MEDCIDS DEPARTAMENTO DE MEDICINA DA COMUNIDADE, INFORMAÇÃO E DECISÃO EM SAÚDE U.PORTO CINTESIS Health. Research.

HEADS PhD PROGRAMME IN HEALTH DATA SCIENCE

DECIDE

Introduction to Health Interventions, Policy and Services

Coordinator:

Luís Filipe Azevedo

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Introduction to Health Interventions, Policy and Services

Economic Evaluation of Healthcare Technologies – Part II

Luís Filipe Azevedo

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Summary

- Types of Economic Evaluation
  - Cost Effectiveness Analysis
  - Cost Utility Analysis
  - Budget Impact Analysis
- Critical Appraisal of Economic Evaluation Studies
- Measurement and Analysis of Costs
  - Classification of costs
  - Identification
  - Measurement
  - Valuation
  - Productivity costs
  - Time preferences and discounting
  - A practical example of a costs measurement model

Economic Evaluation

- Different **types of studies** when analysing **consequences** and **costs** of alternatives:
  1. Descriptive or comparative studies analysing only costs of one or more alternatives – **Partial Economic Evaluation – Economic Impact Analysis (Cost-of-Illness study) or Cost Analysis**
  2. Comparative studies analysing costs and consequences of two or more alternatives – **Complete Economic Evaluation** (**Cost-Minimization, Cost-Benefit, Cost-Effectiveness and Cost-Utility Analysis**)

Types of Economic Evaluation

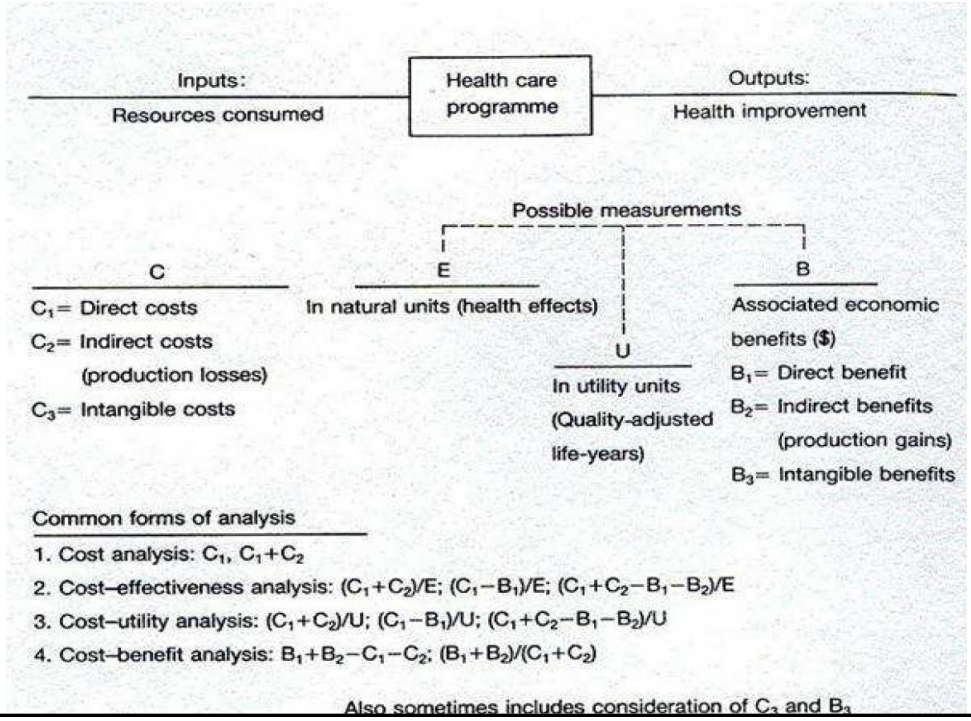
Cost-Effectiveness Analysis

- A **Cost-Effectiveness Analysis** is a form of **complete economic evaluation**
- **Comparative analysis** of two or more alternatives taking into account their **costs and consequences or health effects**

Cost-Effectiveness Analysis

- In this type of analysis the **consequences or health effects** of alternatives are **measured in natural or physical units of effectiveness**
  - E.g. mortality, survival, disability, productivity loss, blood pressure reduction, LDL levels reduction, heart attacks avoided, deaths avoided
- **Lists all costs over time**
- Only **one domain of outcomes** can be explored **at a time**
- In this type of analysis we aim to **answer the following question**:

  Is this program or intervention better than the alternative taking into account the incremental cost per unit of effectiveness?



Cost-Effectiveness Analysis

- A practical example:
  - A group of researchers aims to **compare** the alternatives of **hospital dialysis** versus **kidney transplantation** in **patients with chronic kidney disease (CKD)**, taking into account **clinical outcomes** and **costs** of these alternatives
  - Let us assume that the **first and most relevant clinical outcome** in this population is the **survival time**
  - The researchers will focus on the **valid measurement of the survival times** for patients submitted to each of the alternatives; and, additionally, they will **estimate and analyse the costs associated with each alternative**
  - The **comparison of the alternatives** will **take jointly into account costs and survival** of each alternative through a **joint measure of incremental cost per unit of survival** of one alternative against the other

Cost-Effectiveness Analysis

The ***Average Cost-Effectiveness Ratio*** **– ACER** of one alternative is given by the ratio of the estimate of the average or expected costs for this alternative and its average or expected effectiveness:

$$A\hat{C}ER_i = \frac{\hat{C}_i}{\hat{E}_i}$$

The ***Incremental Cost-Effectiveness Ratio*** **– ICER** of a given alternative (a) against its comparator (b) will be the ratio of the difference between average or expected costs for each alternative (*net costs*) and the difference between the average or expected effectiveness of each alternative (*net benefit*):

$$I\hat{C}ER_{ab} = \frac{\hat{\Delta}_c}{\hat{\Delta}_e} = \frac{\hat{C}_a - \hat{C}_b}{\hat{E}_a - \hat{E}_b}$$

Cost-Effectiveness Analysis

A practical example:

Alternative (A) – is the comparator and the alternative currently in use and it provides, on average, a survival time of 4 life-years and, on average, it has a cost (direct + indirect costs) of 100,000 €

Alternative (B) provides, on average, a survival time of 5 life-years and, on average, it has a cost (direct + indirect costs) of 300,000 €

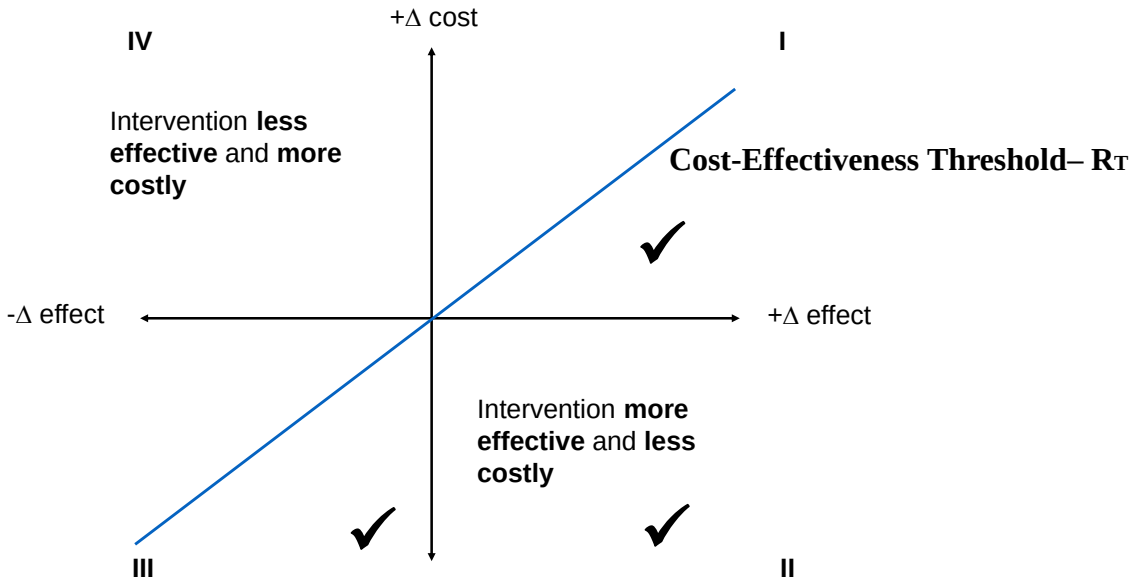
Alternative (C) provides, on average, a survival time of 10 life-years and, on average, it has a cost (direct + indirect costs) of 400,000 €

