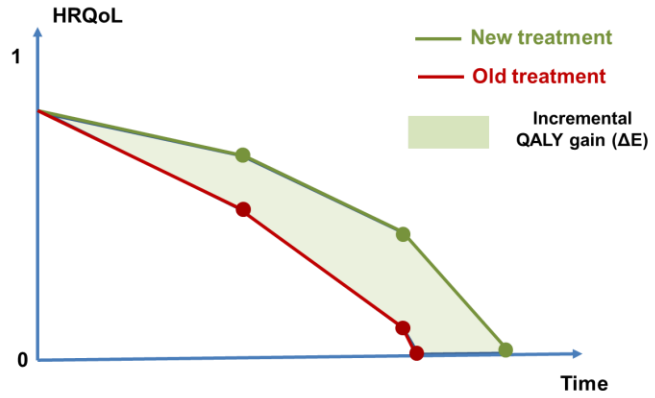
Source: The long-term outlook for health care spending (2007) Congressional Budget Office, The Congress of the United States

An Emerging Framework

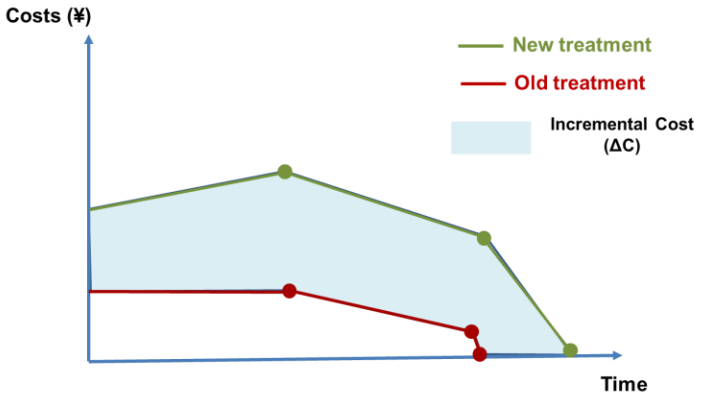
- An emerging international analytical framework which allows decision makers to determine whether new technologies are ***worth it / represent good value for money (economic evaluation)*** and whether it ***can be afforded (Budget Impact)***

- Looks to assess the impact of new technologies on the ***incremental*** patient ***Health Related Quality of Life*** (HRQoL) measured as **Quality Adjusted Life Years** (QALYs) ***relative*** to the additional net cost of the technology
  - HRQoL captured by generic questionnaires or conversion from disease states

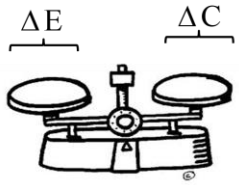
- New medications tend to improve HRQoL by improved disease states / survival which is converted to a difference in QALYs



- And although they may offset the need for some costly medications / treatments, new technologies often mean more expense to the healthcare system



