Cost-effectiveness Particle Therapy

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Content

- cost PT and reimbursement
- efficacy PT
- health economics: some basics
- different approaches
- cost-effectiveness PT: current results
- future needs

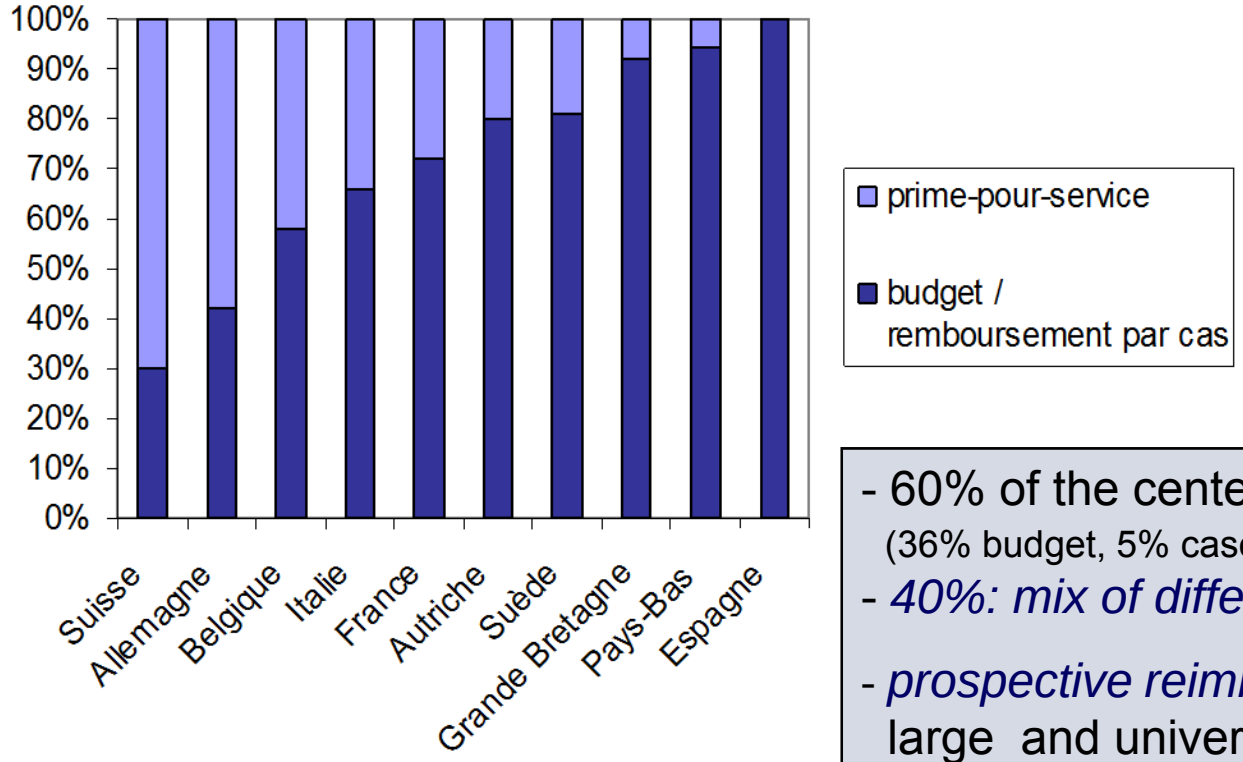
Costs radiotherapy

- Relatively cheap: 5% of costs of global oncology budget (about 3000 euros for standard treatment)
- Increasing complexity will translate in higher costs
  - Charged Particles
  - About 2.4 (Goitein&Jermann, 2003) of highly sophisticated photon beam treatments (IMRT)
  - Between 11.000-35.000 euros, average 25.000 euros

Costs

- Construction (capital)
  - project management, equipment, building, treatment infrastructure (CT, TPS etc.)
- Operation costs
  - personnel, utilities, maintenance, business cost
- Unit cost of treatment/cost per fraction
  - depending on construction/operation costs and reimbursement system (agreements government/health insurances: can be highly variable between countries/regions)

Western European radiotherapy centers



- 60% of the centers: 1 system
  (36% budget, 5% case payment, 15% FFS)
- *40%: mix of different systems*
- *prospective reimbursement*: large and university centers

Lievens, R&O 2000

Cost model (project Etoile)

What are the total cost for each protocol … for the hospital point of view*?

⇨ to discuss the reimbursement

Per patient? Per session?
Specific for preparation & irradiation phases?
Reimbursement per "protocol"? ../..

*** Costs for transportation, hospitalisation, associated therapies… excluded**

Mean cost per patient and per session

Scenarios	« Ref»	Boost	Exclusive	hypofraction	Reduced session duration	1 beam/ session	1 shift
Patient (€)	**21,000**	19,805	**26,122**	17,287	17,033	13,114	**33,194**
Session (€)	**1600**	1650	1462	**2055**	1287	1018	2534

Scenarios for the simulation:

- « boost » vs. « exclusive » C ion therapy
- 13 vs. 10 mean # of sessions per patient
- mean session time duration: 30 vs. 20 min
- Mean # of beam per session: 2.3 vs 1

higher costs worthwhile?