$$\hat{ICER}_{BA} = \frac{\hat{\Delta}_c}{\hat{\Delta}_e} = \frac{\hat{C}_B - \hat{C}_A}{\hat{\pi}_B - \hat{\pi}_A} = \frac{300.000 - 100.000}{5 \text{ years} - 4 \text{ years}} = \frac{200.000 \text{ euros}}{1 \text{ year}} = 200.000 \text{ euros/ life-year}$$

$$\hat{ICER}_{CA} = \frac{\hat{\Delta}_c}{\hat{\Delta}_e} = \frac{\hat{C}_C - \hat{C}_A}{\hat{\pi}_C - \hat{\pi}_A} = \frac{400.000 - 100.000}{10 \text{ years} - 4 \text{ years}} = \frac{300.000 \text{ euros}}{6 \text{ years}} = 50.000 \text{ euros/ life-year}$$

$$\hat{ICER}_{CB} = \frac{\hat{\Delta}_c}{\hat{\Delta}_e} = \frac{\hat{C}_C - \hat{C}_B}{\hat{\pi}_C - \hat{\pi}_B} = \frac{400.000 - 300.000}{10 \text{ years} - 5 \text{ years}} = \frac{100.000 \text{ euros}}{5 \text{ years}} = 20.000 \text{ euros/ life-year}$$

Difference in effect and cost of an option relative to its comparator



Cost-effectiveness Analysis

- Decision rule:

  Two programmes **A** (comparator) and **B**
  - If Outcome **B** = Outcome **A** => Compare costs (CMA)
  - If Outcome **B** > Outcome **A** and Cost **B** < Cost **A**, **B** is **dominant** and should be the chosen alternative
  - If Outcome **B** > Outcome **A** and Cost **B** > Cost **A**, we have to make a decision whether if **B** should be the chosen alternative or not

- In order to make a decision on which intervention to choose, a **cost-effectiveness ratio** (CER) should be calculated.

Cost-Effectiveness Analysis

- **Cost-Effectiveness Threshold – R_T**
  - A fundamental measure, criterion and benchmark to interpret the results of a cost-effectiveness analysis
  - It is generally defined by consensus and in each particular decision-making context
  - Classic reference values

    50,000 American Dollars / life-year or QALY (classic US reference from the 70's)

    20,000 – 30,000 English Pounds / life-year or QALY (NICE recommendations)

    WHO recommends thresholds between 2-3 times the per-capita GDP
  - Reference values for Portugal?
    - Although we have national guidelines for economic evaluation studies, these do not recommend any specific CE threshold
    - According to the World Bank the per-capita GDP in Portugal, is 2019, is around 21 thousand euros, thus per the WHO recommendations we should use a threshold between 40,000 and 60,000 euros

Cost-effectiveness Analysis

- There is no 'magic' cut-off number that establishes whether or not an intervention is '**cost-effective**'
- It will depend on the decision maker's '**Cost-Effectiveness Threshold**'
- The Cost-Effectiveness Threshold can be inferred from the decision-maker's **'willingness to pay'**
- To make a decision:
  - If ICER of the program ≤ Cost-Effectiveness Threshold → adopt the program
  - If ICER of the program > Cost-Effectiveness Threshold → do not adopt the program

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Cost-Effectiveness Analysis

- Coming back to our practical example:
  - A group of researchers aims to **compare** the alternatives of **hospital dialysis** versus **kidney transplantation** in **patients with chronic kidney disease (CKD)**, taking into account **clinical outcomes** and **costs** of these alternatives
  - Let us assume that the **first and most relevant clinical outcome** in this population is the **survival time**
  - The researchers will focus on the **valid measurement of the survival times** for patients submitted to each of the alternatives; and, additionally, they will **estimate and analyse the costs associated with each alternative**
  - The **comparison of the alternatives** will **take jointly into account costs and survival** of each alternative through a **joint measure of incremental cost per unit of survival** of one alternative against the other
  - Now we know the **joint measure of incremental cost per unit of survival** is called the **Incremental Cost-Effectiveness Ratio (ICER)** and it is the **fundamental result of any cost-effectiveness analysis**

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Practical example

Alternatives	Costs	Effectiveness (Average survival – Life Years)	Effectiveness (Utilities associated with the health states resulting from each alternative)	Effectiveness (Quality-Adjusted Life Years - QALYs)	Benefit (monetary value of the health effects of the alternatives)
A	$20000	4,5 years	0,90	4,05 QALYs	$40000
B	$10000	3,5 years	0,80	2,80 QALYs	$20000

Cost-Effectiveness Analysis

We may calculate the Average Cost-Effectiveness Ratio ACER for each alternative A: 20,000/4,5 = $ 4,444 / life-year and B: 10,000/3,5 = $ 2,857 / life-year

But, the most relevant result for the decision-making process is the **Incremental (A vs. B) Cost-Effectiveness Ratio (ICER)**: (20,000–10,000)/(4.5–3.5)= $ 10,000 / life-year

Cost-Utility Analysis

- The concepts of **preference** and **utility** will be covered in more detail in another class
- For now, let us just generally define **utility** as a **formal measure of the preference of individuals or populations for any given health state**, which is assumed to be **constrained between 0 and 1**, with the anchors zero meaning the utility of death (the assumed worst possible health state) and one the utility of a theoretical perfect state of health
- The concepts of **preference** and in particular **utility** as a measure of preference are key to allow us to **incorporate into the analysis components associated with the quality of life and not just its quantity, as measured by the preference of individuals for different health states or health outcomes – utility**