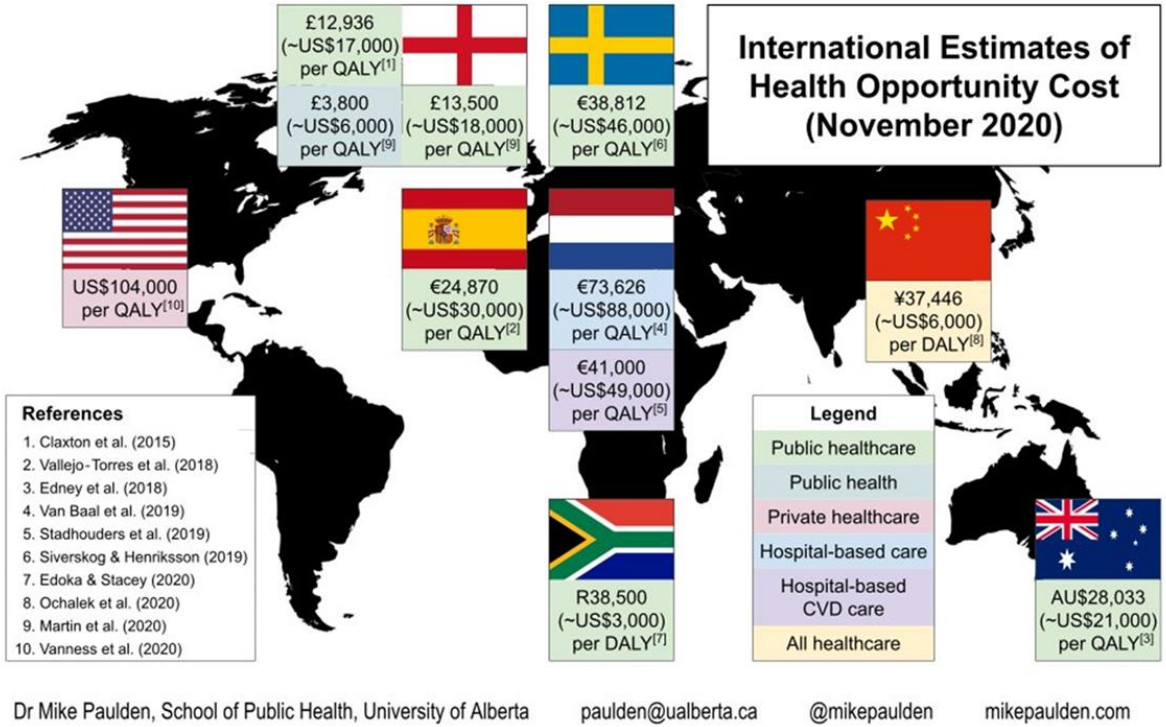
Is it worth it?



- ICER approach $\Delta C / \Delta E \leq \lambda$
- Incremental Net Health Benefit $\Delta E - (\Delta C/\lambda) > 0$
- Incremental Net Monetary Benefit $\lambda.\Delta E - \Delta C)>0$

Where λ = maximum willingness to pay for a QALY

Maximum Willingness to Pay estimates based on opportunity costs



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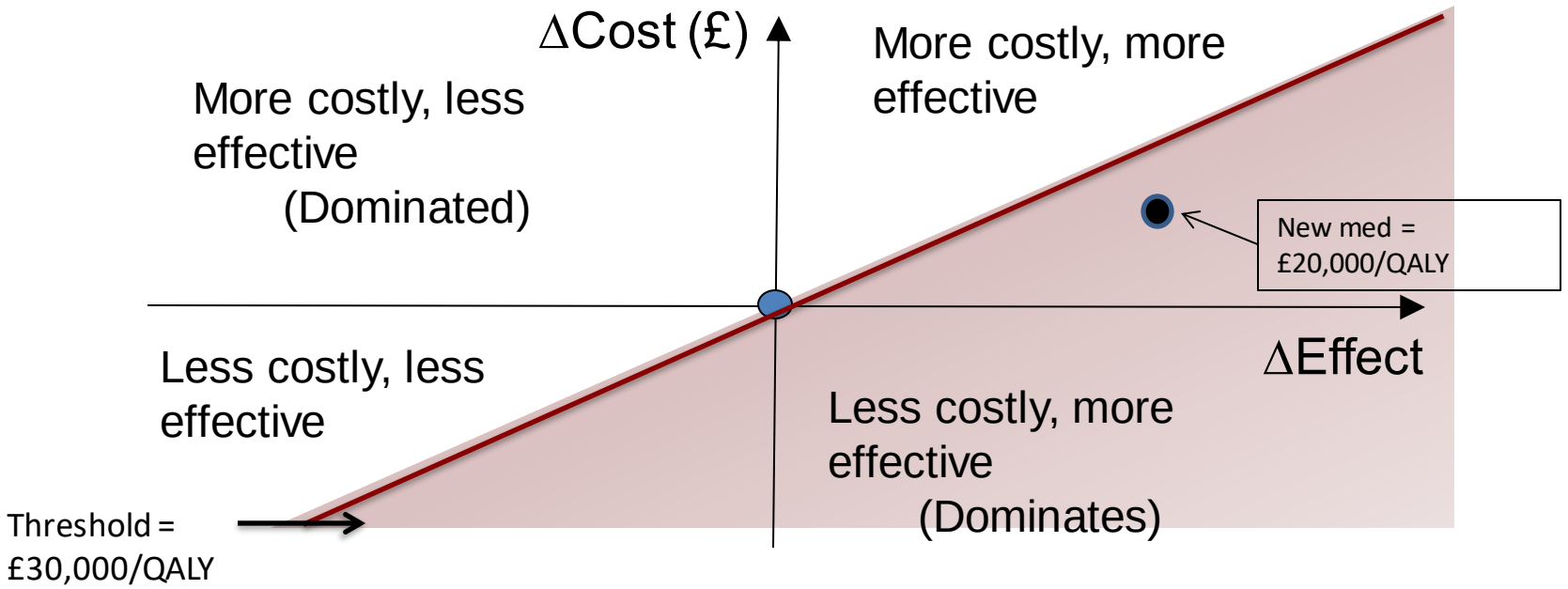
Graphical Representation (Cost-Effectiveness Plane)



