Discrete Event Simulation or Markov Model: War of The Worlds or Expanding the Galaxy?

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ISPOR - 11th Annual European Congress, Athens, 2008

THE UNIVERSITY of York

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Discrete Event Simulation or Markov Model: Why Build a Rocket when a Bicycle will do?

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Why do we model?

- To inform decisions about resource allocation
- Therefore models should deliver:
  - Expected costs and health effects
  - For all options
  - Relating to appropriate population and sub-populations
  - Based on full range of existing evidence
  - Quantification of decision uncertainty
  - Valuation of further research
- In a timely manner to support decisions

Approximations are unavoidable in modelling

"Remember that all models are wrong; the practical question is how wrong do they have to be to not be useful."*

The search for 'absolute accuracy':
- Adds complexity
- Imposes costs (evidence gathering, computation time)
- Complicates communication
- Need to justify in terms of better decisions

* Box and Draper (1987). *Empirical Model-Building and Response Surfaces*, p. 424, Wiley.

Managing complexity in cost-effectiveness analysis

Analytical issue	The ideal	The pragmatic
Choice of comparators	All existing ways of managing the relevant patient group	Most widely used; those with a reasonable chance of being cost-effective
Evidence gathering	Exhaustive search for all sources of evidence for every parameter in the model	Reproducible search; comprehensively related to importance of parameter

Managing complexities in model structure

- **What's the ideal?**

A model structure able to reflect every potential effect of alternative interventions, and exactly capture every feasible prognostic implication of those effects for every type of patient

- **What are the implications**?

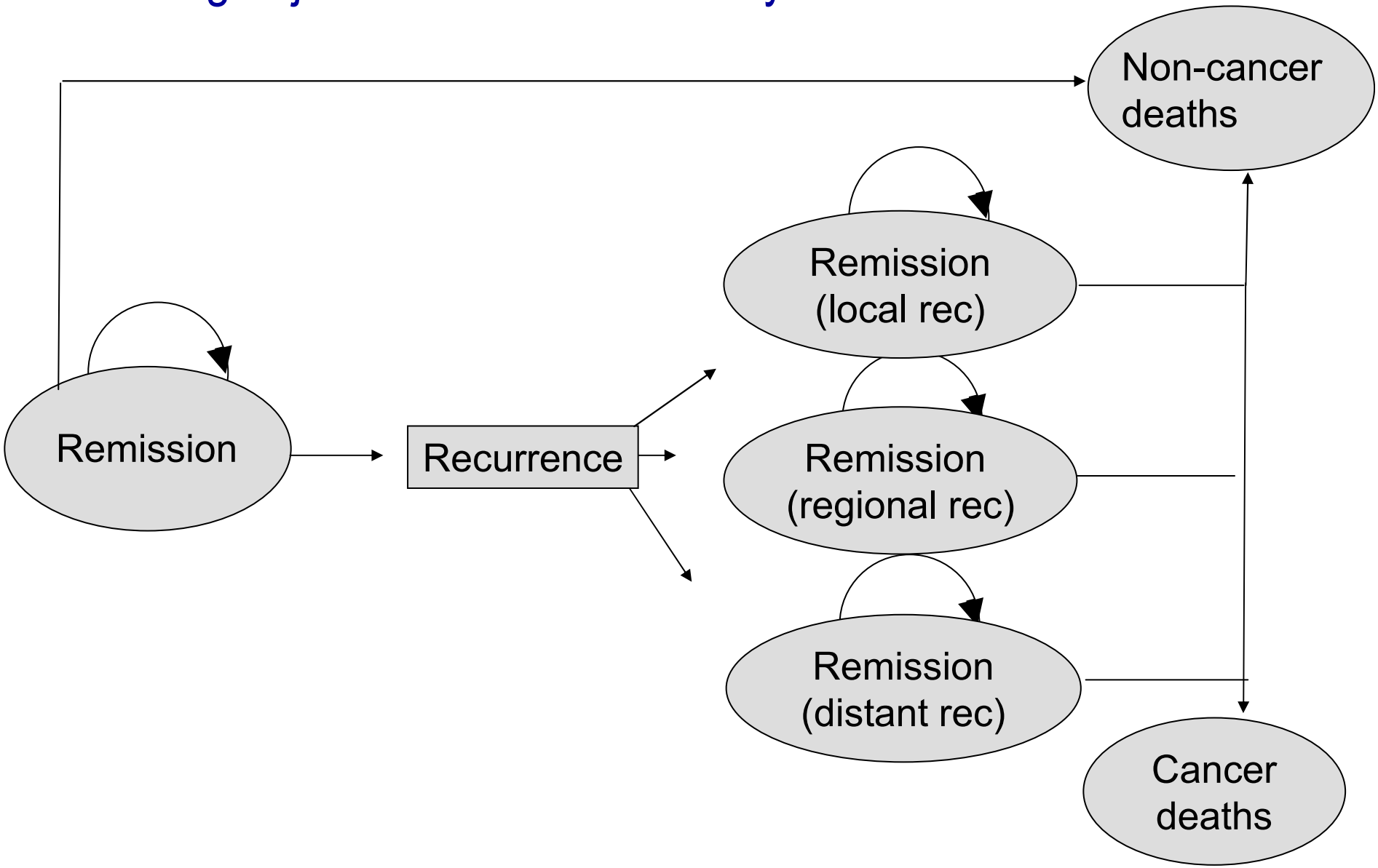
Huge number of parameters to estimate from available evidence imposing very high search and computation costs

- **What's sufficient?**

A model capturing the major characteristics of a disease and intervention, providing guidance on the adoption and research decisions and able to reflect the robustness of the decisions to added complexity

