Module 4 - Simulations and Budget Impact Participant Workbook

Module Four concludes with an examination of simulation and budget impact methods.

The module has two units:

- Unit 1: Discrete Event Simulations
- Unit 2: Budget Impact Analysis

On successful completion, you will be able to:
Unit 1

- outline the rationale for discrete event simulations
- identify the key components and distinctive features of discrete event simulations

Unit 2

- outline the rationale for budget impact analysis
- identify the key components and distinctive features of budget impact analysis

UNITS

- Discrete Event Simulations
- Budget Impact Analysis

Discrete Event Simulations

Welcome to the first unit of Module Four, Discrete Event Simulations.

Unit Objectives

The goals of this unit are:

- Outline the rationale for discrete event simulations
- Identify the key components and distinctive features of discrete event simulations

Unit Topics

The topics covered in this unit are:

1. Rationale for discrete event simulations
2. Core components of discrete event simulations
3. Good practice in developing discrete event simulations

Video Presentation

Here's the video presentation for this unit:

Video presentation notes:

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1. Rationale for Discrete Event Simulations

Discrete event simulation (DES) is a microsimulation technique that was originally developed for operations research purposes, but is now increasingly used in healthcare.

Rationale

Discrete event simulations are generally more complex and data-intensive than decision tree or state transition models, but there are rationales for making the additional commitment required in opting for a discrete event simulation:

(Click each to learn more)

Heterogeneity

Microsimulation techniques such as discrete event simulations can be useful for research questions where we expect costs and outcomes to vary depending on patient characteristics. Discrete event simulations can cater to heterogeneity in both clinicians and patients and allow the results of interactions to depend on the attributes of each.

Downstream consequences

Discrete event simulations allow for costs and outcomes to be shaped by the overall history of the entity (unlike Markov models which are often described to be "memoryless") and by events that may occur at unpredictable time points (e.g. a major health event such as the rupture of an aneurysm, help-seeking behavior by a patient).

Constrained resource environments

Discrete event simulations can be resource constrained (e.g. we can allow queues to form if a resource [hospital bed, clinician] is unavailable).

2. Core Components of Discrete Event Simulations

Discrete Event Simulations are comprised of specific components:

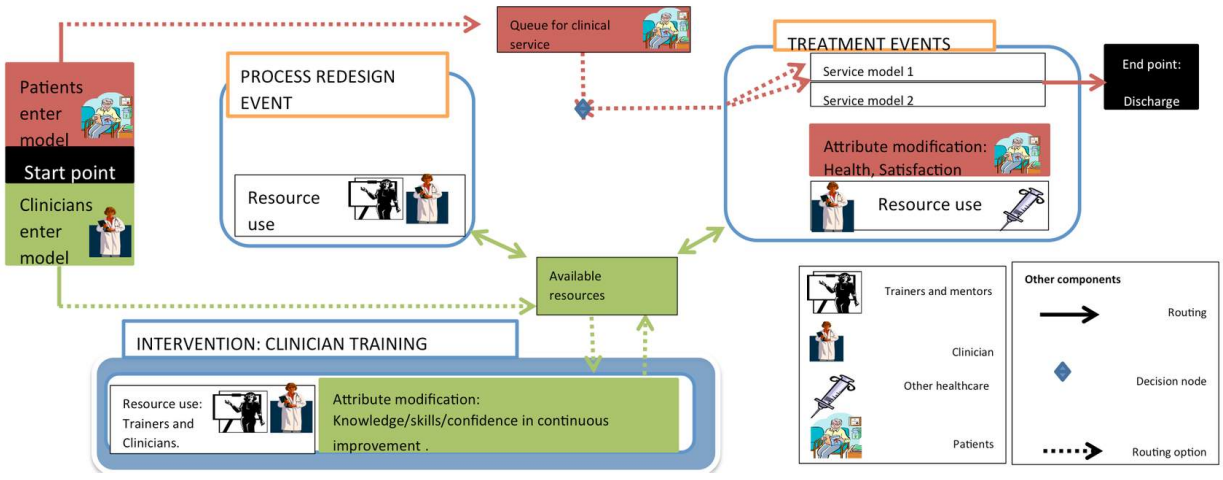
- **Entities** (e.g. patients and clinicians) described by a range of **attributes** (demographic, knowledge/skills, behaviors, risk factors, and health). Entities can interact with each other.

- **Events** such as enter/leave simulation, start/end treatment, modify attributes and health. The **time-to-event** and impact of events are uncertain.
- Some events (e.g. interventions, treatment sequences, consultations) will involve the use of specified **resources** (medicines, staff, devices). If those resources are unavailable, a **queue** may form, where the event does not occur again until all the required resources are available.

Some additional features of a Discrete Event Simulation include:

- The journey of each individual is simulated until the time horizon is reached or death occurs.
- The simulation will normally be run as a probabilistic sensitivity analysis consisting of an inner loop and an outer loop:
    - The **Inner Loop** simulates one journey each for every entity (normally patients) being simulated. The purpose of the inner loop is to explore uncertainty relating to heterogeneity.
    - The **Outer Loop** simulates repeated instances of the inner loop in order to explore parameter uncertainty. In every instance of the outer loop, a new set of values is drawn for each parameter.

Graphical representation



Practical considerations

Discrete event simulations are data intensive, so in addition to standard data requirements for models (treatment effects, costs), DES requires data relating to heterogeneity (how do different patients/clinicians behave) and the time of each potential event (hazard or rate data).