Systematic literature review: no firm conclusions about clinical or cost-effectiveness protons of C-ions could be drawn [1,2]

1. Brada M, Pijls-Johannesma M, De Ruysscher D. Proton therapy in clinical practice: current clinical evidence (JCO, vol.25(8), 2007)

2. Lodge M, Pijls-Johannesma M, Stirk L, Munro AJ, De Ruysscher D, Jefferson TO. A systematic literature review of the clinical and cost effectiveness of hadron therapy in cancer (accepted R&O, 2007)

where do we expect a gain?

- less side effects
- less relapses: cost-sparing palliative treatment
- reduction late morbidity
- improvement in QoL
- less secundairy cancer inductions
- …

Health Technology Assessment (HTA) Why??

- To provide evidence-based information about aspects and consequences of the (new) medical technology
- Calculating healthcare costs
- Cost control/management and efficiency
- Strategic decision for budget allocation

main problems with HTA

- often difficult to interpret by non HTA-researchers (like clinicians, physicists, policy-makers, etc)
- often performed with inadequate methodology
- no uniform terminology (e.g. often incorrect use of term cost-effectiveness analysis)
- problems with transferability (often only applicable to specific country/region)

Economics: some basics

How <u>societies</u> meet their <u>wants</u> from <u>limited resources</u>

Three key questions:

- **What** should we produce?

  VALUE

- **How** should we produce what is to be produced?

  EFFICIENCY

- How to **distribute** what is to be produced between individual citizens?

  FAIRNESS

What is efficiency?

1. Technical efficiency
   - do not waste resources

2. Allocative efficiency
   - produce products which people value most

3. Cost–effectiveness
   - produce each product at least cost

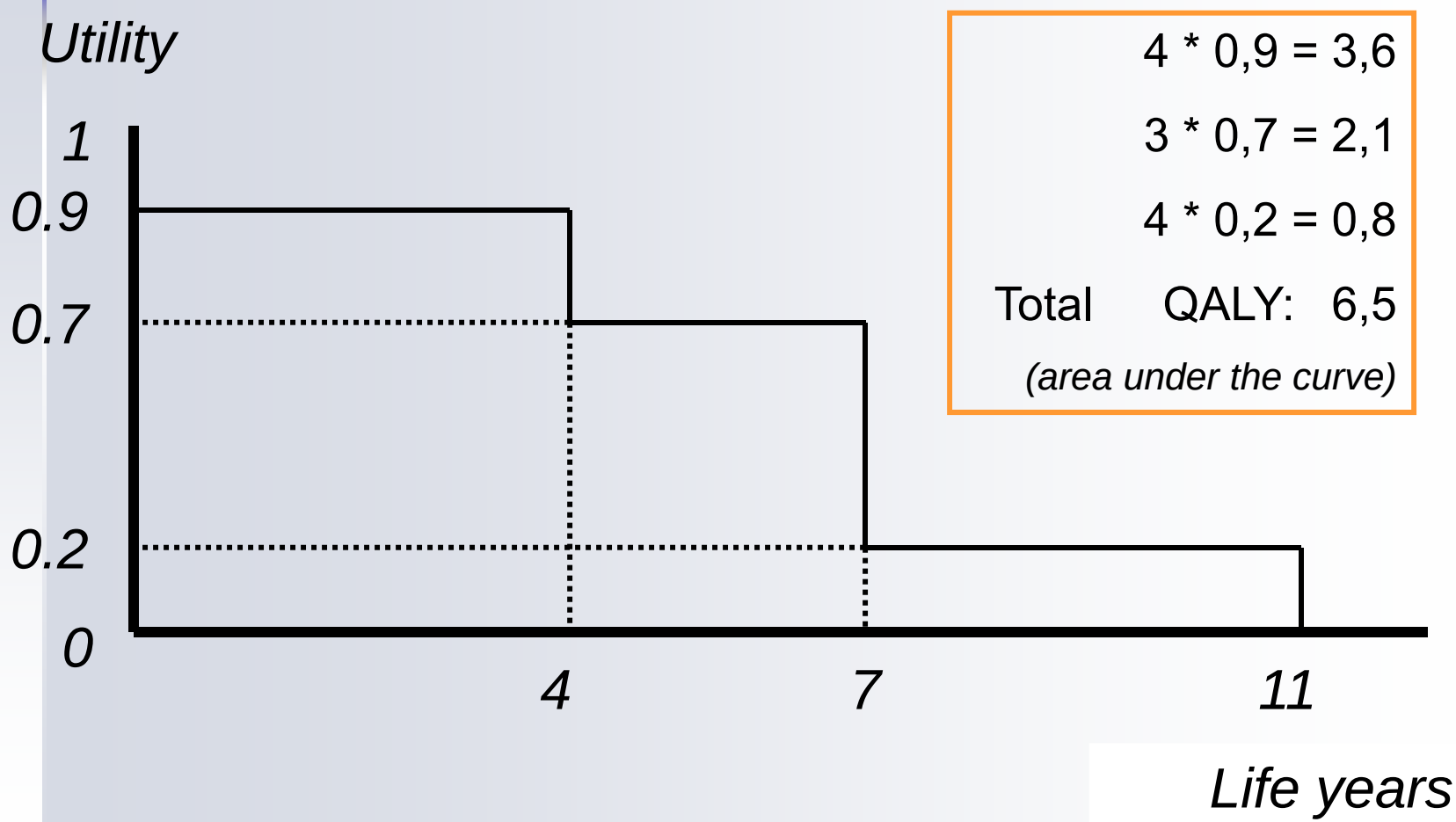
Tool to assess efficiency: economic evaluation

