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## Cost Effectiveness Modelling for Economics in Health Care

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## Exeter, UK



## Exeter City



## Countryside around Exeter



## Exeter University UK



## PenCHORD Team (est. 2010)



**PenCHORD** = The Peninsula Collaboration of Health Operational  
Research and Development



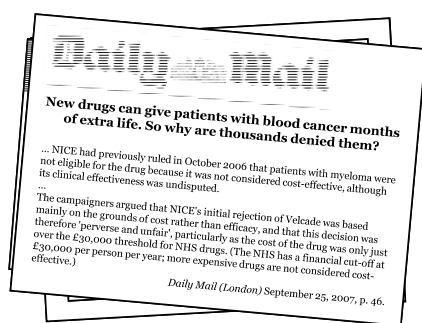
## Presentation Contents

- **Context of HTA modelling**
  - Role of NICE in the UK
  - Allocative versus Technical Efficiency
- **Representation and abstraction**
  - State Transition - Markov Models
- **Data Requirements**
  - Model Structure and Design
  - Data : Structural, Costs, Utilities, Transitions
- **Outputs**
  - Base Case, Sensitivity and Scenario analyses
- **Dealing with uncertainty**

## NICE in the UK NHS

- NICE was originally set up in 1999 as the National Institute for Clinical Excellence, a special health authority, to reduce variation in the availability and quality of NHS treatments and care across England (*Wales, Scotland, Northern Ireland indirectly*).
- Now called 'National Institute of Health and Care Excellence'
- World leading organisation in assessing the value of health care interventions
- Led to development of advanced methods for Systematic Review and Economic modelling across wide range of healthcare interventions

## Importance and Publicity



## Health Technology Assessment (HTA) Reports

- **Two Main Parts**
  - **Clinical Effectiveness/Systematic review**
    - Evidence Synthesis/Meta-analysis
    - Reviews of Trial evidence
    - Comparison of Data sources
  - **Cost Effectiveness**
    - Economic Modelling, Cost Utility Analysis
    - Sensitivity Analysis/ Probabilistic
    - Interpretation/ Dealing with uncertainty etc.



## Technical versus Allocative Efficiency

### TECHNICAL EFFICIENCY

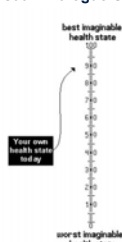
- Used to compare alternatives in specific treatment contexts
- Typically uses outcome measures specific to context
- Associated with **Cost Benefit Analysis**

### ALLOCATIVE EFFICIENCY

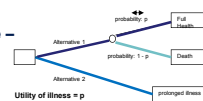
- Required for assessment of health interventions
- Relies on metric of the QALY – Quality Adjusted Life Year
- Extra life years are weighted by 'Utility' (quality measure)
- Assessed using **Cost Utility Analysis** (*Cost Effectiveness Analysis*)

## Utility Assessment

### Visual Analogue Scale



### Standard Gamble –



### Time Trade Off –



Quality of Life Instruments : - EQ5D, SF36 etc

## Example Health State

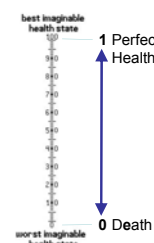
Audience Participation



Disability after Stroke  
assigned a Modified Rankin Score of 4

- Moderately severe disability;
- unable to walk without assistance
- unable to attend to own bodily needs –
  - assistance essential for eating,
  - using the toilet, daily hygiene etc.
- Speech and communication severely impaired

Visual Analogue Scale



## Example Health State

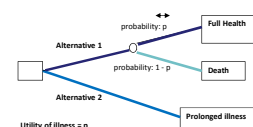
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Standard Gamble



## Example Health State

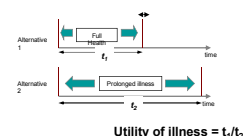
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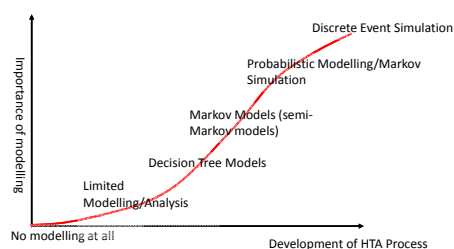
Time Trade Off



