# Aspects of Decision Making in Cost-effectiveness Modelling

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(with thanks to Gianluca Baio, Chris Jackson, Nicky J. Welton, Mark Strong, Anna Heath)

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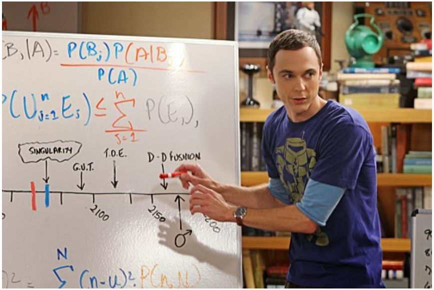
# Preliminaries

# University College London

- UCL was rated 2nd in the UK for research power in the Research Excellence Framework 2021
- UCL is ranked 8th in the 2022 QS World University Rankings
- The Department of Statistical Science has played a major role in the development of the subject ever since its foundation in 1911 as the Department of Applied Statistics

# Objectives

**Lectures**




- Introduction to *Health economics modelling*
  - Decision trees
  - Markov models

- Introduction to sensitivity analyses
  - Deterministic
    - One-way & multi-way
    - Scenario
  - Probabilistic

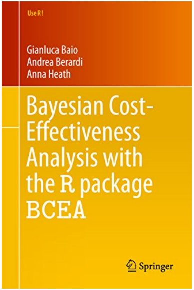
**Computer practicals**

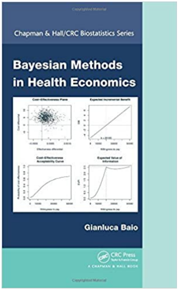
- Emphasis on practical examples
  - Decision tree and Markov models
  - using R programming language

# Timetable

- 0:00-1:00 Health Economics modelling lecture
- 1:00 - 1:45 Decision tree and Markov model practical
- BREAK
- 1:50 - 2:20 Sensitivity analysis
- 2:20-3:00 Sensitivity analysis practical

**Books**




- This course is only a small part of an *annual week-long summer school*
  - usually in Florence, Italy
- Several books available
- Edition two of BCEA book in the pipeline and a Health Economic in R book close to being finished!

Lecture 2

# Uncertainty analysis

# Summary

- Health economic evaluation
  - What is health economics?
  - Why do we need health economics?
- A framework for health economic evaluation
  - Statistical modelling
  - Economic modelling
  - Decision analysis
  - Uncertainty analysis
- Standard vs Bayesian HTA
  - Two-stage vs integrated approach
- Decision-making
  - Cost-effectiveness plane
  - ICER
  - EIB

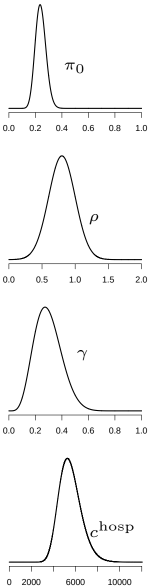
References

*Bayesian Methods in Health Economics*, chapter 1.
Baio et al (2017). *Bayesian Cost-Effectiveness Analysis with the* R *package* BCEA

# 4. Uncertainty analysis

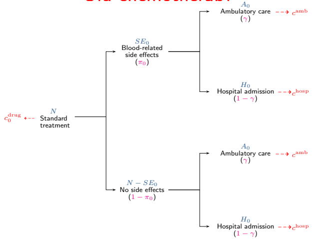
$[p(\boldsymbol{\theta} \mid e, c)$ vs $g_i(\theta_i)]$

## Parameters

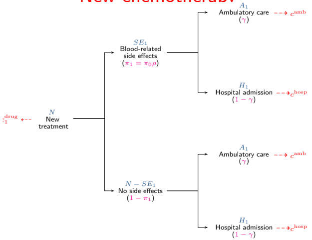



## Model structure

Old chemotherapy




New chemotherapy

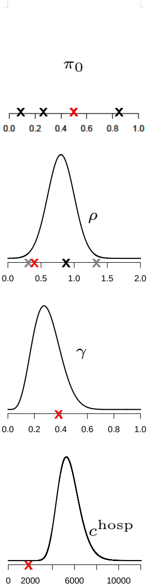



## Decision analysis

| Old chemotherapy | |
|---|---|
| Benefits | Costs |
| | |
| | |

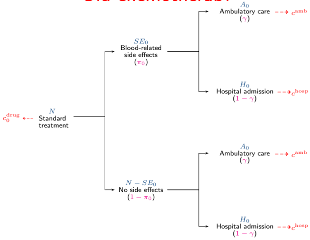
| New chemotherapy | |
|---|---|
| Benefits | Costs |
| | |
| | |

