Economic Evaluation
(How to do?)

Online Workshop On Health Economics

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Outline

➢ Economic Evaluation: Brief Recap

➢ Methods for Economic Evaluation
   ❖ Trial Based
   ❖ Model Based

➢ How to use Decision Trees

➢ How to use Markov Models

➢ Endpoints of Economic Evaluation

➢ Uncertainty in Economic Evaluation

Examples

Economic Evaluation

➢ The comparative analysis of alternative courses of action in terms of both their costs and consequences

➢ It is NOT

  ➢ A form of accountancy

  ➢ Cutting costs

  ➢ Cost of illness

  ➢ Burden of illness

Data Source

➢ Sometimes data for undertaking economic evaluation can be collected in a single RCT

➢ More often multiple data sources needs to be integrated and outcomes extrapolated using a decision analytic model.

How to undertake an Economic Evaluation?

- ➢ Randomized controlled trial

- ➢ Decision model

- ➢ Both

RCT: Incomplete Solution?

➢ Clinical efficacy vs Real-world effectiveness?

➢ Can we compare results from RCT based CEA to CEA of other

clinical conditions?

➢ Is the time horizon appropriate?

➢ Have all available options been compared?

Are the results generalizable?

Randomised Control Trials

Advantages

➢ Quality data on clinical effectiveness

➢ Possible to collect the economic data for economic evaluation

  ❖ Health-related quality of life
  ❖ Resource use and costs

Disadvantages

➢ Typically short follow ups
   (6 months to 2 years)

➢ Does not guide for what happens beyond trial

➢ Does not use other available information for health technology/treatment etc.

More Reasons to Use Model

- Trial just one source of data, could be others

  - Model allows to synthesize information from all sources for a health technology

- Explore scenarios not explicitly found in data

- Accounts for how uncertainty in available evidence translates into decision uncertainty for a policy question under consideration

Difference in Approach

Characteristic	Approaches for undertaking economic evaluation	
	RCT	**Decision model**
Focus of assessment	Internal validity	External validity
Time horizon	Usually short – enough to estimate proximal clinical endpoints	Usually long – to comprehensively estimate downstream costs and consequences
Measure of outcome	Usually proximal clinical endpoint, eg. reduction in blood pressure	Utility-based measure such as quality-adjusted life year (QALY)
Number of comparators	Limited	No limitation

RCT: randomized controlled trial, QALY: quality-adjusted life year.

Gupta et al; 2019, Journal of Global Oncology

Summarising: Why use model?

Need to

➢ Compare all relevant options

➢ Reflect all relevant evidence

➢ Extrapolate beyond trial (over appropriate time horizon)

➢ Link intermediate to final endpoints

➢ Generalise in other settings

➢ Indicate uncertainty and future research

What is a Model?