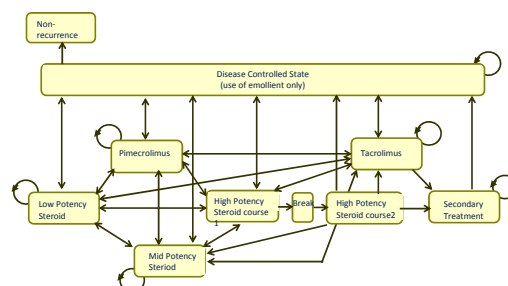
## Economic Modelling in HTA

- development ↓
- No modelling at all
  - Limited Modelling
  - Decision Tree Models
  - Markov Models (semi-Markov models)
  - Probabilistic Modelling/Markov Simulation
  - Discrete Event Simulation

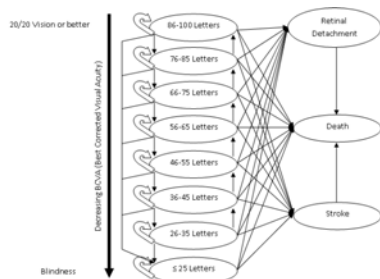
## The Growth of Modelling in HTA



## Markov State Transition Model for HTA

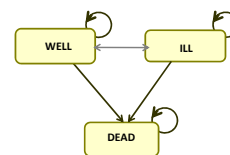


## Markov State Transition Model



## Data for Models: Key parameters

1. Structure
2. Transition Probabilities
3. State Utilities
4. Costs



## Data - Structure



- Previous Models
- Literature
- Clinical Experts
  - Transitions in process (treatment, progression)
  - Time scales
  - Key areas of comparison (comparator vs intervention)
- Constraints and objectives of modelling
- Data
  - What is available?
- Issues to do with granularity
  - Level of detail, Cycle time, Time horizon

## Data - Utility Assessment

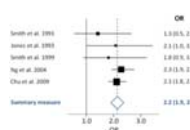


- Active area of Qualitative Research
- Variety of Methods – argued over
- Many challenges
  - Practical issues (finding subjects etc)
  - Dealing with sub-groups
  - Assessment of unknown and unexperienced
- Debate about scales
- Presentation may be important (e.g. computers)

## Data - Transitions



- Literature – clinical evidence base
- Randomised Controlled Trials
- Systematic Review/ Meta-analysis
- Other evidence (case controlled trials)
- Expert opinion
- Selection (incl. and excl. criteria)
- Often require range of sources
  - Hierarchy of evidence

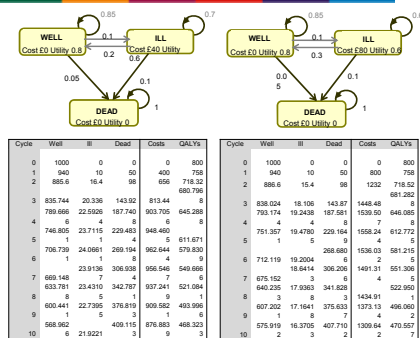


## Data - Costs

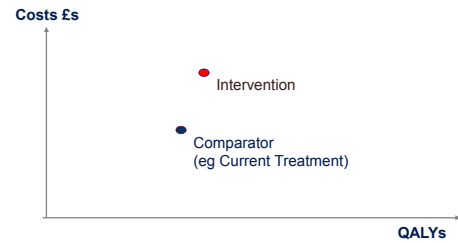


- Perspective – NHS and Personal Social Services
- Use of Standard References for NHS costs
- Dosages and procedures – various sources
  - Manufacture information
  - Licence
  - Experts
  - etc.
- All treatment costs need to be included
- Variations – due to a range of factors (e.g. complications)