		Are both costs (input) and effects (output) examined?		
		No		***Yes***
		Only effects	*Only costs*	
Is there a comparison of two alternatives?	***No***	Outcome description	Cost description	Cost outcome description
	Yes	Efficacy or effectiveness	Cost analysis	Full economic evaluation*

Types of full economic evaluation

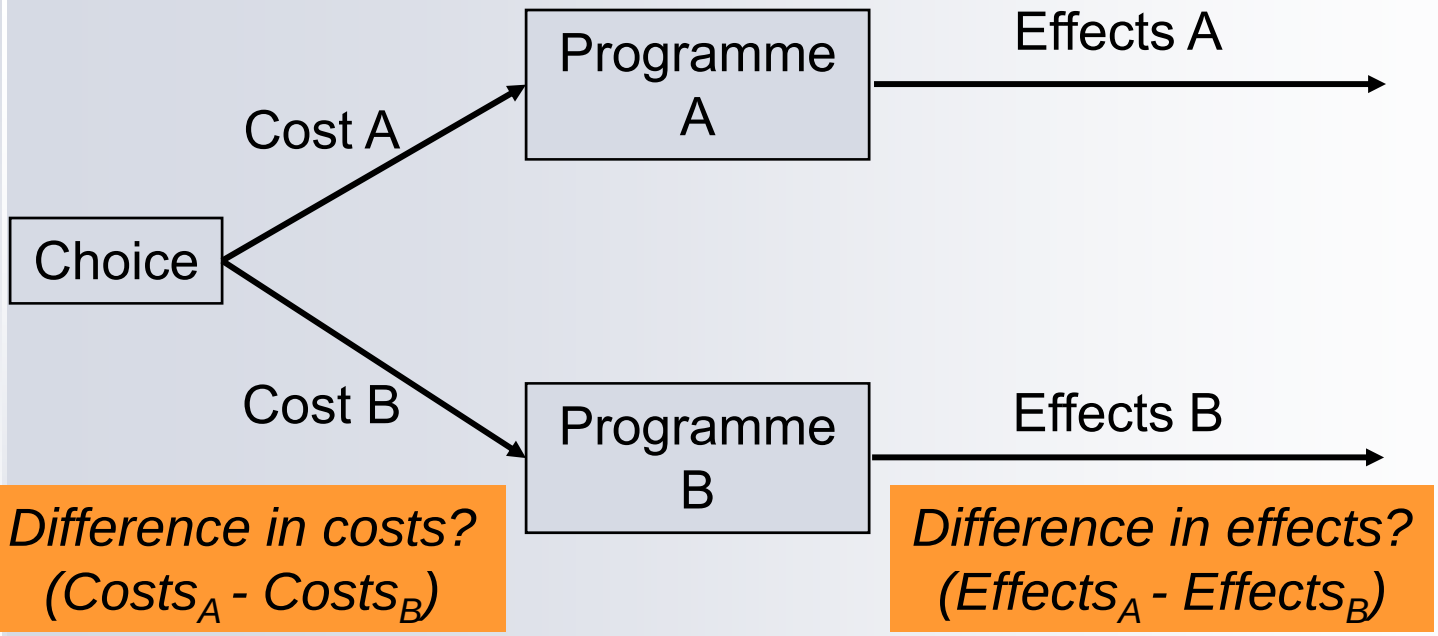
Method	Costs	Effects
Cost-minimisation analysis (CMA)	Monetary units (€)	No difference in effects
Cost-effectiveness analysis (CEA)	Monetary units (€)	Natural units (life years gained, point blood pressure, etc)
Cost-utility analysis (CUA)	Monetary units (€)	Utilities and Quality Adjusted Life Years (QALYs)
Cost –benefit analysis (CBA)	Monetary units (€)	Monetary units (€)