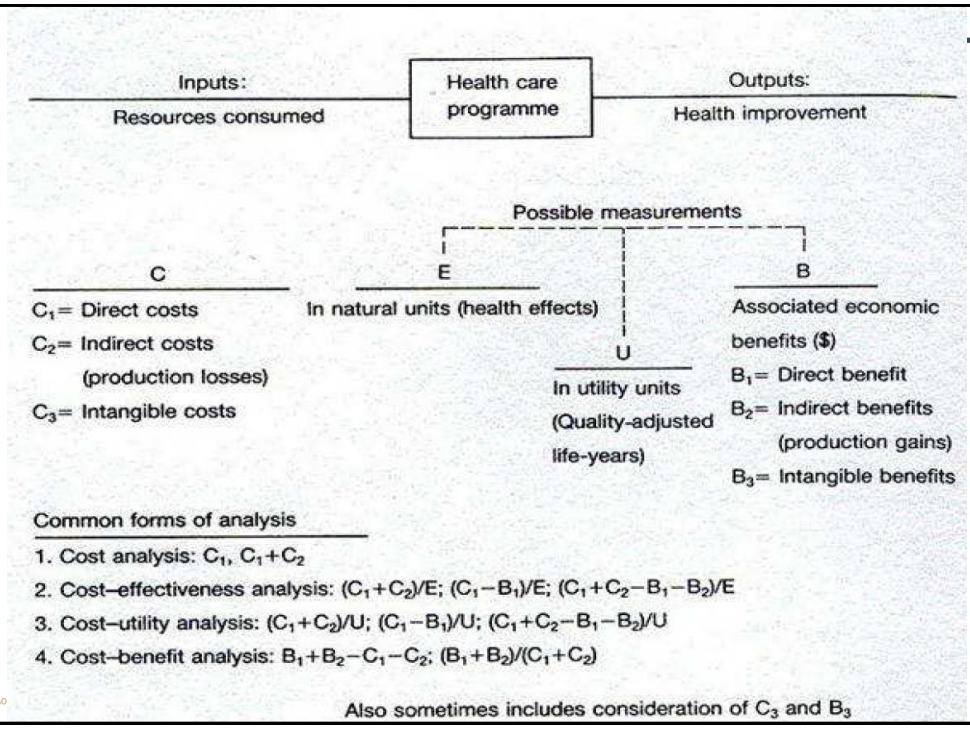
Cost-Utility Analysis

- A **Cost-Utility Analysis** is a form of **complete economic evaluation**
- **Comparative analysis** of two or more alternatives taking into account their **costs and consequences or health effects**
- It is generally considered a **particular subtype of Cost-Effectiveness Analysis**

Cost-Utility Analysis

- In Cost-Utility Analysis the **units used to measure the consequences or health outcomes of alternatives** are **natural or physical units of effectiveness, but in this case appropriately adjusted for the preferences of individuals or populations** for those health states or outcomes, as **measured by their utilities and using joint measures of quantity and quality of life**
- **Examples of joint measures of quantity and quality of life** calculated from utilities or similar preference measures:
  - Quality adjusted life years – QALY
  - Disability adjusted life years – DALY
  - Healthy-year equivalents – HYE
  - Saved-Young-Life Equivalents – SAVE
- In this type of analysis we aim to **answer the following question**:

  Is this program or intervention better than the alternative taking into account the incremental cost per unit of effectiveness appropriately adjusted for the preferences of individuals or populations for those health outcomes?



Practical example

Alternatives	Costs	Effectiveness (Average survival – Life Years)	Effectiveness (Utilities associated with the health states resulting from each alternative)	Effectiveness (Quality-Adjusted Life Years - QALYs)	Benefit (monetary value of the health effects of the alternatives)
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Cost-Utility Analysis

QALYs are calculated from the direct weighting of life-years by their respective utilities
For alternative A: (4,5) * (0,9) = 4,05 QALYs; and for alternative B: (3,5) * (0,8) = 2,80 QALYs

Incremental (A vs. B) Cost-Utility Ratio (ICUR): 10,000 / 1.25 = $ 8,000 / QALY

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Budget Impact Analysis – BIA

- A **BIA** addresses **the financial consequences and expected changes in the expenditure of a healthcare system after the adoption and diffusion of a NEW healthcare technology given budget constraints**
- It is part of the comprehensive economic assessment of healthcare technologies along with CEA before the technology is approved or reimbursement by healthcare payers is decided
- **BIA provides a framework for stakeholders to examine how different assumptions about the potential impact of the new interventions with regard to**
  - Changes in **technology mix**
  - Changes in **technology cost**

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Budget Impact Analysis – BIA

- **Predicts** how a **change in the mix of technologies** used for a given clinical indication **affects the trajectory of spending** on that clinical indication
- BIA **evaluates a scenario** and **not a single technology**
- The **comparator in BIA is the status quo**
- **Uses of BIA:**
  - **Budget planning**
  - **Forecasting**
  - **Estimating impact of health technology changes in the budget of health systems or healthcare providers and payers**
  - **Estimating (potential) financial impact of pursuing a technology at the national level**

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Budget Impact Analysis – BIA

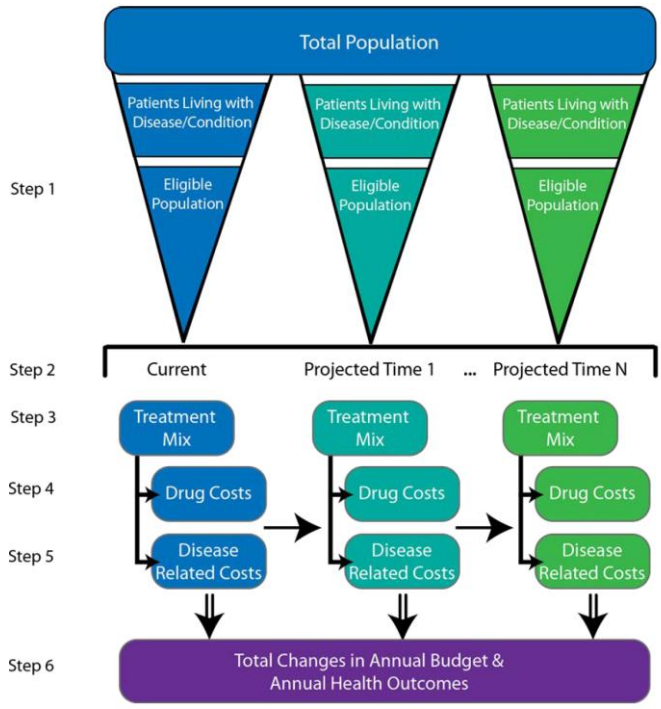
	CEA	BIA
Objective	Quantify net health ROI	Quantify impact on resource consumption
Outcomes	Net health benefits, net resource consumption	Net resource consumption
Perspective	Societal, healthcare sector, payer	Payer
Time horizon	Long-term (until all costs and benefits realized)	Budget cycle (1 – 5 years)
Unit	ICER	Absolute costs and savings
Interpretation	↓ICER = ↑Cost-effectiveness	↓Cost = ↑Affordability
Threshold	ICER—WTP threshold	No metric or threshold for individual intervention assessment

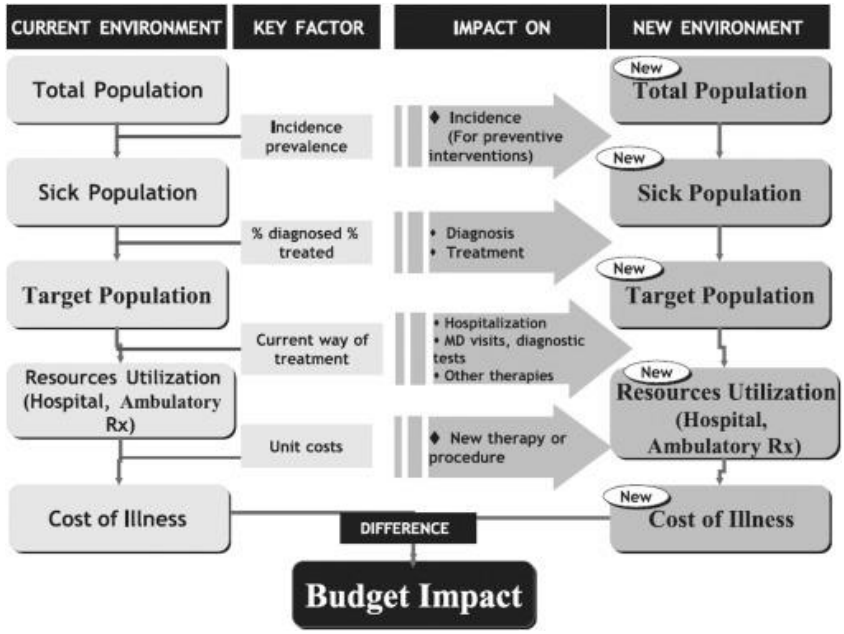
Citation: Bilinski A, Neumann P, Cohen J, Thorat T, McDaniel K, Salomon JA (2017) When cost-effective interventions are unaffordable: Integrating cost-effectiveness and budget impact in priority setting for global health programs. PLoS Med 14 (10): e1002397. https://doi.org/10.1371/journal.pmed.002397