The new treatment is cost-effective if it falls in the shaded region, under the willingness-to-pay threshold line (NICE £30k per QALY threshold illustrated)

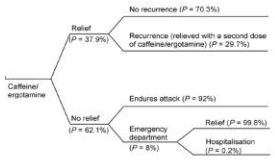
Estimating QALYs and Costs

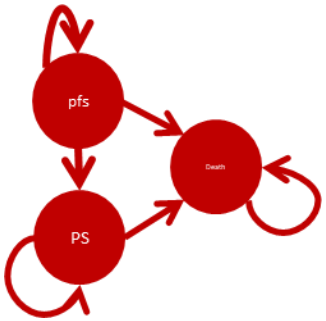
- Ideally, estimates of incremental QALYs and Costs are generated from RCTs
- Often not possible to capture all necessary data from single RCT:
  - Insufficient follow-up of patients to observe quality of life and survival impact
  - Not practical to include all comparators
  - Not ethical to randomise patients
- These issues are a common problem for tests

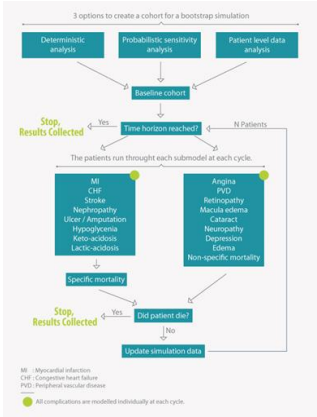
Modelling in Economic Evaluation

- Decision analytic modelling, where evidence from multiple sources can be combined