Quality Adjusted Life Year

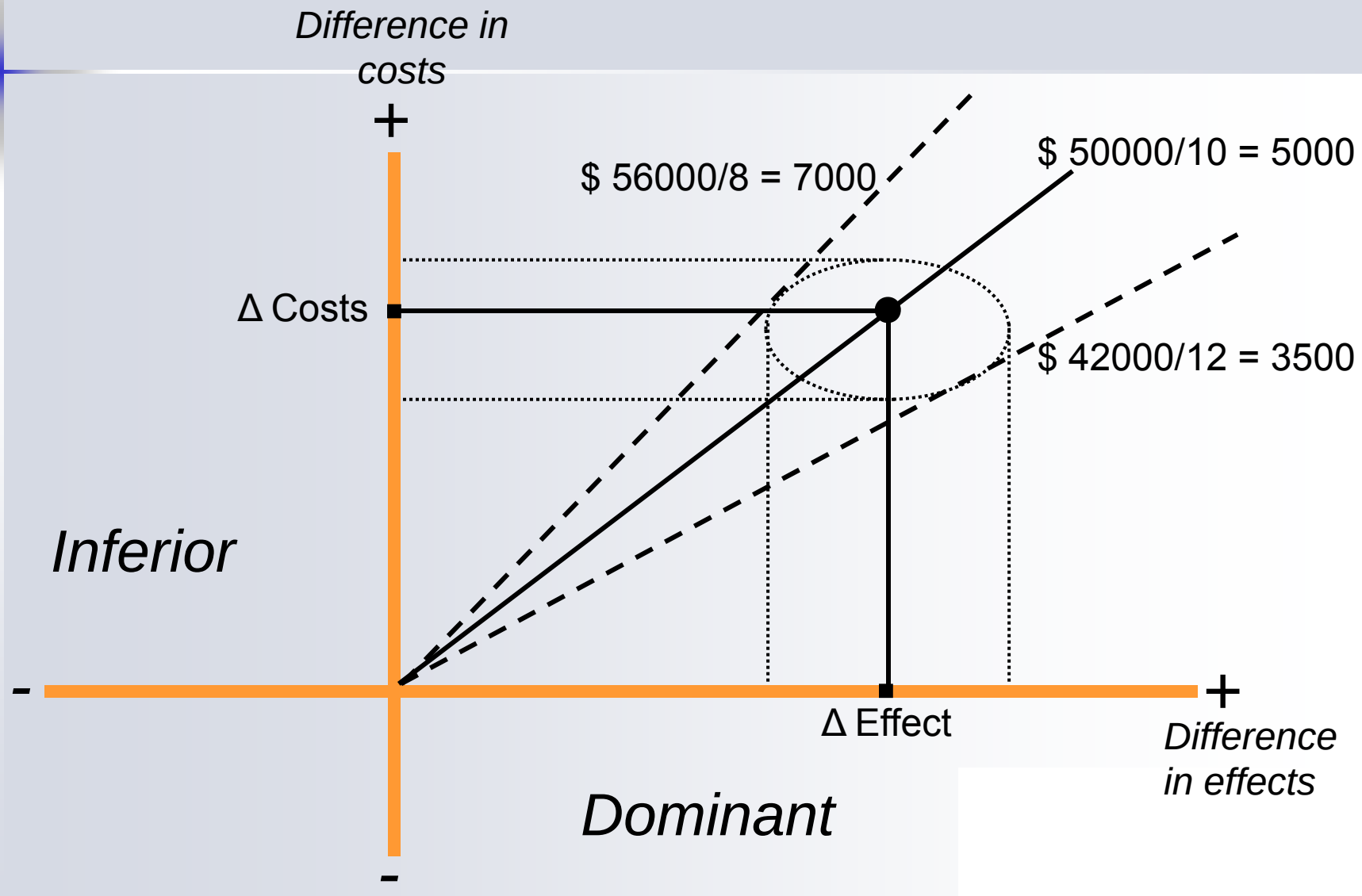


Full economic evaluation: Relevant costs and effects for each alternative (using the same methodology)

Incremental cost-effectiveness ratio: $(Costs_A - Costs_B)/(Effects_A - Effects_B)$



Incremental analysis



Cost-effective or not?

€5000/ QALY or LYG acceptable?

YES!!

Depending on benchmarked (varies between countries between 20.000-100.000 euros)

ceiling-ratio of €50.000 is often used

Study design: two approaches

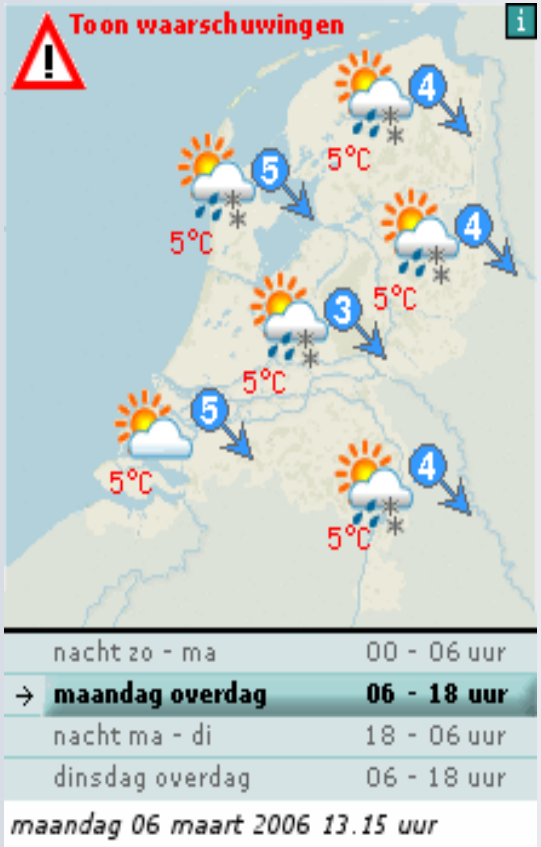
- Trial based economic evaluation
  - Use economic data collected alongside a single trial
  - Only right approach if the trial truly reflects the decision context
- Model based economic evaluation
  - Use a model as an analytical framework to synthesize evidence relevant to the decision problem from different sources