Budget Impact Analysis – BIA

Six Steps of Budget Impact Analysis:

1. **Characterize the population with the potential to be impacted by the intervention**
2. **Select the time horizon**
3. **Determine the current and future mix of technologies**
4. **Estimate technology costs**
5. **Estimate changes in disease-related costs**
6. **Present results of budget impact predictions**





Budget Impact Analysis—Principles of Good Practice: Report of the ISPOR 2012 Budget Impact Analysis Good Practice II Task Force
Sean D. Sullivan, PhD, Josephine A. Mauskopf, PhD, Federico Augustovski, MD, MSc, PhD, J. Jaime Caro, MDCM, FRCPC, FACP, Karen M. Lee, MA, Mark Minchin, MBA, Ewa Orlewska, MD, PhD, Pete Penna, PharmD, Jose-Manuel Rodriguez Barrios, RPh, MPH, MSc, Wen-Yi Shau, PhD, MD
Value in Health Volume 17, Issue 1, Pages 5-14 (January 2014) DOI: 10.1016/j.jval.2013.08.2291

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Budget Impact Analysis – BIA

VALUE IN HEALTH 17 (2014) 5–14

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ISPOR TASK FORCE REPORT

Budget Impact Analysis—Principles of Good Practice: Report of the ISPOR 2012 Budget Impact Analysis Good Practice II Task Force

Sean D. Sullivan, PhD[1], Josephine A. Mauskopf, PhD[2,*], Federico Augustovski, MD, MSc, PhD[3], J. Jaime Caro, MDCM, FRCPC, FACP[4], Karen M. Lee, MA[5], Mark Minchin, MBA[6], Ewa Orlewska, MD, PhD[7,8], Pete Penna, PharmD[9], Jose-Manuel Rodriguez Barrios, RPh, MPH, MSc[10], Wen-Yi Shau, PhD, MD[11]

[1]Pharmaceutical Outcomes Research and Policy Program, University of Washington, Seattle, WA, USA; [2]RTI Health Solutions, Research Triangle Park, NC, USA; [3]Health Economic Evaluation and Technology Assessment, Institute for Clinical Effectiveness and Health Policy, Buenos Aires, Argentina; [4]Evidera, Lexington, MA, USA; [5]Health Economics, Canadian Agency for Drugs and Technologies in Health, Ottawa, ON, Canada; [6]PASLU, National Institute for Health and Care Excellence, Manchester, UK; [7]Centre for Pharmacoeconomics, Warsaw, Poland; [8]The Jan Kochanowski University, Kielce, Poland; [9]Formulary Resources, LLC, Mercer Island, WA, USA; [10]Stryker, Madrid, Spain; [11]Center for Drug Evaluation, Taipei, Taiwan

ABSTRACT

Background: Budget impact analyses (BIAs) are an essential part of a comprehensive economic assessment of a health care intervention and are increasingly required by reimbursement authorities as part of a listing or reimbursement submission. **Objectives:** The objective of this condition-specific model may be used to estimate the budget impact of the new intervention, accounting appropriately for those entering and leaving the eligible population over time. In either case, the BIA should use data that reflect values specific to a particular decision

https://www.valueinhealthjournal.com/article/S1098-3015(13)04235-6/fulltext

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Economic Evaluation – Summary

Method	How are benefits measured?	How are results expressed?	What is the decision making rule?
Cost minimisation	**Proven equal**	**€**	**Choose that which costs least**
Cost Benefit Analysis	**€**	**Net benefit (NB) in € Benefit cost ratio**	**NB > 0 B:C ratio > 1**
Cost Effectiveness Analysis	**Natural units, e.g. pain free days life years gained**	**Cost effectiveness ratio (CER)= ΔCosts/Δoutcome**	**That with the lowest CER is best value for money***
Cost Consequences Analysis	**In a variety of different natural units.**	**CERs for each alternative measure of effectiveness**	**That with the lowest CER is best value for money***
Cost Utility Analysis	**Quality Adjusted Life Years (QALYs)**	**Cost effectiveness ratio= ΔCosts/ΔQALYs**	**That with the lowest CER is best value for money***

* and those with a CER lower than society's 'threshold' CER are desirable

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Practical example

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Cost Minimisation Analysis

Comparative analysis of costs if we assume equal effectiveness / benefit of alternatives

In this example we would choose B, because it has lower costs than A

Cost-Benefit Analysis

Results are expressed in monetary units

Monetary value of the health effects of the alternative A is $ 40000; and for B it is $ 20000

Ratio (A vs. B) benefit-cost (Ratio B-C): (40000–20000)/(20000–10000)= 2

Difference (A vs. B) benefit-cost (*Incremental Net benefit*): (40000–20000)–(20000–10000)= 10000 $

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Incremental (A vs. B) Cost-Utility Ratio (ICUR): 10,000 / 1.25 = $ 8,000 / QALY

Critical Appraisal of Economic Evaluation Studies

Economic Evaluation

- **Critical Appraisal of Economic Evaluation Studies**

ISPOR TASK FORCE REPORT

Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluation Publication Guidelines Good Reporting Practices Task Force

Don Husereau, BScPharm, MSc[1,2,3,], Michael Drummond, PhD[4], Stavros Petrou, MPhil, PhD[5], Chris Carswell, MSc, MRPharmS[6], David Moher, PhD[7], Dan Greenberg, PhD[8,9], Federico Augustovski, MD, MSc, PhD[10,11], Andrew H. Briggs, MSc (York), MSc (Oxon), DPhil (Oxon)[12], Josephine Mauskopf, PhD[13], Elizabeth Loder, MD, MPH[14,15], on behalf of the ISPOR Health Economic Evaluation Publication Guidelines - CHEERS Good Reporting Practices Task Force*

[1]Institute of Health Economics, Edmonton, Canada; [2]Department of Epidemiology and Community Medicine. University of Ottawa, Ottawa, ON, Canada; [3]University for Health Sciences, Medical Informatics and Technology, Hall in Tirol, Austria; [4]Centre for Health Economics, University of York, Heslington, York, UK; [5]Warwick Medical School, University of Warwick, Coventry, UK; [6]Pharmacoeconomics, Adis International, Auckland, New Zealand; [7]Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, ON, Canada; [8]Faculty of Health Sciences, Department of Health Systems Management, Ben-Gurion University of the Negev, Beer-Sheva, Israel; [9]Center for the Evaluation of Value and Risk in Health, Tufts Medical Center, Boston, MA, USA; [10]Health Economic Evaluation and Technology Assessment, Institute for Clinical Effectiveness and Health Policy (IECS), Buenos Aires, Argentina; [11]Universidad de Buenos Aires, Buenos Aires, Argentina; [12]Institute of Health & Wellbeing, University of Glasgow, Glasgow, Scotland; [13]RTI Health Solutions, Research Triangle Park, NC, USA; [14]Brigham and Women's/Faulkner Neurology, Faulkner Hospital, Boston, MA, USA; [15]Clinical Epidemiology Editor, BMJ, London, UK*