➢ Analytical models are simplified description or representation of reality……
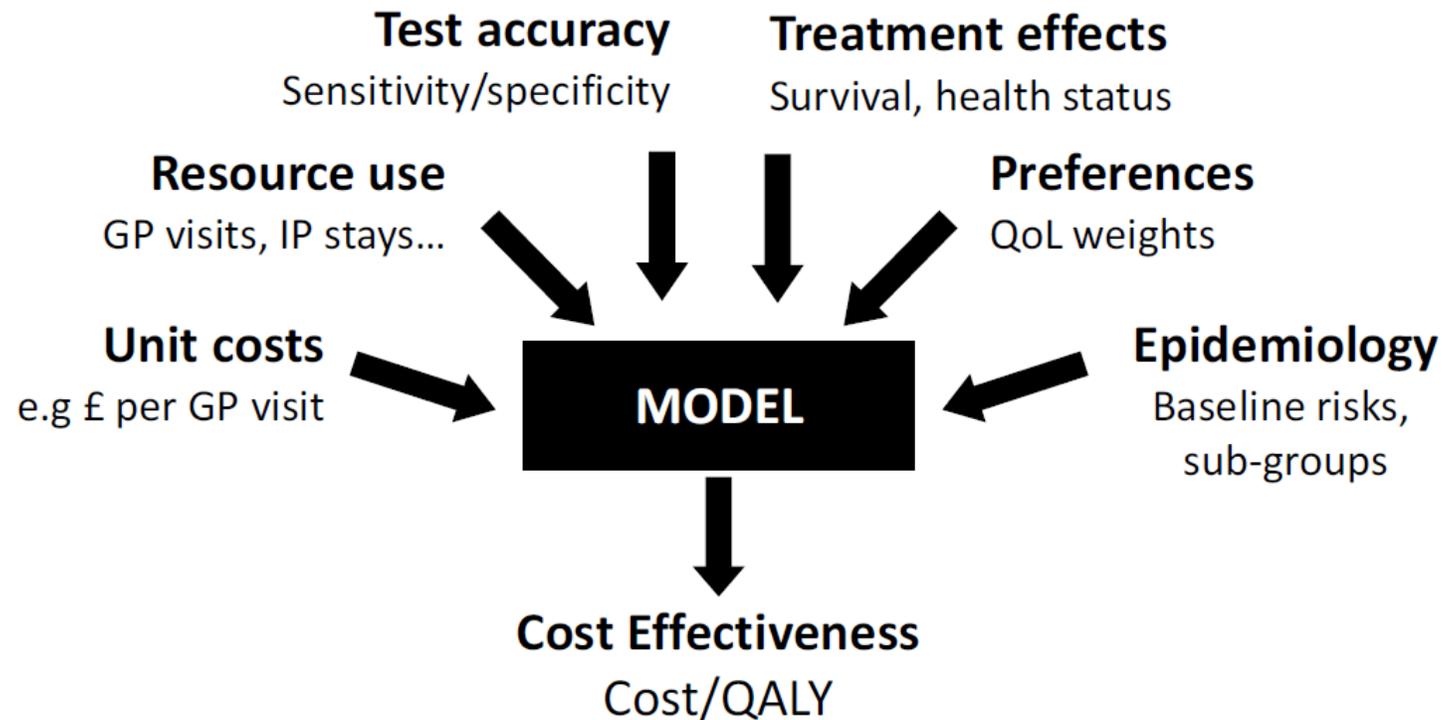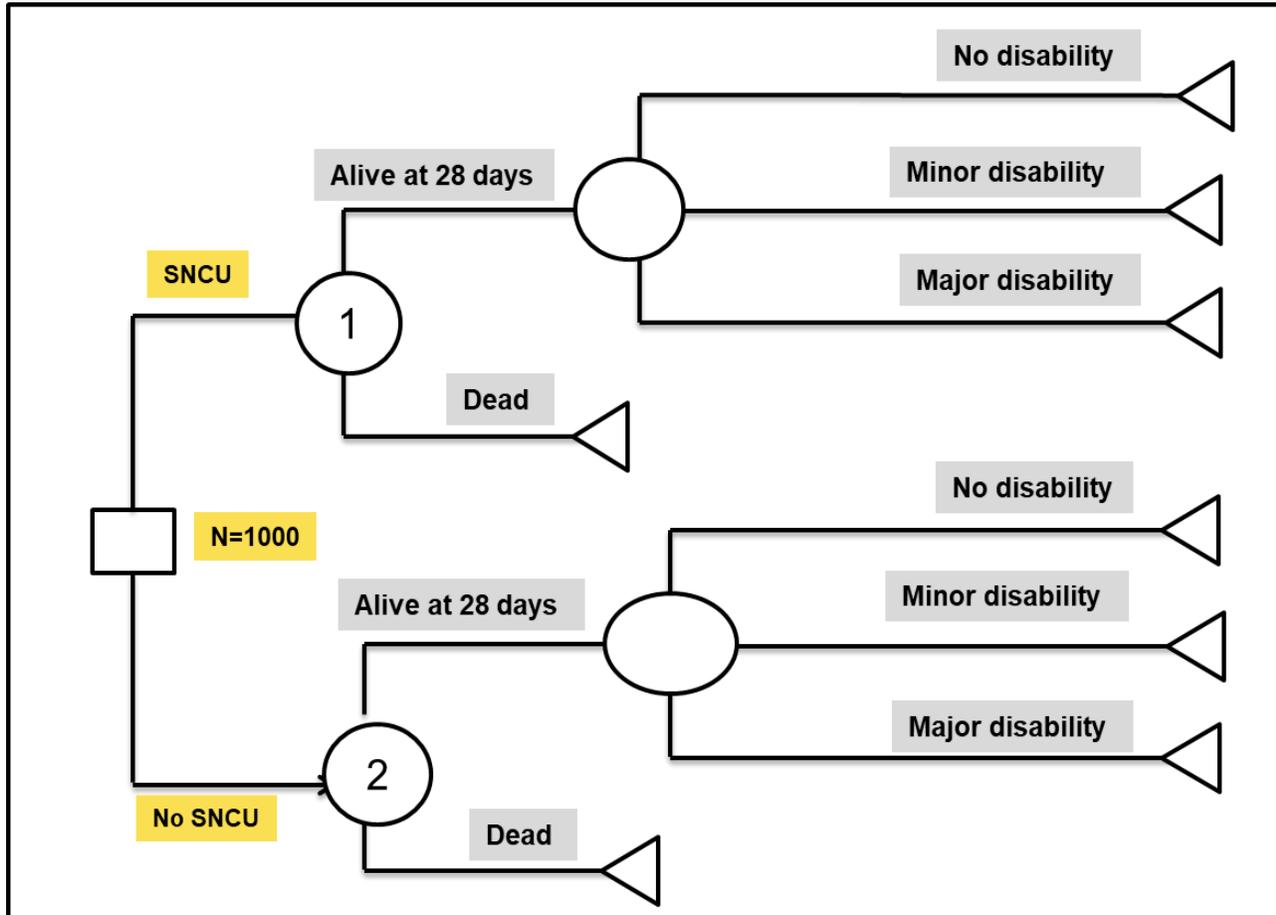
Decision Tree

Decision Tree....