A model is a ‘simple’ reflection of former, current or future reality

Current reality ??

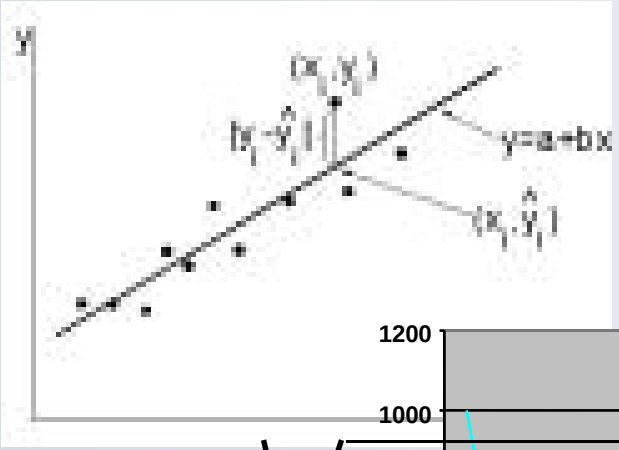
Current reality

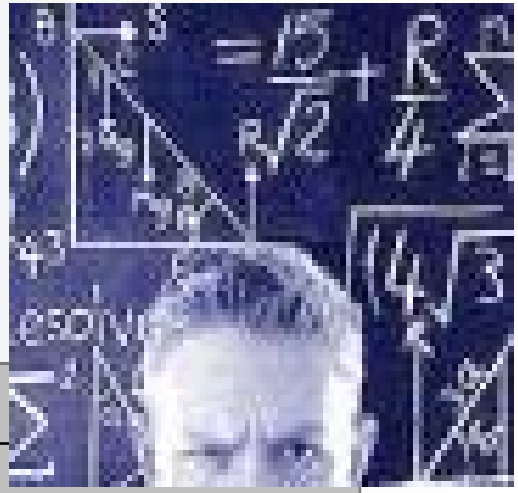
Future reality



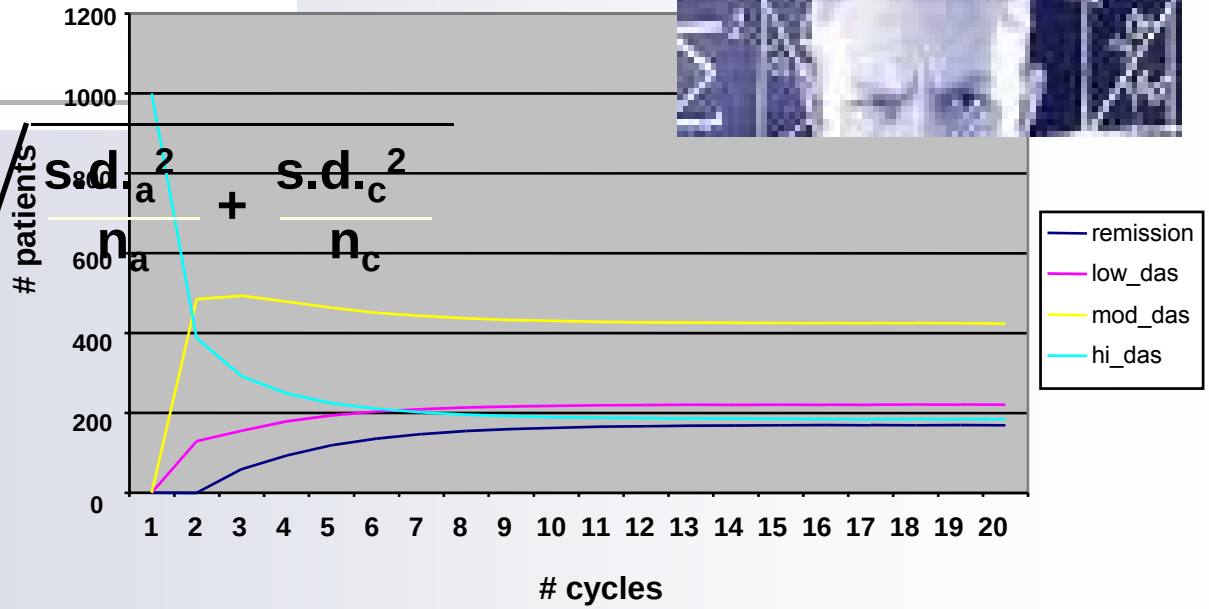
Models in health care:
support decision for future course of action