There are technical considerations to consider as well. The main software development choice is between using specialist software (e.g. Simul8, TreeAge) which tend to be easier to use but more expensive, or to develop the DES code yourself in something like R. R is a free, but very powerful, statistics package that affords more flexibility in model development, but requires coding skills

3. Good Practice

To get best results, care should be taken at every step in development and validation of your DES model. Two particularly useful resources that provide guidance and good practice standards are:

- Modeling Using Discrete Event Simulation
- Cost-Effectiveness Modelling using Patient Level Simulation

However, perhaps the most important thing to do is to think carefully about whether a DES is necessary. Ask yourself:

- Does this research question merit the extra time and resources involved in developing a discrete event simulation?
- Would other modeling techniques suffice?

Exercises and Further Reading

Self-assessment and critical review exercises

There are no self-assessment or critical review tasks associated with this module.

References and Further Optional Reading

If you would like to do further optional reading about the topic, you may wish to consider the following resources:

- S Davis, M Stevenson, P Tappenden, A Wailoo. "Cost-Effectiveness Modelling Using Patient-Level Simulation" 2014, NICE Decision Support Unit, ScHARR, University of Sheffield.

  M Duerden. "What are Hazard Ratios?" 2009, Hayward Medical Communications.

  J Karnon, J Stahl, A Brennan, J Caro, J Mar, J Möller, "Modeling using Discrete Event Simulation: A Report of the ISPOR-SMDM Modeling Good Research Practices Task Force-4" 2012, Value in Health.

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Budget Impact Analysis

Welcome to Unit Two of Module Four: Budget Impact Analysis.

Unit Objectives

The goals of this unit are:

- Outline the rationale for budget impact analysis
- Identify key components and distinctive features of budget impact analysis

Unit Topics

The topics that will be covered in this unit are:

1. Rationale for budget impact analysis
2. Key components of budget impact analysis
3. Technical development and good practice

Video Presentation

Here's the video presentation for this unit:

Video presentation notes:

1. Rationale for Budget Impact Analysis

The health economic evaluation concepts and methods we have examined in this course aim to address questions of value for money. However, they do not address questions of affordability.

An intervention can be great value for money, but not be affordable. For example, an intervention may be highly cost-effective, but may possess attributes that cause a huge surge in demand your service may not be able to meet. Alternatively, although an intervention may be cost-effective over a five-year timeframe, because costs are front-loaded this may result in a spike in your year one cost that exceeds the budget capacity of your organization.

For these reasons, economic evaluations measuring value for money frequently need to be supplemented with an analysis of affordability provided by budget impact analyses.

2. Key Components of Budget Impact Analysis

It is worth noting that in developing a budget impact analysis, we are really building a type of model. Many of the steps will be similar to the steps undertaken in the economic evaluation that may be the starting point for your budget impact analysis. In many respects, the data used in the budget impact analysis will also be common with that used in the economic evaluation. However, there are some important distinctions as well.

As an initial step, we need to specify the **Perspective, Intervention, Comparator,** and **Timeframe** of our analysis. The Intervention and Comparator will be the same as used in the economic evaluation. However,

- you may be interested in a shorter timeframe (e.g. the next 1 to 5 years) to that adopted in the economic evaluation (which may have used a lifetime horizon)
- you might be interested in a narrower perspective (organization/department instead of health system, or health system instead of society)

The next thing to consider is the **population and demand** for the service:

- Unlike economic evaluation, a budget impact analysis will be modeled for the anticipated size of the population that will be using the service
- A population changes over time (year 3 population might be different to year 1 population due to gradual demographic changes or a staged rollout of the project to new locations)
- The demand for the service can be modeled either using epidemiological evidence combined with service update data/assumptions or alternatively to base demand on the numbers using of the current service (who are thus assumed to switch to the new service)

- The number of times individual patients might access the new service also needs to be identified
- Variations in demand by different population subgroups (e.g. by illness severity, age, gender, socioeconomic status, etc.) should also be accounted for

There are a number of important considerations when analyzing costs:

(Click each to learn more).

Costs

Costs are not discounted in budget impact analysis (unlike in economic evaluations where costs are discounted)

Total costs

Total costs should be fully described (as opposed to counting only costs that are different between options and reporting incremental costs)

Annual depreciation	Annual depreciation of capital costs should be included
Uncertainty	Uncertainty should be analyzed with at least deterministic sensitivity analysis and ideally with probabilistic sensitivity analysis
Cost savings	All potential spin-off cost savings of the new project should be included (these should also have been

captured in the economic evaluation)

3. Technical Development and Good Practice

Budget impact analyses can be developed in spreadsheet packages like Excel. Alternatively, you could use a stats package like R.

When developing budget impact analyses, as far as is practical you should adhere to good practice guidelines:

- Budget Impact Analysis – Principles of Good Practice (2014)
- Guidelines for the Budget Impact Analysis of Health Technologies in Ireland (2010)

References and Further Optional Reading

If you would like to do further optional reading about the topic, you may wish to consider the following resources:

- Health Information and Quality Authority (Ireland). "Guidelines for the Budget Impact Analysis of Health Technologies in Ireland" 2010, HIQA.
- S Sullivan, J Mauskopf, F Augustovski, J Caro, K Lee, M Minchin, E Orlewska, P Penna, J Rodriguez Barrios, W Shau. "Budget Impact Analysis—Principles of Good Practice: Report of the ISPOR 2012 Budget Impact Analysis Good Practice II Task Force" 2014, Value in Health.

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Self-Assessment Exercise 7 - Budget Impact Analysis

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XLS

Self-Assessment Exercise 7 -Budget Impact Analysis.xlsx
65.2 KB

Solution to Self Assessment Exercise 7

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80.5 KB

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