	Costs (INR)	Benefits (QALY)
No disability 0.2, 818, 1 *64	163600	12800
Minor disability 0.3, 1024, 0.7*60	307200	12600
Major disability 0.2, 1200, 0.4 *55	240000	4400
No disability, 0.1, 1000, 1*64	100000	6400
Minor disability 0.1,1100, 0.7*60	110000	4200
Major disability 0.2, 1400, 0.4*55	280000	4400

Alive at 28 d (0.7)

SNCU

Dead (0.3)

N=1000

Alive at 28 d (0.4)

No SNCU

Dead (0.6)
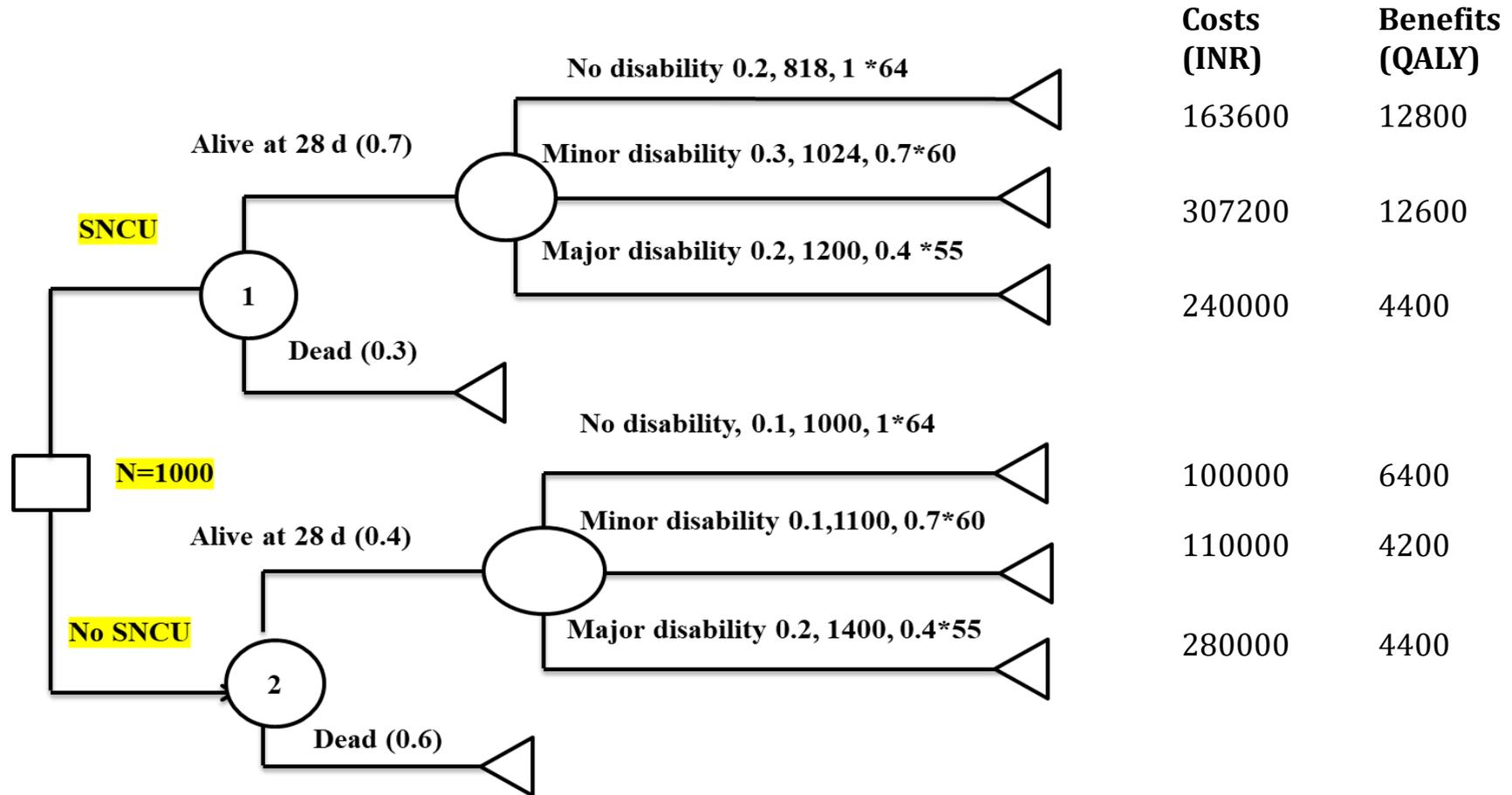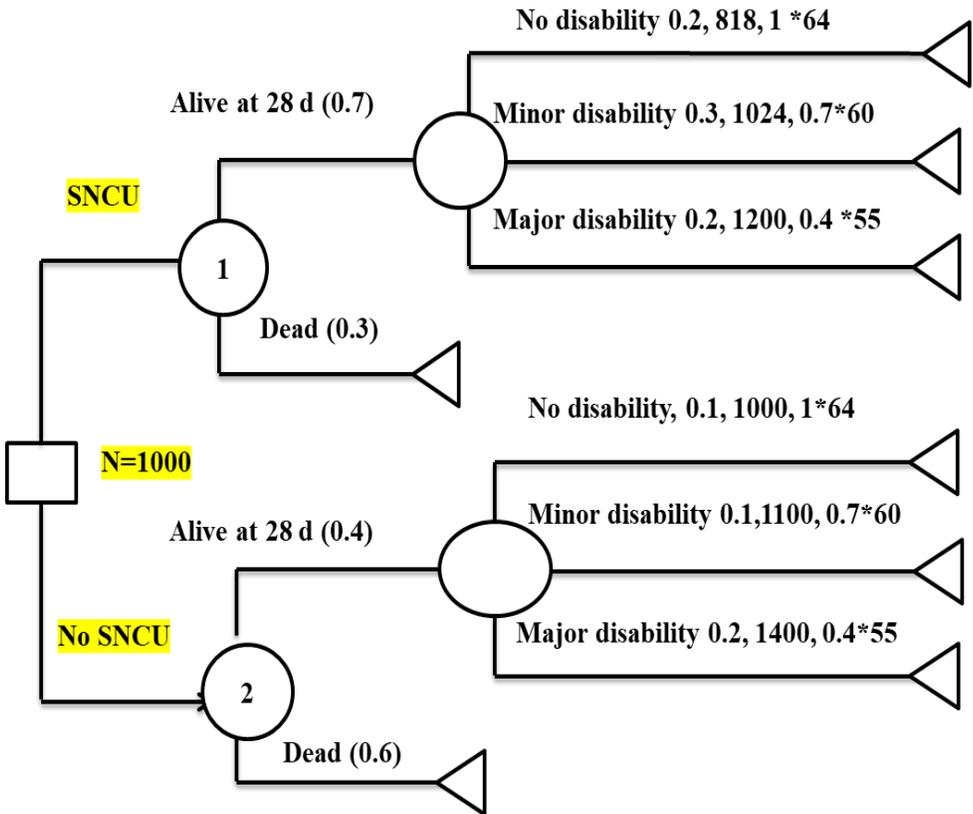
Decision Tree....