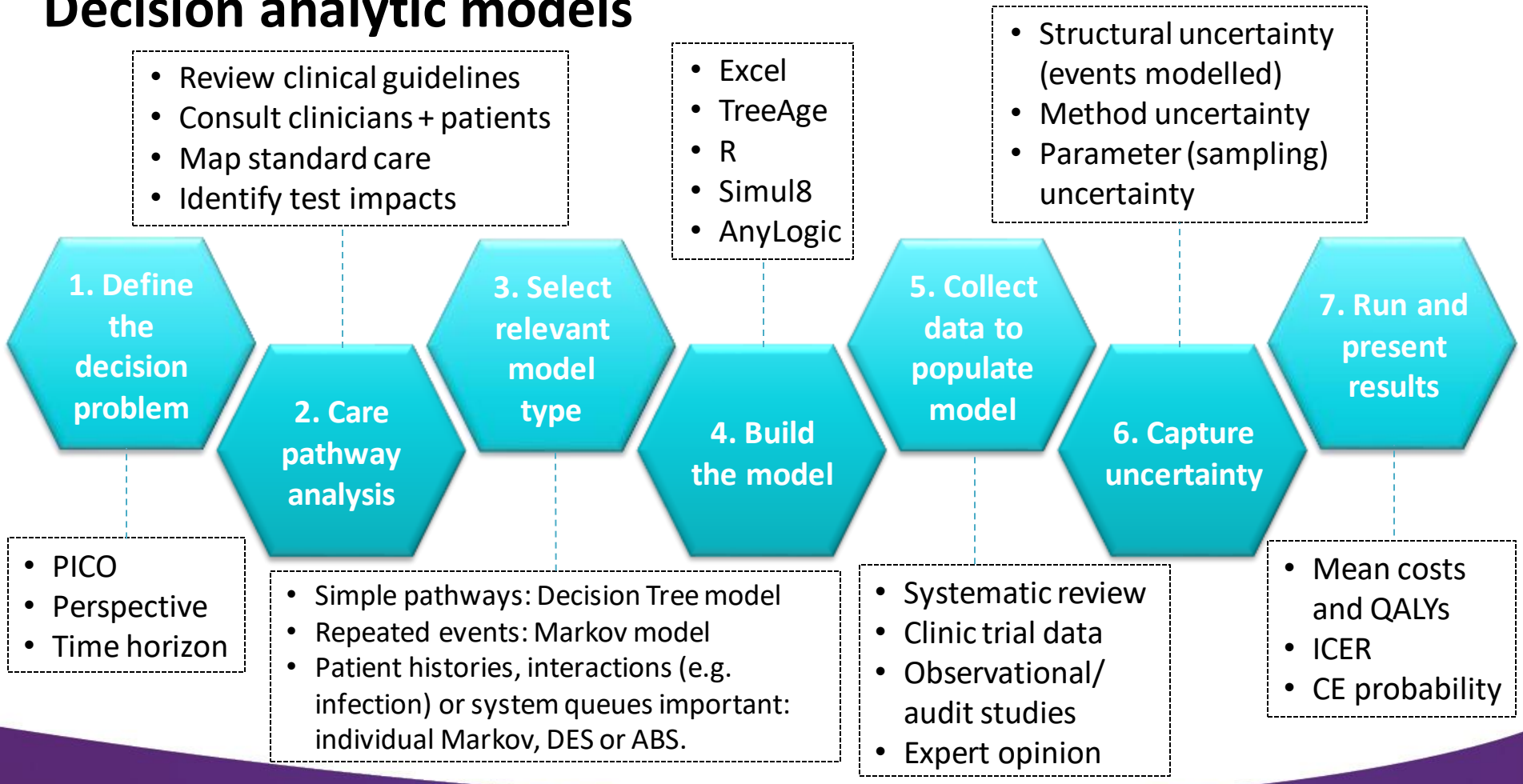
- We usually do so by synthesising all the evidence in a coherent mathematical model that often follows a standard framework
  - Decision Trees
  - Markov Models
  - Patient level simulations







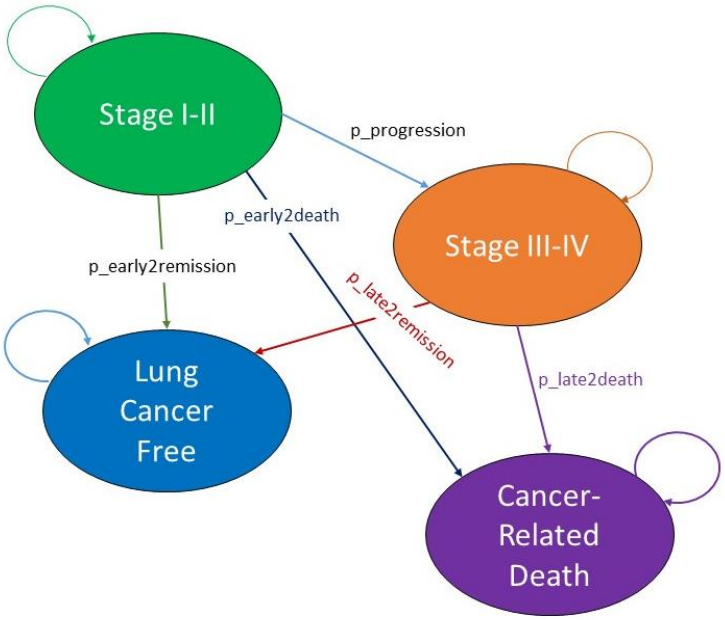
Decision analytic models



Markov models

- Better suited to modelling recuring events
- Time is captured using model **cycles**, which consist of a defined fixed period of time (e.g. 1 day, 1 year)
- Patient pathways are captured as a series of mutually exclusive **health states**
- At the beginning of each cycle, patients occupy one of the model health states and are assumed to stay there for the duration of the cycle
- At the end of each cycle, patients can move between health states according to a fixed set of **transition probabilities**