CHEERS - Publications

- **CHEERS Statement**
  - Statement jointly published regarding need
  - Checklist endorsed by journals internationally

- **CHEERS Explanation and Elaboration**
  - Task Force Report (User's Guide)
  - Description of the need for reporting requirements
  - Description of the Task Force process
  - Explanation of each recommendation
  - Example(s) for each recommendation
  - Published only in Value in Health

Purpose of CHEERS

- A paper that meets all the requirements in the checklist will:
  - Clearly state the study question and its importance to decision makers
  - Allow a reviewer and a reader to assess the appropriateness of the methods, assumptions, and data used in the study
  - Allow a reviewer and reader to assess the credibility of the results and the sensitivity of the results to alternative data choices
  - Have conclusions that are supported by the study results
  - Potentially allow a researcher to replicate the model

Recommendations

- The recommendations are subdivided into the five sections generally found in a paper presenting an economic evaluation
  - Title and Abstract
  - Introduction
  - Methods
  - Results
  - Discussion

CHEERS Checklist – Items to include when reporting economic evaluations of health interventions (1)

Section/Item	Item No	Recommendation
Title and abstract		
Title	1	Identify the study as an economic evaluation, or use more specific terms such as ``cost-effectiveness analysis``, and describe the interventions compared.
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.
Introduction		
Background and objectives	3	Provide an explicit statement of the broader context for the study.
		Present the study question and its relevance for health policy or practice decisions.
Methods		
Target Population and Subgroups	4	Describe characteristics of the base case population and subgroups analyzed including why they were chosen.
Setting and Location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.
Study Perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.
Time Horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.

CHEERS Checklist – Items to include when reporting economic evaluations of health interventions (2)

Section/Item	Item No	Recommendation
Discount Rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.
Choice of Health Outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.
Measurement of Effectiveness	11a	*Single Study-Based Estimates*: Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.
	11b	*Synthesis-based Estimates*: Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.
Measurement and Valuation of Preference-Based Outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.
Estimating Resources and Costs	13a	*Single Study-based Economic evaluation*: Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.
	13b	*Model-based Economic Evaluation*: Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.

CHEERS Checklist – Items to include when reporting economic evaluations of health interventions (3)

Section/Item	Item No	Recommendation
Currency, Price Date and Conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.
Choice of model	15	Describe and give reasons for the specific type of decision-analytic model used. Providing a figure to show model structure is strongly recommended.
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytic model.
Analytic Methods	17	Describe all analytic methods supporting the evaluation. This could include methods for dealing with skewed, missing or censored data, extrapolation methods, methods for pooling data, approaches to validate or make adjustments (e.g., half-cycle corrections) to a model, and methods for handling population heterogeneity and uncertainty.
Results		
Study parameters	18	Report the values, ranges, references and if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.

CHEERS Checklist – Items to include when reporting economic evaluations of health interventions (4)

Section/Item	Item No	Recommendation
Characterizing Uncertainty	20a	*Single study-based economic evaluation*: Describe the effects of sampling uncertainty for estimated incremental cost, incremental effectiveness and incremental cost-effectiveness, together with the impact of methodological assumptions (e.g. discount rate, study perspective).
	20b	*Model-based economic evaluation*: Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.
Characterizing Heterogeneity	21	If applicable, report differences in costs, outcomes or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.
Discussion		
Study Findings, Limitations, Generalizability, and Current Knowledge	22	Summarize key study findings and describe how they support the conclusions reached. Discuss limitations and the generalizability of the findings and how the findings fit with current knowledge.
Other		
Source of Funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct and reporting of the analysis. Describe other non-monetary sources of support.
Conflicts of Interest	24	Describe any potential for conflict of interest among study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors' recommendations

Measurement and Analysis of Costs

Measurement and Analysis of Costs

- The perspective of the analysis determines the type of costs we should consider
  - Society: all relevant costs
  - Health system: only costs in the context of the health system
  - Healthcare payers: only costs covered or reimbursed by the payer
  - Patients: only costs supported by the patient

HEADS

Measurement and Analysis of Costs

- **Types of costs**
  - **Direct costs**
  - **Indirect costs**
  - **Intangible costs**

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Measurement and Analysis of Costs

- **Types of costs**

	Healthcare costs	Non-healthcare costs
Direct costs	(1) Healthcare costs	(3) Costs for the patient, family or care takers
Indirect costs	(2) Healthcare related costs (throught the remaining time horizon of the analysis)	(4) Productivity costs and other non-healthcare related costs (e.g.: special education, legal costs, etc.)

Measurement and Analysis of Costs

- Types of costs – Drummond's classification
  - Healthcare associated costs
  - Costs for the patient or care takers
  - Costs allocated to other sectors

Measurement and Analysis of Costs

- **Types of costs – Classification proposed by the *"Panel on Cost-Effectiveness Analysis of the U. S. Public Health Service"***
  - **Direct costs**
    - ***Direct costs associated with healthcare***
    - ***Direct costs not associated with healthcare***
    - ***Direct costs associated with informal care takers (e.g.: family, friends, etc)***
    - ***Indirect costs associated with the patient's time***
  - **Productivity costs**

Figure 1. Impact Inventory Template

Sector	Type of Impact (list category within each sector with unit of measure if relevant)[a]	Included in This Reference Case Analysis From…Perspective?		Notes on Sources of Evidence
		Health Care Sector	Societal	
Formal Health Care Sector				
Health	Health outcomes (effects)			
	Longevity effects	☐	☐	
	Health-related quality-of-life effects	☐	☐	
	Other health effects (eg, adverse events and secondary transmissions of infections)	☐	☐	
	Medical costs			
	Paid for by third-party payers	☐	☐	
	Paid for by patients out-of-pocket	☐	☐	
	Future related medical costs (payers and patients)	☐	☐	
	Future unrelated medical costs (payers and patients)	☐	☐	
Informal Health Care Sector				
Health	Patient-time costs	NA	☐	
	Unpaid caregiver-time costs	NA	☐	
	Transportation costs	NA	☐	
Non–Health Care Sectors (with examples of possible items)				
Productivity	Labor market earnings lost	NA	☐	
	Cost of unpaid lost productivity due to illness	NA	☐	
	Cost of uncompensated household production[b]	NA	☐	
Consumption	Future consumption unrelated to health	NA	☐	
Social Services	Cost of social services as part of intervention	NA	☐	
Legal or Criminal Justice	Number of crimes related to intervention	NA	☐	
	Cost of crimes related to intervention	NA	☐	
Education	Impact of intervention on educational achievement of population	NA	☐	
Housing	Cost of intervention on home improvements (eg, removing lead paint)	NA	☐	
Environment	Production of toxic waste pollution by intervention	NA	☐	
Other (specify)	Other impacts	NA	☐	

[a] Categories listed are intended as examples for analysts.

[b] Examples include activities such as food preparation, cooking, and clean up in the household; household management; shopping; obtaining services; and travel related to household activity.[18]

NA indicates not applicable.