	SNCU	No SNCU	Difference
Costs (INR)	710,800	490,000	220,800
Benefits (QALY)	29,800	15,000	14,800
ICER (INR per QALY)	220800/14800 = 14.9		

Decision Tree: More Examples

Bahuguna P et al; 2019, Applied Health Economics Health Policy

Decision Tree: More Examples

Prinja S et al; 2015, Plos One
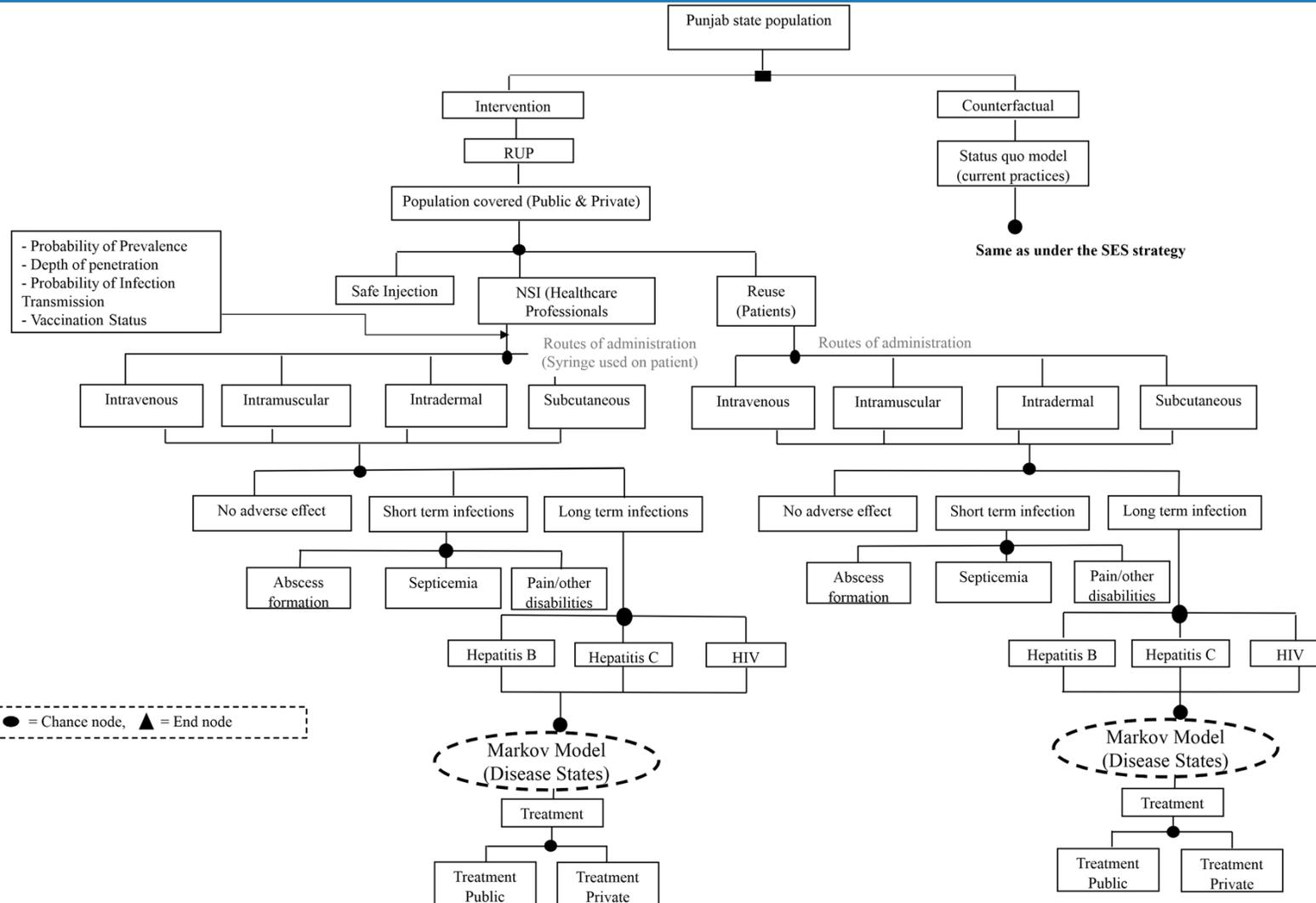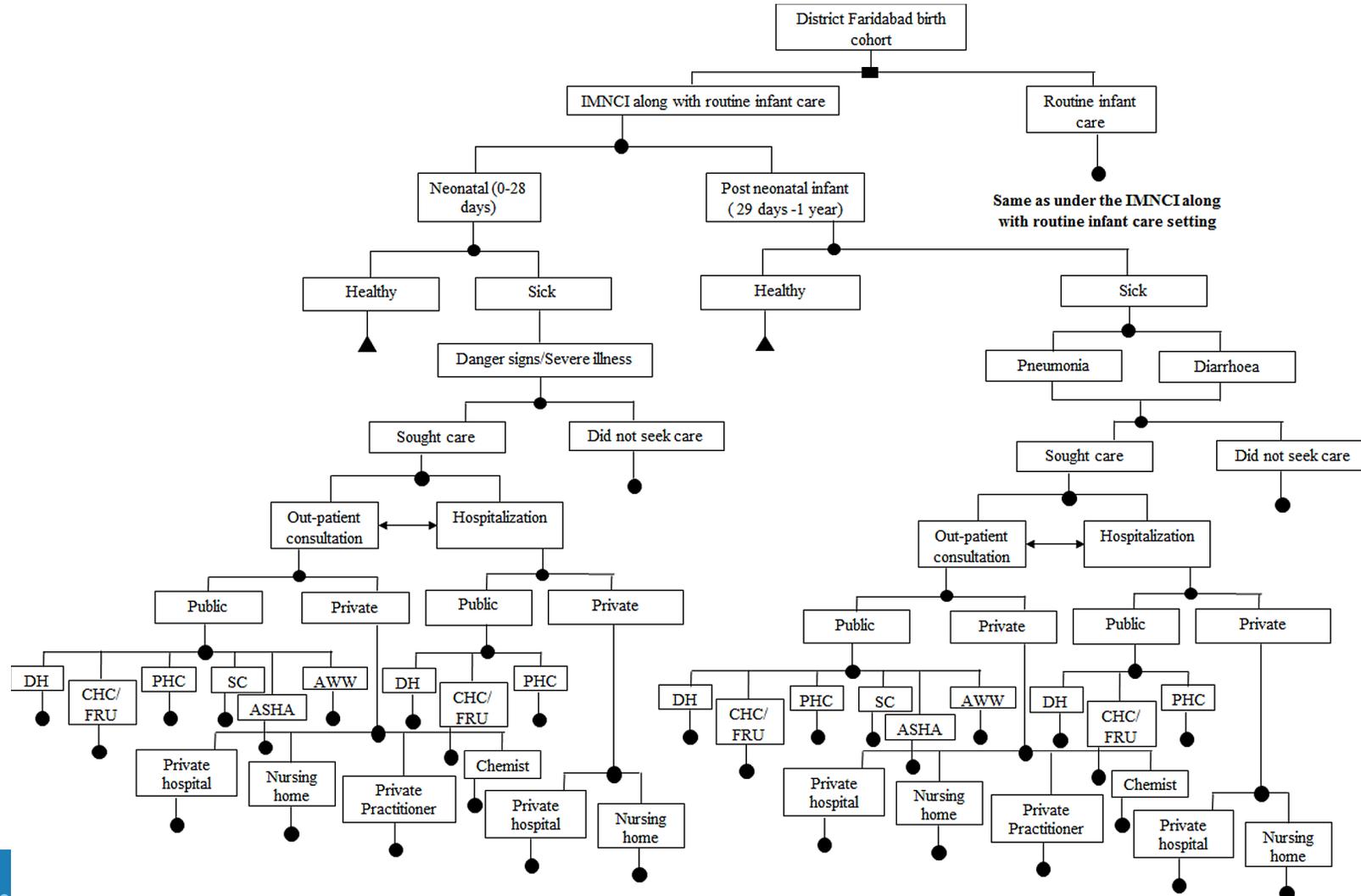
Limitations of Decision Tree