Mathematical models





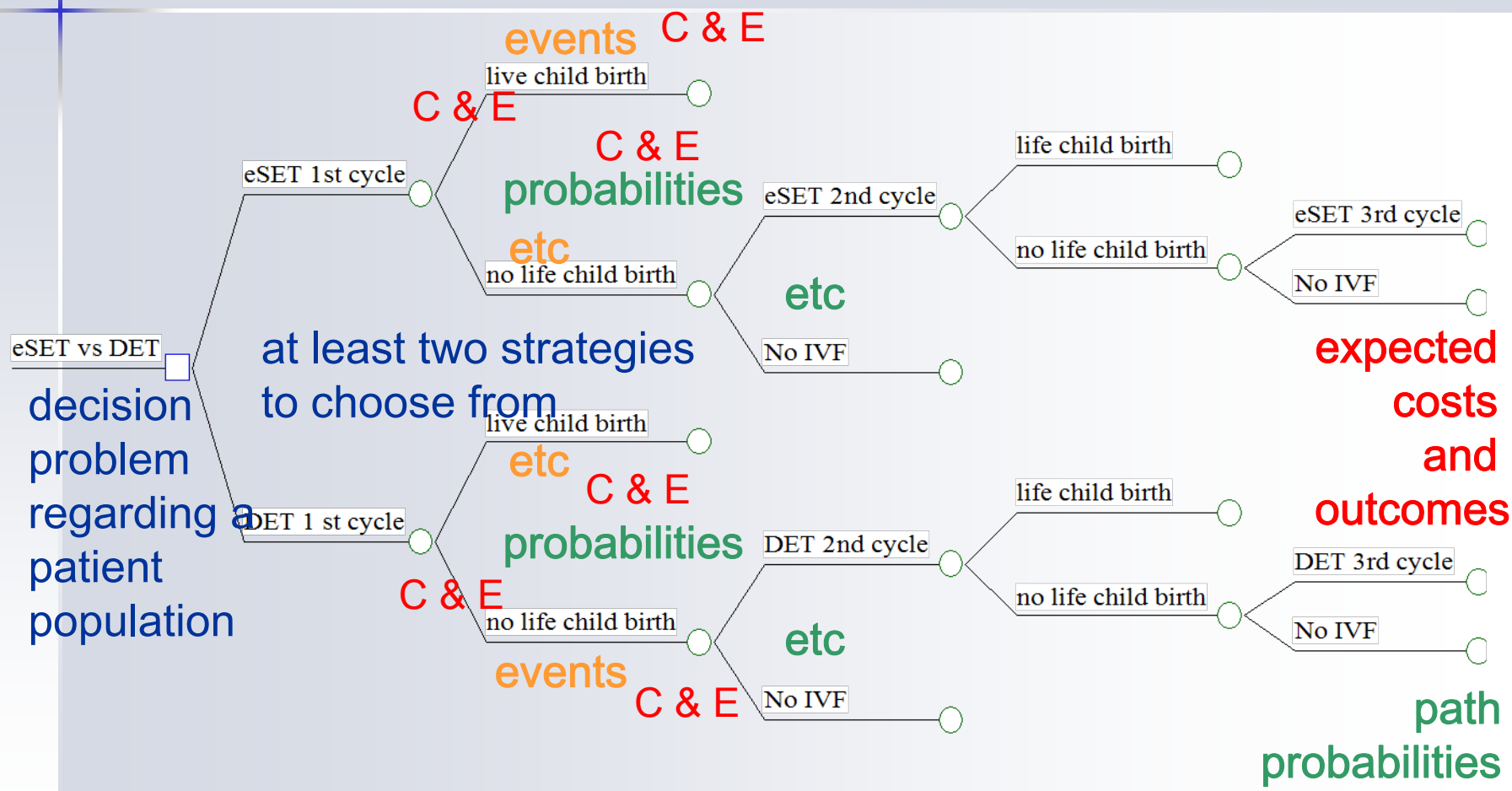
$$(X_a - X_c) +/- 1.96 * \sqrt{\frac{s.d._a^2}{n_a} + \frac{s.d._c^2}{n_c}}$$