An example

Modelling adjuvant treatment for early cancer



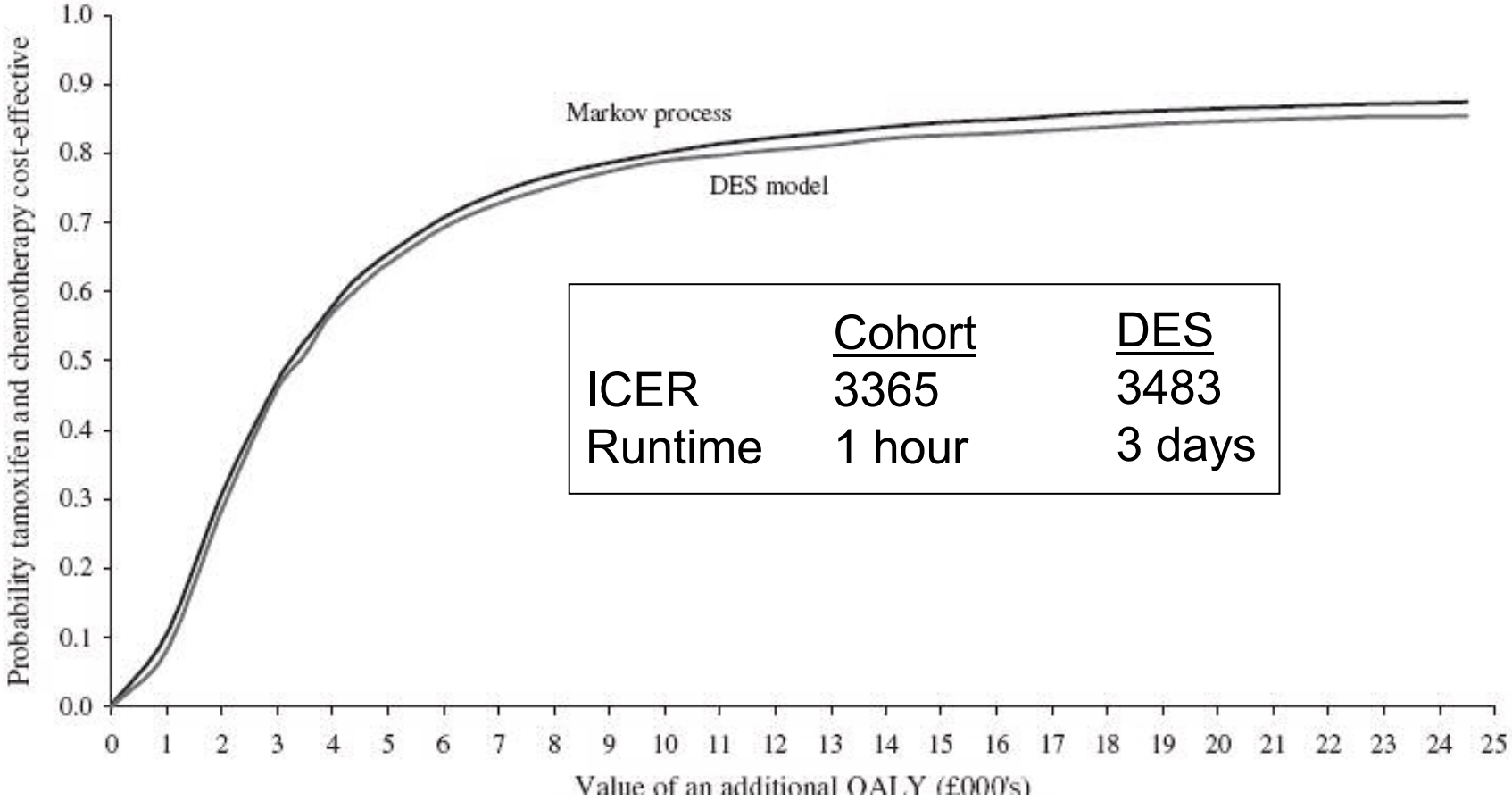
Where might we want to add complexity?

Issue	**Modelling response**	**Evidence?**	**DES?**
Baseline characteristics affect prognosis	Make relevant parameters conditional on baseline characteristics	Parameters by sub-group	No
Rate of 1st recurrence varies with time	Incorporate time dependent transition probabilities	Rates by time	No
Side effects of treatment	Are they prognostic? Are the effects additive or multiplicative with cancer	Additional parameters	Possibly
Post recurrence prognosis exhibits time dependencies and/or heterogeneity	Wrap up as mean prognosis; add additional states	Additional parameters	Possibly

Implications of moving to a DES

- Evidence
  - Need risk of mortality/future cancer events as a function of time from recurrence and/or characteristics at recurrence
  - Mean values plus uncertainty
  - Will this vary by treatment?
- Computational
  - In non-linear models, need two levels of simulation to estimate expected costs and effects
  - Two levels required to quantify decision uncertainty (PSA)
  - Multiple levels of simulation to implement value of information methods
  - Potentially millions of simulations
- Will the adoption and research decisions be influenced by added complexity?

Evidence on DES versus cohort models



	Cohort	DES
ICER	3365	3483
Runtime	1 hour	3 days

Karnon, *Health Economics* 2003;12:837–848

Pragmatic way forward?

- All analyses should reflect nature of decision problem, available evidence and requirements of decision making
- Compelling case to start simple (typically cohort)
- What are the marginal costs and benefits of adding complexity in evidence?
- Marginal effects: will added complexity alter decisions?
- *Prima facie* case DES for some decision problems:
  - Build two model structures
  - Do deterministic results differ markedly and importantly?
  - If so, move to DES for uncertainty and sub-group analysis
  - If not, stay with cohort for uncertainty and sub-group analysis