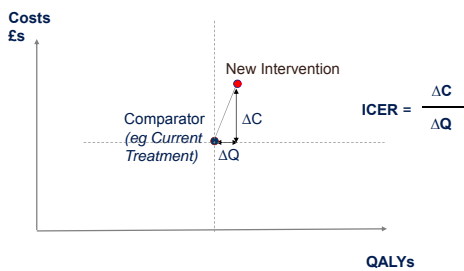
## Comparison of two alternatives



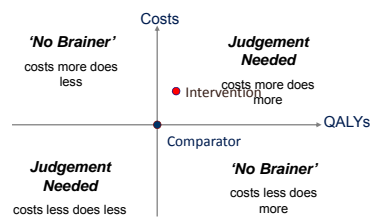
## Cost Effectiveness/Utility



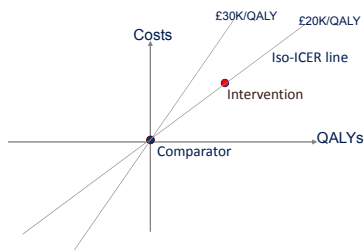
## Incremental Cost-Effectiveness Ratio



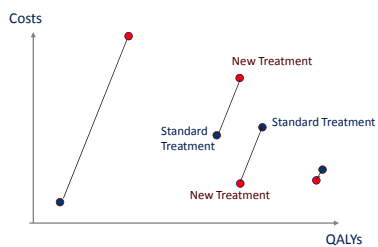
## Incremental Cost Effectiveness Plane



## Incremental Cost Effectiveness Plane

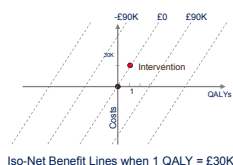


## Interpretation of ICER output



## Net Benefit measure

- Simple equation based on an assigned value for each QALY gained by an intervention
- e.g. If a QALY is assumed to be worth £30K
- then Net benefit can be calculated by converting QALY gains to £s ( $\Delta Q \times £30K$ ) and then deducting the additional cost of the intervention ( $\Delta C$ )



## Dealing with Uncertainty

- Key area in current HTA work
- Assessment of level of uncertainty
- Assessment of importance of uncertainty
- One Way Sensitivity Analysis
- Scenario Analysis, Threshold Analysis
- Probabilistic Sensitivity Analysis
- Value of Information analysis

## One Way Sensitivity Analysis

One input parameter changed at a time

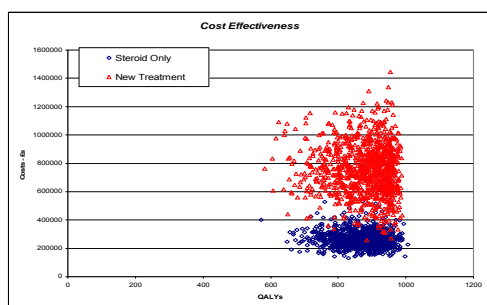
Test highest and lowest plausible values of each parameter of interest and observe impact on model outputs



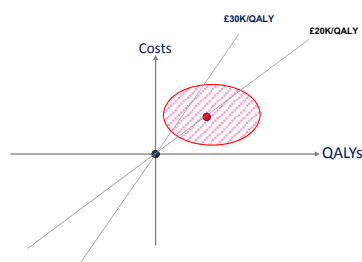
## Scenario and Threshold Analysis

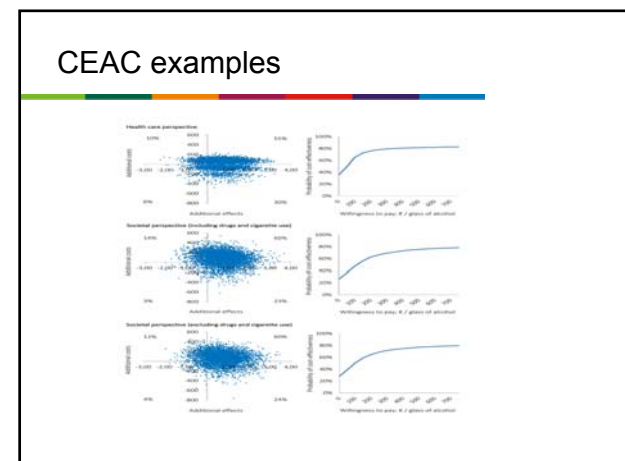
- Scenario Analysis
  - (several model parameters changed to reflect area of interest)
    - Sub-group of interest (e.g. age, gender related)
    - Specific pattern of care
- Threshold Analysis
  - Test for a specific limit
    - e.g. how cheap would new drug need to be to be cost effective?
    - e.g. how effective would new drug need to be to be cost effective?

## Probabilistic Sensitivity Analysis



## Probabilistic Sensitivity Analysis







# Thank You !

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<http://clahrc-peninsula.nihr.ac.uk/penchord>

<https://health-modelling.org>



## Questions & Suggestions