➢ Unidirectional flow of events

➢ Less suitable for chronic diseases

➢ No temporal element, everything happens at one time

➢ Can get bushy with greater detail

Markov Model

- Identify markov states or health states

- Choose length of cycle (days, week, month, year)

- Identify feasible transitions

- Ascertain initial and transition probabilities

- Attach costs and QOL to each health state

Markov Model: Example
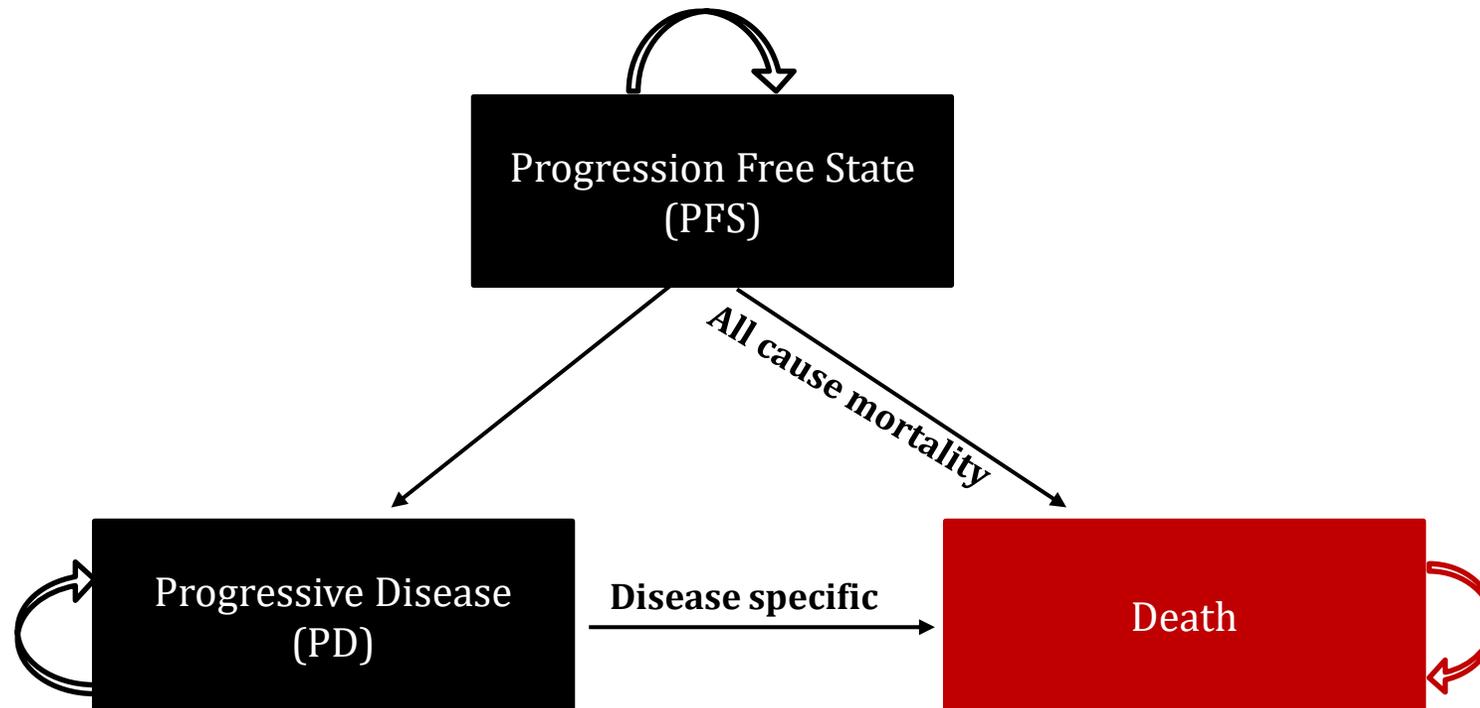
Transition Probabilities

➢ Probability of moving from one health state to another is transition probability.