Recommendations for Conduct, Methodological Practices, and Reporting of Cost-effectiveness Analyses

Second Panel on Cost-Effectiveness in Health and Medicine

JAMA. 2016;316(10):1093-1103. doi:10.1001/jama.2016.12195

HEADS

Measurement and Analysis of Costs

- Measurement and calculation methods:
  - Costs = Resources utilization × Costs per unit of resource
  - Operational stages:
    - **Identification**: difining the relevant types of costs and cost items
    - **Measurement**: measuring or quantifiying resources utilization for each cost item and/or type
    - **Valuation:** valuing and defining the unit costs for each resource of each cost item and/or type

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Measurement and Analysis of Costs

(1) Identification:

- Detailed analysis of the healthcare/treatment process
- Ask for opinions of different stakeholders and experts!
  - Physicians and other healthcare professionals and specialists, healthcare management specialists, policy makers, patients, family, scientific literature, guidelines, etc.
- **Focus on major cost items**
- **Focus on items expected to behave differently between alternatives**

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Measurement and Analysis of Costs

(2) Measurement:

- Measurement or quantification of resources utilization for each cost item
- Quantification of health services used and necessary inputs, using the following data sources:
  - Administrative or clinical registries and databases – nation wide or regional;
  - Electronic or non-electronic hospital healthcare records – clinical or administrative;
  - Electronic or non-electronic primary care records – clinical or administrative;
  - Drugs sales or prescription databases;
  - Healthcare Insurers registries and databases;

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Measurement and Analysis of Costs

(2) Measurement:

- Measurement or quantification of resources utilization for each cost item
- Quantification of health services used and necessary inputs, using the following data sources:
  - Surveys or questionnaires applied to patients or healthcare professionals;
  - Diaries applied to patients, care takers or healthcare professionals;
  - Asking for opinions of experts or different stakeholders (may need to use qualitative methods);
  - Primary data collection – experimental or observational studies, prospective or retrospective, etc.

Measurement and Analysis of Costs

(3) Valuation:

- **How to value health services?** How to define the cost per unit of resource for each of the resources and cost items?
- Once the relevant range of costs has been **identified**, the **individual items must be measured** and **valued**
- Costing includes two elements: **measurement of the quantities of resource use (q)** and the **assignment of unit costs or prices (p)**
- **Market prices** will be available for many of the resource items
- Although the **theoretical proper price for a resource is its opportunity cost** (i.e. the value of the forgone benefits because the resource is not available for its best alternative use), **the pragmatic approach to costing is to take existing market prices unless there is some particular reason to do otherwise** (e.g. the price of some resources may be subsidized by a third party such as a charitable institution, health insurance or a governmental health system)

HEADS

Measurement and Analysis of Costs

(3) Valuation:

- Market prices generally reflect item costs! Yes, but… That is mainly true in normal competitive open markets (under typical rules of supply and demand)!
- The market of health care services and health care products usually has special rules and regulatory frameworks that change the rules of normal competitive open markets (special regulatory frameworks, reimbursements, co-payments, low capacity and/or productivity may not affect prices, etc.); thus, many times prices may not exactly reflect costs!

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Measurement and Analysis of Costs

(3) Valuation:

- What costs to consider per unit of resources?
  - **Total costs = Fixed costs + Variable costs**
  - **Fixed costs** – fixed per volume of resource (E.g.: Operating room with capacity for 1000 surgeries per year). For example, infrastructure costs, room space, office space, maintenance costs, overheads.
  - **Variable costs** – vary directly with the amount of resources / output / goods or services used or produced (E.g.: drugs, consumables, etc.)
  - **Average costs** – average costs per unit of output / production
  - **Marginal costs** – costs of producing one aditionall unit of output / production

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Measurement and Analysis of Costs

(3) Valuation:

- **We should always prefer total costs** (and not only variable costs)
  - They include a broader range of relevant costs
  - More easily accessible (commonly produced statistics, reference list costs, etc.)
  - In the long run all costs are variable, thus total costs=variable costs

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Measurement and Analysis of Costs

- **Level of detail or granularity in cost analysis**
  - **Micro-costing – "Bottom up"**
    - More precise
    - Detailed costing resulting from the sum of a detailed list of all relevant cost items
  - **Macro-costing – "Top-down"**
    - Using average costs per unit of resources / output
    - It uses global cost estimates taking into account total resources used and total output produced
    - Guidelines (see, for example, the Dutch guidelines to macro-costing – www.cvz.nl)

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Measurement and Analysis of Costs

- **Using Diagnosis-Related Groups (DRG)**
  - Classification system of hospital admissions and procedures
  - Classification is dependent upon professional DRG coders
  - Guides healthcare funding and productivity measurement
  - We should however be cautious when using DRG databases for costing purposes in economic evaluation

Measurement and Analysis of Costs

- **Direct costs for the patient and familiy/care takers**
  - Costs with transport / travels
  - Costs associated with the time spent / productivity loss
  - Costs for the family / care takers (time and others)
  - Costs associated with informal care
  - Other costs

Measurement and Analysis of Costs

- **Costs with transport / travels**
  - We should take into account number of consults/appointments, type of transportation, distance (Km) and cost per distance (Km)
  - Data collection:
    - Clinical charts / registries
    - Questionnaires applied to the patient
    - General routine national or regional statistics
    - Prices / tariffs guides of transportation services
    - Official governmental or legal references (cost per Km for a public employees in out of office work assignements)

Measurement and Analysis of Costs

- **Productivity costs**
  - Costs associated with productivity loss (absenteeism or presenteeism) and/or costs associated with a replacement to warrant the production
    - It should include the productivity loss due to:
      - Absenteeism
      - Loss of efficiency
      - Change of responsibilities
      - Disability
      - Mortality
    - Usually it does not include costs associated with reduction of quality of life (e.g. pain, discomfort, etc.)

Measurement and Analysis of Costs

- **Productivity costs**
  - **How to measure productivity costs?**
    - The human capital approach to economic evaluation places a monetary value on loss of health as the lost value of economic productivity due to ill health, disability, or premature mortality
    - Number of days of absence from work / sick leave
    - Reduction of productivity while at work
    - Duration of the absence / sick leave
    - Methods: records and registries from employers, social security records, questionnaires to the patients (HLQ – Health and Labor Questionnaire; PRODISQ – Productivity and disease questionnaire)

Measurement and Analysis of Costs

- **Productivity costs**
  - **How to measure productivity costs?**
    - Cost per unit of resource – monetary value of productivity loss
    - Quantifying the productivity loss
      - **Human capital method** (valuation of work days estimated by the individual gross wage/salary, including employee benefits, assuming that wages are a proxy measure of employee output, counting losses until the date of usual retirement)
      - **Friction cost method** (measures lost productivity due to illness based on the employee replacement cost, rather than the employee wage)

Measurement and Analysis of Costs

- **Productivity costs**
  - **Human capital method**
    - **Mortality-related productivity costs** correspond to the present value of lost gross wages from time of death to retirement age
    - A **life-prolonging intervention** therefore reduces productivity costs by the gross wages earned over the additional years of life. Similarly, **morbidity-related productivity costs** represent the present value of lost gross wages over the period of illness; hence, an intervention that avoids ill health reduces productivity costs by the wages earned over the duration of illness prevented
    - Depending on the availability of data sources, or on guidelines for socio-economic evaluation, authors have either used gross national wages (**top-down approach**) for the conversion or the actual salaries of individual patients (**bottom-up approach**).
    - The **ethics surrounding the use of individualized wages** has been questioned as this approach leads to the identification of patients with lower incomes, and a preference for treating patients with higher incomes

Measurement and Analysis of Costs

- **Productivity costs**
  - The measurement and valuation of productivity loss remains a much debated topic in the field of economic evaluation
  - Health technology assessment organizations in many countries impose restrictions on the inclusion of productivity costs in health economic evaluations, questioning both their relevance and the available methodology

Lensberg BR, Drummond MF, Danchenko N, Despiégel N, François C. Challenges in measuring and valuing productivity costs, and their relevance in mood disorders. Clinicoecon Outcomes Res. 2013 Nov 18;5:565-73. doi: 10.2147/CEOR.S44866. eCollection 2013.