- Lung Cancer Example



Transition Matrix: CXR					
		LC FREE	STAGE I-II	STAGE III-IV	DEAD
	LC FREE	1.000	0.000	0.000	0.000
	STAGE I-II	0.210	0.720	0.060	0.010
	STAGE III-IV	0.006	0	0.494	0.500
	DEAD	0	0	0	1

State	Costs	HRQoL
LC FREE	$0.00	0.80
STAGE I-II	$11,276.00	0.70
STAGE III-IV	$16,914.00	0.55
DEAD	$0.00	0.00

- With late presentation high costs and low QALYs

		PROBABILITIES					COSTS				Utilities			
YEARS	PERIOD	LC FREE	STAGE I-II	STAGE III-IV	DEAD	discount	LC FREE	STAGE I-II	STAGE III-IV	DEAD	LC FREE	STAGE I-II	STAGE III-IV	DEAD
1.0	1	0	0.22	0.78	0	1.000	0.00	2631.86	13728.78	0.00	0.00	0.15	0.43	0.00
2.0	2	0.051	0.158	0.399	0.392	0.966	0.00	1725.72	6512.63	0.00	0.04	0.11	0.21	0.00
3.0	3	0.087	0.114	0.206	0.593	0.934	0.00	1200.50	3258.50	0.00	0.06	0.07	0.11	0.00
4.0	4	0.112	0.082	0.109	0.697	0.902	0.00	835.13	1659.66	0.00	0.08	0.05	0.05	0.00
5.0	5	0.130	0.059	0.059	0.753	0.871	0.00	580.96	864.77	0.00	0.09	0.04	0.03	0.00
6.0	6	0.142	0.043	0.033	0.783	0.842	0.00	404.15	463.27	0.00	0.10	0.03	0.02	0.00
7.0	7	0.152	0.031	0.019	0.799	0.814	0.00	281.15	256.26	0.00	0.10	0.02	0.01	0.00
8.0	8	0.158	0.022	0.011	0.809	0.786	0.00	195.58	146.76	0.00	0.10	0.01	0.00	0.00
9.0	9	0.163	0.016	0.007	0.815	0.759	0.00	136.06	87.05	0.00	0.10	0.01	0.00	0.00
10.0	10	0.166	0.011	0.004	0.818	0.734	0.00	94.65	53.38	0.00	0.10	0.01	0.00	0.00