➢ Transition probabilities (or probabilities) are key inputs for formulating the calculations pertaining to *Decision* and *Markov* model in a modelling exercise under economic evaluation.

Markov Model: Example
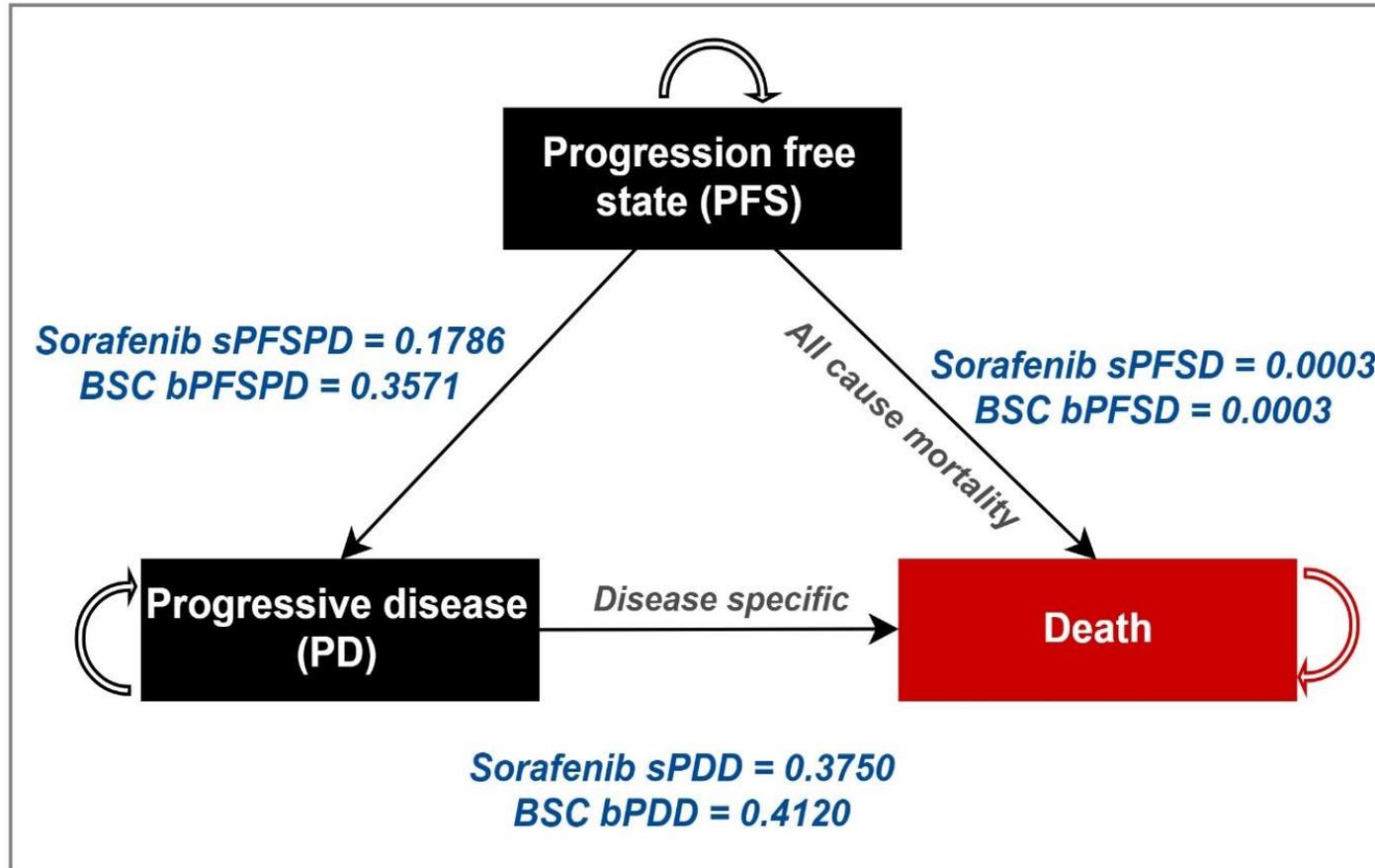
Markov Transition Matrix

		PFS	PD	Death from disease	All-cause mortality
				State going to	
State came from	PFS	1-sPFDPD-sPFSD	sPFSPD	0	sPFSD
	PD	0	1-sPDD	sPDD	0
	Death from disease	0	0	1	0
	All-cause mortality	0	0	0	1