Table I Productivity costs by health technology assessment agency

Country	Primary perspective	Secondary perspective	Productivity costs	Method of valuation	Notes
United Kingdom (National Institute for Health and Care Excellence[1])	NHS and PSS	Societal perspective	Not included	NA	For the reference case, the perspective on costs should be that of the NHS and PSS. For technologies for which a substantial proportion of the costs are expected to be incurred outside of the NHS and PSS, information on costs to other government bodies may be reported separately from the reference case analysis. However, productivity costs and costs borne by patients and carers that are not reimbursed by the NHS or PSS are not included in either the reference case or non-reference case analyses.
Canada (Canadian Agency for Drugs and Technologies in Health[2])	Publicly funded health care system	Public payer, societal perspective	May be included	FC approach	The primary perspective of the analysis should be that of the publicly funded health care system. The costs associated with adopting a wider perspective should be reported separately where it is likely that they have an impact on the results of the analysis; for example, when an intervention permits patients to return to work sooner than otherwise, costs shift to patients and their families, or result in savings or additional costs to other public sector agencies.
Australia (PBAC[3])	Health care budget perspective	Societal perspective	May be included	FC approach preferred	The PBAC mainly considers the costs of providing health care resources. It may also consider costs and cost offsets of non-health care resources, but these might not be as influential in decision-making as health care resources. If a claim is made for a change in non-health care resource costs or a change in non-health outcomes (eg, production changes), a supplementary analysis must be presented with these included.
The Netherlands (College vor Zorgverzekeringen[4])	Societal perspective		Included	FC approach	The pharmacoeconomic evaluation should be performed and reported from a societal perspective, Separate analyses for productivity costs should be performed and reported.
Sweden (Tandvårds-och läkemedelsförmånsverket[5])	Societal perspective		Included	HC method	All relevant costs associated with treatment and illness should be identified, quantified and evaluated. The production loss for treatment and sickness should also be included (estimated using the HC method).

Abbreviations: FC, friction cost; HC, human capital; NA, not applicable; NHS, National Health Service; PBAC, Pharmaceutical Benefits Advisory Committee; PSS, personal social services; SHI, Statutory Health Insurance.

Lensberg BR, Drummond MF, Danchenko N, Despiégel N, François C. Challenges in measuring and valuing productivity costs, and their relevance in mood disorders. Clinicoecon Outcomes Res. 2013 Nov 18;5:565-73. doi: 10.2147/CEOR.S44866. eCollection 2013.

Measurement and Analysis of Costs

- **Discounting – adjustments for time preferences**
  - The existence of **time preferences** for costs and benefits is one of the fundamental concepts in economics
  - The time value of money assumes **a dollar in the present is worth more than a dollar in the future** and **a cost of one dollar today is higher than the cost of one dollar in the future**

Measurement and Analysis of Costs

- **Discounting – adjustments for time preferences**
  - Prefer to have benefits now and bear costs in the future – **"time preference"**
  - Rate of time preference is termed **"discount rate"**
  - To allow for differential timing of costs (and benefits) between programmes **all future costs (and benefits) should be stated in terms of their present value** using discount rate. Thus, **future costs given less weight than present costs**.

Measurement and Analysis of Costs

- **Discounting – adjustments for time preferences**
  - Assuming costs occur at the start of each time unit of analysis, we calculate the cost today adjusted for a discounting rate using the following formula:

$$c_{presente} = c_0 + \frac{c_1}{(1+r)^1} + \frac{c_2}{(1+r)^2} + \ldots + \frac{c_n}{(1+r)^n}$$

  - Where $c_{present}$ is the cost today in monetary units adjusted for the discount rate – r; and c_0, c_1, c_2,…,c_n are the initial costs and the costs at each time unit period (e.g. a year) in the future

Measurement and Analysis of Costs

- **Discounting – adjustments for time preferences**
  - The *Panel on Cost-Effectiveness Analysis of the U. S. Public Health Service* recommends a discount rate as defined by local economic authorities or, in its absence, the use of a standard rate of 3%
  - It is also common to see researchers using discount rates of 5% or values between 3% and 6%
  - The more contemporary recommendations in Portugal strongly suggest a discount rate of 4%

A Practical Example of a Costs Measurement Model

	Elective Surgery					Emergency Surgery				
Key Reource Use Items	Centre A (n=91)	Centre B (n=110)	Centre C (n=50)	Centre D (n=109)	Overall (n=360)	Centre A (n=62)	Centre B (n=61)	Centre C (n=29)	Centre D (n=65)	Overall (n=217)
Pre-hospital										
Assessment for surgery* (n)	91	110	50	109	360	NA	NA	NA	NA	NA
Emergency ambulance transport to hospital† (n)	NA	NA	NA	NA	NA	62	61	29	65	217
In-hospital pre-surgery										
Patients admitted via A&E‡ (n)	NA	NA	NA	3	3	62	61	29	65	152
Days on ITU or ward prior to surgery§ mean (95% CI)	3.279¶ (2.48 to 4.57)	1.585 (1.35 to 1.88)	1.742 (1.44 to 2.24)	2.149 (1.72 to 2.81)	2.20 (1.95 to 2.60)	0.309 (0.09 to 0.69)	0.033 (0 to 0.08)	0.519 (0.03 to 1.62)	0.293 (0.11 to 0.58)	0.255 (0.13 to 0.42)
Patients undergoing other surgical procedures prior to AAA surgery (n)	3	NA	NA	NA	NA	NOT APPLICABLE				

A Practical Example of a Costs Measurement Model

Surgery										
Use of theatre mean duration in minutes (95% CI)	236.6 (221.9 to 251.7)	188.8 (179.3 to 199.7)	259.1 (241.6 to 279.7)	194.6 (184.2 to 206.6)	212.4 (206.1 to 220.3)	193.3 (169.3 to 217.7)	174.9 (159.3 to 192.5)	187.3 (163.1 to 217.5)	175.2 (162.0 to 191.7)	182 (172.4 to 192.7)
Staff present during surgery (see list below)	1, 2, 3, 4, 5, 7, 9	1, 2, 3, 4, 6, 7, 8, 9,	Info not provided	1, 2, 3, 4, 5, 7, 8, 9	NA	1, 2, 3, 4, 5, 7, 9	1, 2, 3, 4, 6, 7, 8, 9,	Info not provided	1, 2, 3, 4, 5, 8, 9	NA
Theatre consumables	Extensive list of items - not presented here					Extensive list of items - not presented here				
Patients receiving tube grafts	60	76	27	69	232	40	31	13	48	132
Patients receiving bifurcated grafts	30	33	23	38	124	13	18	13	12	56
Patients not receiving a graft	NA	NA	NA	NA	NA	5	6	1	2	14
Patients for whom graft data are missing	1	1	0	2	4	4	6	2	3	15
Patients receiving a second graft during surgery	0	0	0	1 **	1	0	0	1 **	0	1
Surgery and ward blood products	VARIOUS AS USED					VARIOUS AS USED				
Surgery and ward drugs	ESTIMATED USING LINEAR REGRESSION ANALYSIS					ESTIMATED USING LINEAR REGRESSION ANALYSIS				
Patients readmitted to theatre for 2nd time during AAA inpatient episode (n)	5	3	5	5	13	8	7	5	15	20
Patients readmitted to theatre for => 3 times during AAA inpatient episode (n)	0	0	2	0	2	2	0	1 ††	6	9