**Parameters**

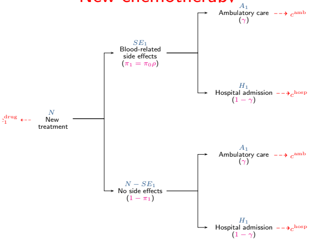



**Model structure**

Old chemotherapy




New chemotherapy




**Decision analysis**

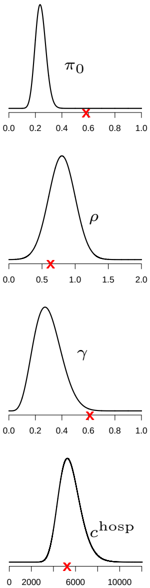
| Old chemotherapy | |
|---|---|
| Benefits | Costs |
| 741 | 670 382.1 |

| New chemotherapy | |
|---|---|
| Benefits | Costs |
| 732 | 1 131 978 |

# 4. Uncertainty analysis

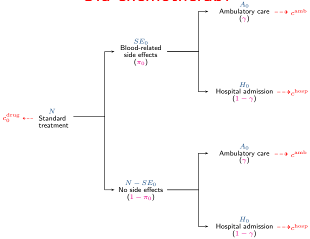
$[p(\boldsymbol\theta \mid e, c)$ vs $g_i(\theta_i)]$

## Parameters

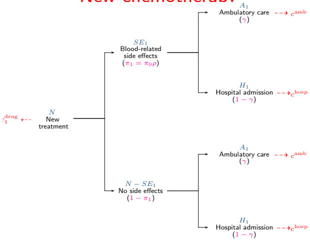



## Model structure

Old chemotherapy




New chemotherapy



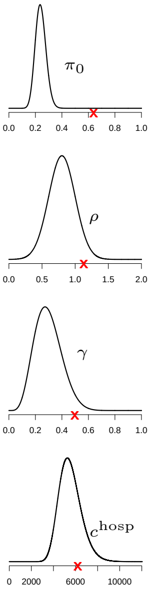

## Decision analysis

| Old chemotherapy | |
|---|---|
| Benefits | Costs |
| 741 | 670 382.1 |
| 699 | 871 273.3 |

| New chemotherapy | |
|---|---|
| Benefits | Costs |
| 732 | 1 131 978 |
| 664 | 1 325 654 |

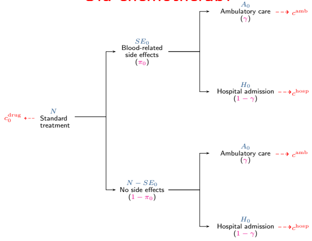
# 4. Uncertainty analysis $[p(\boldsymbol{\theta} \mid e, c)$ vs $g_i(\theta_i)]$

## Parameters

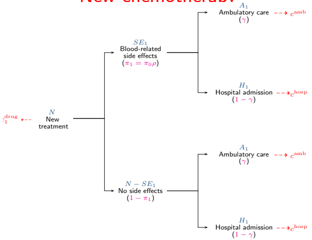



## Model structure

Old chemotherapy




New chemotherapy




## Decision analysis

| Old chemotherapy | |
|---|---|
| Benefits | Costs |
| 741 | 670 382.1 |
| 699 | 871 273.3 |
| ... | ... |
| 726 | 425 822.2 |
| **716.2** | **790 381.2** |

| New chemotherapy | |
|---|---|
| Benefits | Costs |
| 732 | 1 131 978 |
| 664 | 1 325 654 |
| ... | ... |
| 811 | 766 411.4 |
| **774.5** | **1 066 849.8** |

$$\text{ICER} = \frac{276\,468.6}{58.3} = 6\,497.1$$

## Is this *all* we need? *(see VoI)*

- The CEAC only deals with the **probability** of making the "right decision"
- But it does not account for the **payoff/penalty** associated with making the "wrong" one!

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- **Example 1**: Intervention $t = 1$ is the most cost-effective, given current evidence
  - $\Pr(t = 1 \text{ is cost-effective}) = 0.51$
  - If we get it wrong: Increase in costs = £3
    Decrease in effectiveness = 0.000001 QALYs
  - Large uncertainty/negligible consequences ⇒ **can afford uncertainty**

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- **Example 1**: Intervention $t = 1$ is the most cost-effective, given current evidence
  - $\Pr(t = 1$ is cost-effective$) = 0.51$
  - If we get it wrong: Increase in costs $=$ £3
    Decrease in effectiveness $=$ 0.000001 QALYs
  - Large uncertainty/negligible consequences $\Rightarrow$ **can afford uncertainty**

- **Example 2**: Intervention $t = 1$ is the most cost-effective, given current evidence
  - $\Pr(t = 1$ is cost-effective$) = 0.999$
  - If we get it wrong: Increase in costs $=$ £1 000 000 000
    Decrease in effectiveness $=$ 999999 QALYs
  - Tiny uncertainty/dire consequences $\Rightarrow$ **probably should think about it...**