Only first 10 years shown

TOTAL COST	27253.28

TOTAL QALYs	3.74

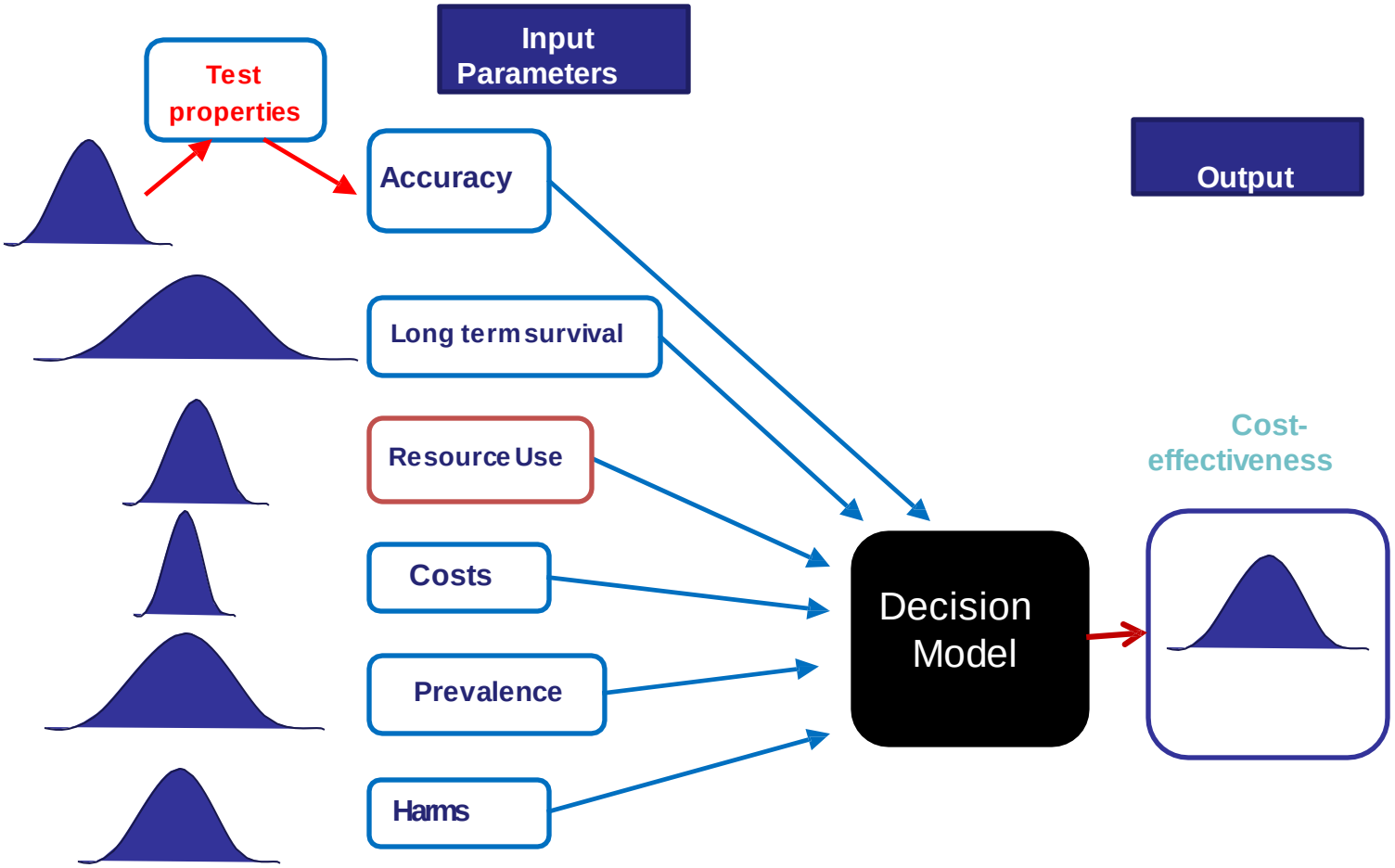
- With earlier presentation higher costs and higher QALYs

		PROBABILITIES					COSTS				Utilities			
YEARS	PERIOD	LC FREE	STAGE I-II	STAGE III-IV	DEAD	discount	LC FREE	STAGE I-II	STAGE III-IV	DEAD	LC FREE	STAGE I-II	STAGE III-IV	DEAD
1.0	1	0	0.78	0.22	0	1.000	0.00	9331.14	3872.22	0.00	0.00	0.55	0.12	0.00
2.0	2	0.165	0.562	0.155	0.118	0.966	0.00	6118.46	2540.86	0.00	0.13	0.38	0.08	0.00
3.0	3	0.284	0.404	0.111	0.201	0.934	0.00	4256.32	1744.78	0.00	0.21	0.26	0.06	0.00
4.0	4	0.370	0.291	0.079	0.260	0.902	0.00	2960.92	1202.89	0.00	0.27	0.18	0.04	0.00
5.0	5	0.431	0.210	0.056	0.303	0.871	0.00	2059.77	831.60	0.00	0.30	0.13	0.03	0.00
6.0	6	0.476	0.151	0.040	0.333	0.842	0.00	1432.88	576.03	0.00	0.32	0.09	0.02	0.00
7.0	7	0.507	0.109	0.029	0.355	0.814	0.00	996.79	399.53	0.00	0.33	0.06	0.01	0.00
8.0	8	0.530	0.078	0.021	0.370	0.786	0.00	693.42	277.37	0.00	0.33	0.04	0.01	0.00
9.0	9	0.547	0.056	0.015	0.382	0.759	0.00	482.38	192.69	0.00	0.33	0.03	0.01	0.00
10.0	10	0.559	0.041	0.011	0.390	0.734	0.00	335.57	133.91	0.00	0.33	0.02	0.00	0.00

Only first 10 years shown

TOTAL COST	34910.53

TOTAL QALYs	10.79


Input Parameters
Test properties
Accuracy
Long term survival
Resource Use
Costs
Prevalence
Harms
Output
Decision Model
Cost-effectiveness