A Practical Example of a Costs Measurement Model

In-hospital post-surgery										
Total days on ITU mean (95% CI)	1.62 (1.29 to 2.20)	1.62 (1.37 to 2.01)	3.83 (2.97 to 6.03)	2.72 (2.14 to 3.67)	2.264 (1.97 to 2.65)	2.90 (1.96 to 4.89)	5.70 (3.73 to 8.68)	3.81 (2.65 to 5.49)	5.44 (4.11 to 7.82)	4.56 (3.72 to 5.69)
Total days on ward ‡‡ mean (95% CI)	7.98 (7.16 to 9.31)	8.62 (7.40 to 11.52)	9.86 (8.32 to 12.27)	10.84 (8.53 to 17.51)	9.29 (8.43 to 11.47)	5.29 (3.90 to 6.98)	7.31 (5.58 to 9.28)	9.23 (6.03 to 13.02)	7.73 (5.8 to 10)	7.07 (6.06 to 8.09)
Inpatient investigations (main types)										
Mean no of ECGs (95%CI)	2.53 (2.09 to 3.14)	2.287 (1.98 to 2.72)	1.92 (1.38 to 2.8)	2.43 (2.11 to 2.73)	2.35 (2.12 to 2.55)	2.682 (2.07 to 3.61)	3.294 (2.53 to 4.38)	2.89 (2.14 to 3.86)	2.60 (1.98 to 3.38)	2.85 (2.51 to 3.35)
Mean no of CXRs (95%CI)	1.627 (1.31 to 2.04)	0.083 (0.03 to 0.19)	1.137 (0.8 to 1.76)	0.211 (0.11 to 0.35)	0.658 (0.53 to 0.79)	2.419 (1.59 to 3.52)	0.052 (0.007 to 0.12)	0.930 (0.59 to 1.29)	0.327 (0.19 to 0.50)	0.926 (0.66 to 1.30)
Mean no of Ultrasound scans (95%CI)	0.156 (0.09 to 0.25)	0.055 (0.02 to 0.10)	0	0.175 (0.10 to 0.27)	0.110 (0.08 to 0.15)	0.233 (0.14 to 0.37)	0.602 (0.45 to 0.75)	0.517 (0.31 to 0.69)	0.640 (0.44 to 0.86)	0.496 (0.42 to 0.60)
Mean no of Echos (95% CI)	0.10 (0.05 to 0.17)	0.04 (0.01 to 0.11)	0.082 (0.02 to 0.18)	0.101 (0.04 to 0.19)	0.078 (0.05 to 0.12)	0.033 (0.001 to 0.11)	0.034 (0.002 to 0.12)	0.105 (0 to 0.21)	0.061 (0.002 to 0.25)	0.051 (0.02 to 0.11)
Mean no of CT scans (95%CI)	0.122 (0.06 to 0.21)	0.05 (0.02 to 0.09)	0.042 (0 to 0.12)	0.119 (0.05 to 0.19)	0.087 (0.06 to 0.12)	0.333 (0.20 to 0.5)	0.120 (0.06 to 0.23)	0.172 (0.03 to 0.31)	0.389 (0.26 to 0.53)	0.271 (0.21 to 0.34)
Post-operating hospital discharge										
Patients discharged to another hospital (n)	4	9	4	13	30	8	7	4	16	35
Patients readmitted back to operating hosp (n)	1	0	0	0	1	1	3	1	0	5
Patients having 2nd discharge to another hosp (n)	0	0	0	0	0	0	2	1	0	3
Mean no of follow-up surgical outpatient clinics (95% CI)	1.847 (1.66 to 1.91)	1.911 (1.78 to 1.96)	1.82 (1.58 to 1.92)	1.862 (1.74 to 1.94)	1.867 (1.81 to 1.91)	0.962 (0.71 to 1.16)	1.376 (1.08 to 1.57)	1.234 (0.83 to 1.52)	1.368 (1.11 to 1.57)	1.236 (1.11 to 1.38)
Patients having follow-up AAA related hospital admissions (n)	6	4	3	5	18	5	3	1	2	11

A Practical Example of a Costs Measurement Model

			Centre		
Unit cost items	**Centre A**	**Centre B**	**Centre C**	**Centre D**	**Overall**
Pre-hospital					
Assessment for surgery	£458.83	£352.38	**£309.88**	£118.43	£309.88
Emergency ambulance transport to hospital	£188	£188	£188	£188	£188
In-hospital pre-surgery					
Cost of A&E attendance	£63.36	£70	£54.47	£99.00	£71.71
Day on surgical ward prior to surgery	£205	£165	£84.22	£74.49	£132.18
Day on ITU prior to surgery	£1,100	£1,727	£782	£975	£1,145.97

A Practical Example of a Costs Measurement Model

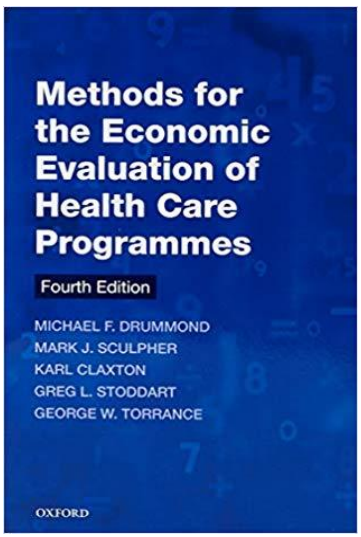
Surgery					
Cost of an empty theatre per hour (inc/ hosp o/h and capital equip)	£13.62	£86.94	£85.81	**£62.12**	£62.12
Theatre staff costs	mid-point of salary scales plus employers contributions to pensions and NI				
Theatre consumables	Extensive list of items - not presented here				
Grafts - tube	**£211.32**	£135.13	**£211.32**	£287.50	£211.32
Grafts - bifurcated	**£402.70**	£405.39	**£402.70**	£400.00	£402.70
Blood products					
Full Blood			£78.88		
Platelets			£141.93		
FFP			£18.47		
Cryoprecipitate			£22.31		
HAS 4.5%			£41.06		
HAS 20 %			£36.49		
Handling charges per unit of blood	£3.94	£10.00	£3.55	£3.94	£5.36
Handling charges per unit of other products	3.00%	£3.00	**average**	3.00%	--
Surgery and ward drugs					
Pharmacy overheads	**24%**	18%	31%	23%	24%
Hospital discounts	36.15%	41.69%	**38.31%**	37.10%	38.31%

A Practical Example of a Costs Measurement Model

In-hospital post-surgery					
Day on ITU post surgery	£1,100	£1,727	£782	£975	£1,146
Day on surgical ward post surgery	£205	£165	£84.22	£74.49	£132
Day on HDU ward post surgery	£338.15	£338.15	£338.15	£338.15	£338
Inpatient investigations					
Echo	£255.00	£118.09	**£141.00**	£50.00	£141
CT scan	£136.00	£129.00	£330.00	£60.00	£164
Ultrasound	£50.00	£38.00	£45.00	£32.00	£41
Chest x-ray	£31.00	£15.00	£24.00	£10.00	£20
ECG	£30.00	£39.71	£33.00	£20.00	£31
Aortagram	NA	**£163**	NA	£163.00	£163
MUGA	£319	NA	NA	NA	£319
Angiogram	£163	NA	**£163.00**	NA	£163
Exercise stress test	£96	NA	NA	**£96.00**	£96
Duplex scan	£77	NA	NA	£93.00	£85
Arteriogram	NA	NA	**£275.00**	£275.00	£275
Post hospital discharge					
Follow-up surgical outpatient clinics	£83	£85	£65	£20	£63

Recommended readings

HEADS



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