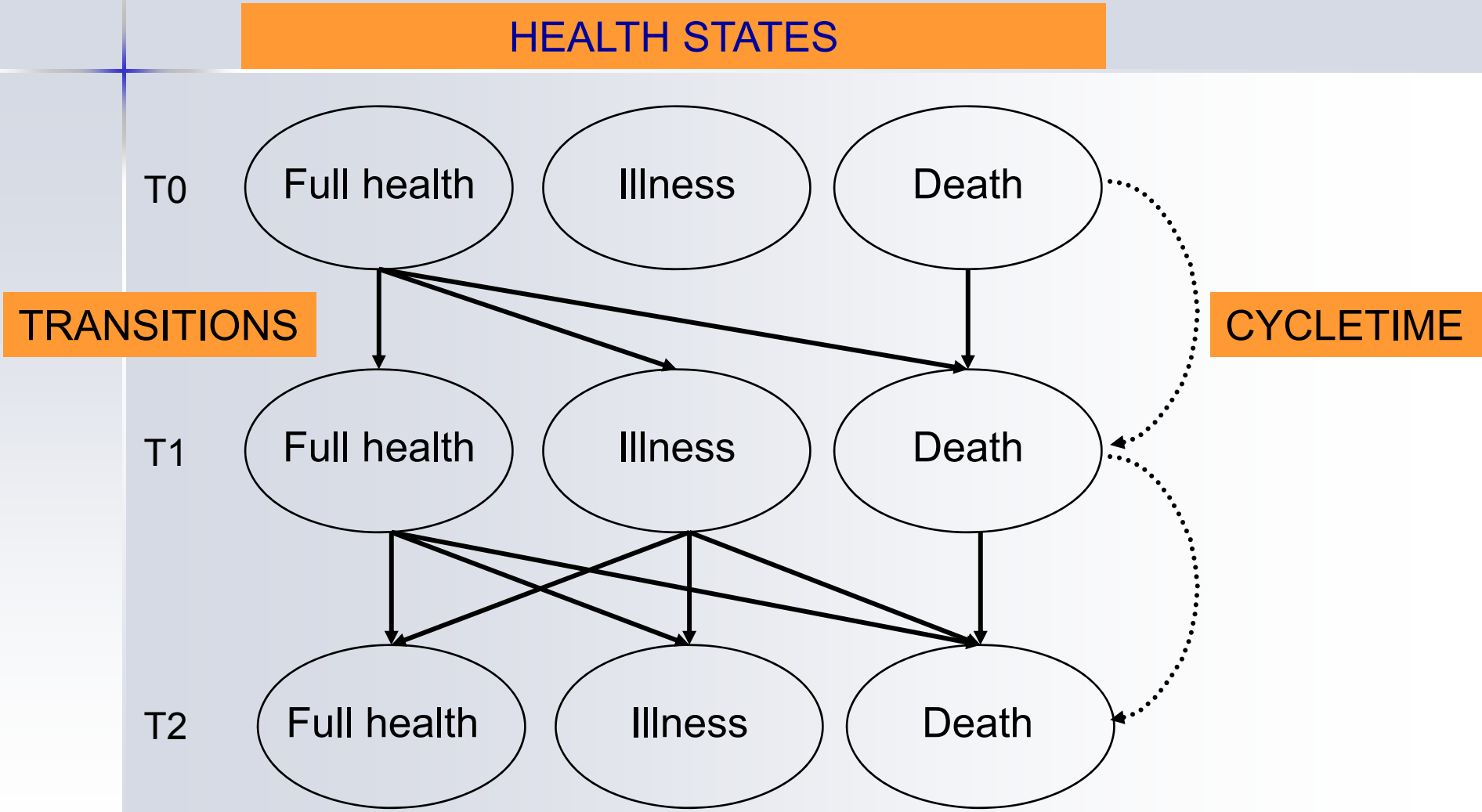
Different approaches

- Decision tree
- Markov model
- Discrete event simulation

Decision tree



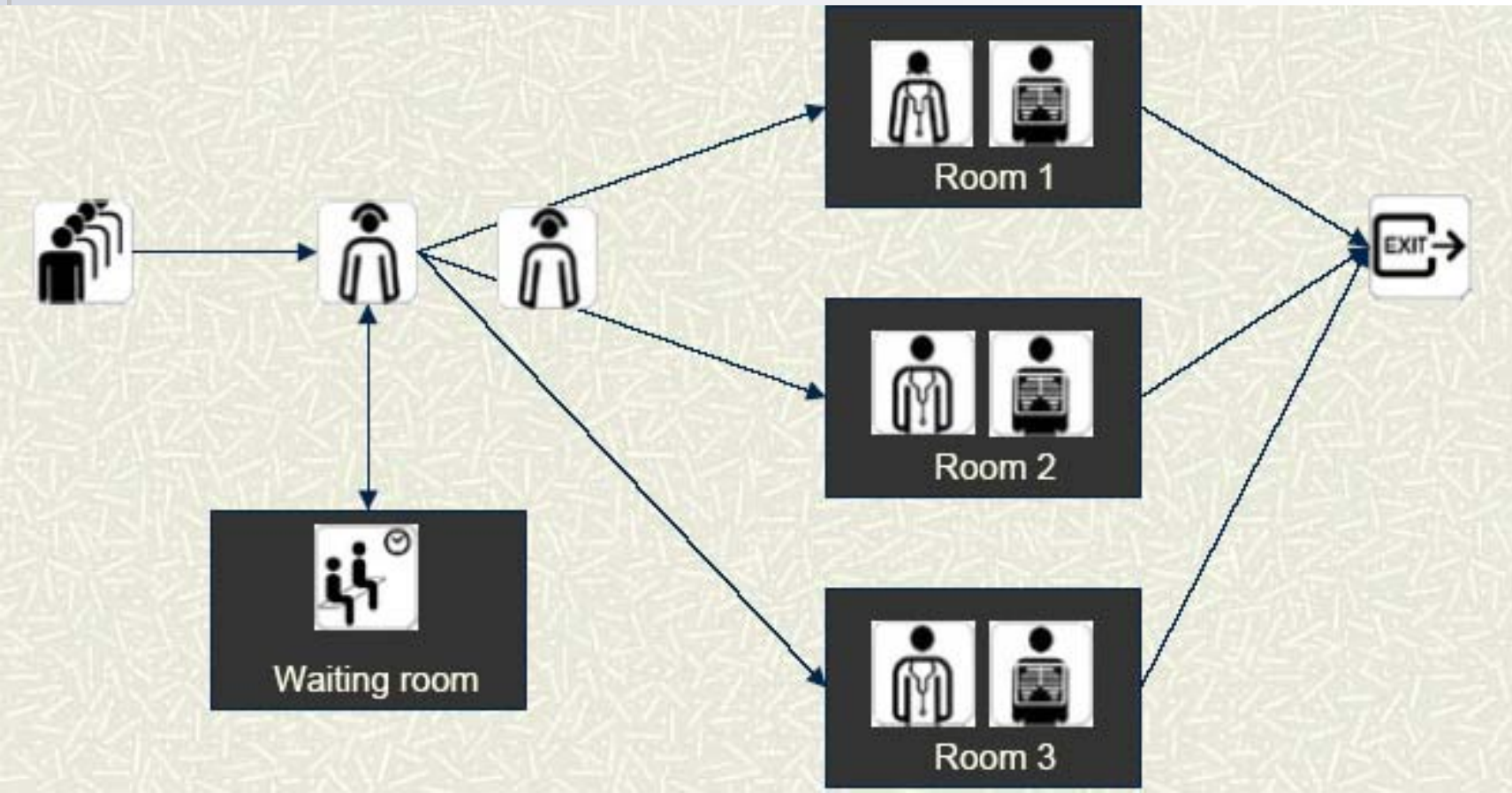
Markov model



Simulation models

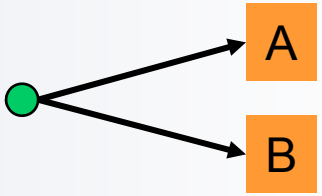
Discrete event simulation:

How much time does it take for an event to happen?

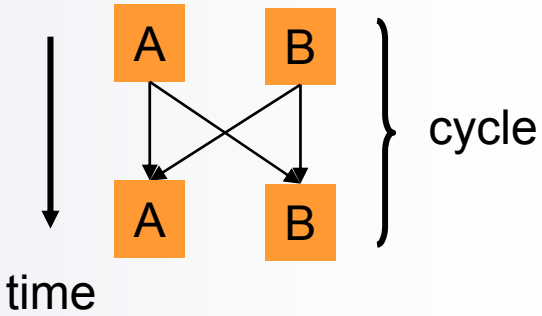


Comparison

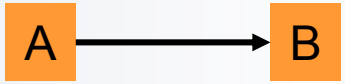
- Decision tree
  - What is the probability of A?



- Markov model
  - What is the transition probability of A to B within one cycle?



- Discrete Event Simulation model
  - How long does it take for B to happen, given A?



Courtesy to Aukje van Gestel, dept. Ophtalmology, university hospital Maastricht

current literature on "cost-effectiveness"

- so far, only 14 papers on economic evaluation of PT were identified [2]
- only 4 reported on cost-effectiveness [3-6]

3. Lundkvist J, Ekman M, Ericson SR, et al: Economic evaluation of proton radiation therapy in the treatment of breast cancer. Radiother Oncol 2005:179-185
4. Lundkvist J, Ekman M, Ericson SR, et al: Cost-effectiveness of proton radiation in the treatment of childhood medulloblastoma. Cancer 2005;103:793-801
5. Lundkvist J, Ekman M, Ericson SR, et al: Proton therapy of cancer:potential clinical advantages an cost-effectiveness. Acta oncol 2005;44:850-861
6. Jaekel O, Land B, Combs SE et al: On the cost-effectivness of Carbon ion radiation therapy for skull base chordoma. Radiother Oncol 2007: in press

some results

- CUA based on Markov model for breast, prostate, H&N and medulloblastoma [5]:

  average cost QALY ≈ € 10.130
- CEA skull base chordoma [6]:

  € 7692 per LYG (life year gained)

  both studies high level of uncertainty: many assumptions, non-optimal methodology

future perspective in effectiveness of PT

- more hospital based facilities
- improvement in equipment
- number of treated patients will be increase
- possibilities to perform high quality international multicentric research (RCT's ??)
- likely to expect clinical evidence on efficacy in future

What do we need NOW to prove EVB effectiveness?

- model based economic evaluations
- with an adequate methodology
- multidisciplinary project team
- as much real data to decrease uncertainty
- long term effects from broad health care perspective