Transition Probability Matrix: Sorafenib Arm

	PFS	PD	Death from disease	All cause mortality
PFS	0.8211	0.1786	0	0.0003
PD	0	0.6250	0.3750	0
Death from disease	0	0	1	0
All cause mortality	0	0	0	1

Cohort Simulation

Sorafenib (Intervention) Arm - markov cycle
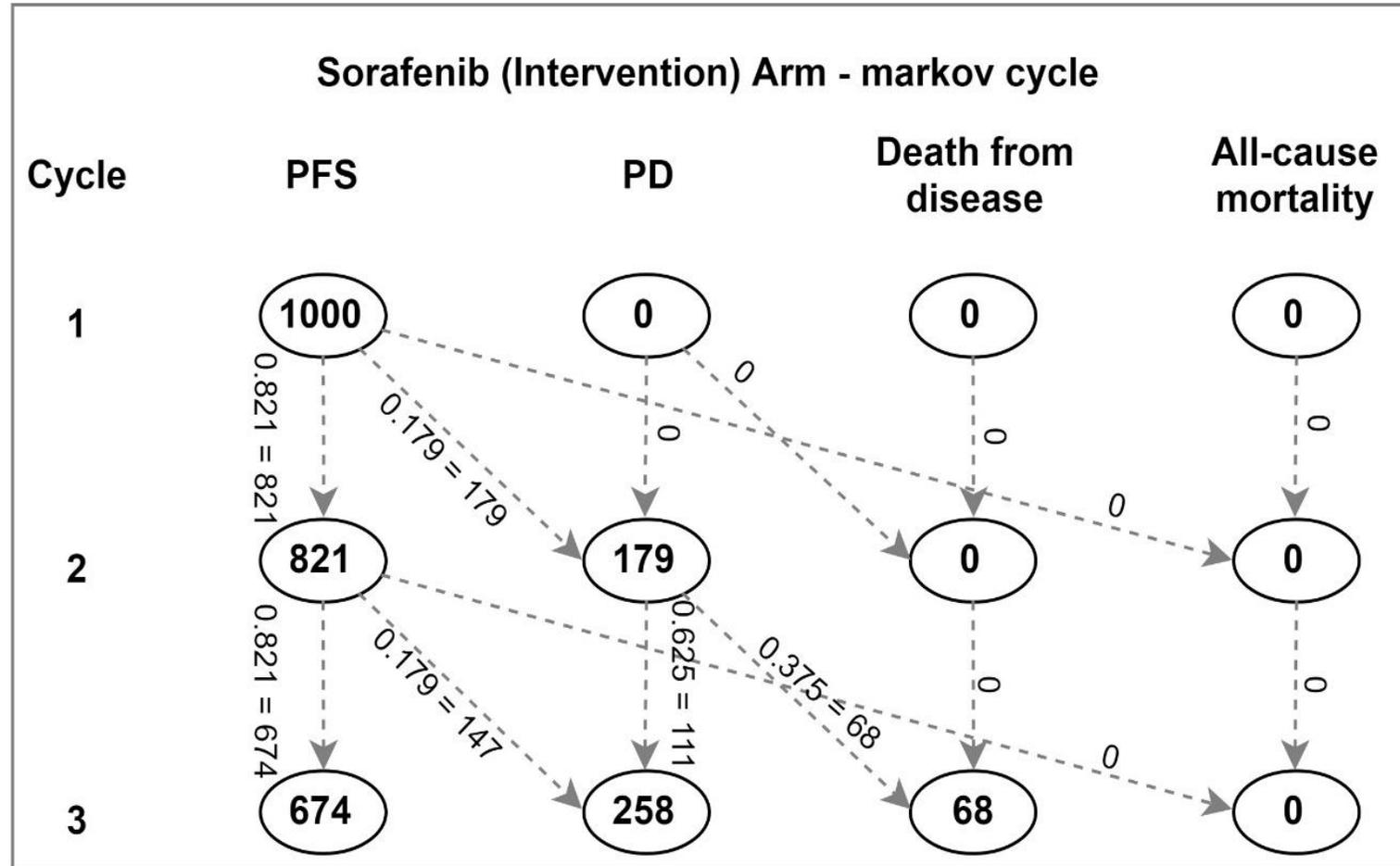
Markov Trace: Sorafenib Arm

Months	PFS	PD	Death from disease	All cause mortality	Total		Life Years	QALYs	Cost
0	1000	0	0	0	1000		83.3	63.33	₹ 47,30,000
1	821	179	0	0	1000		83.3	62.12	₹ 45,91,773
2	674	258	67	1	1000		77.7	57.34	₹ 42,12,787
3	554	282	164	1	1000		69.6	51.03	₹ 37,35,670
4	455	275	270	1	1000		60.8	44.37	₹ 32,40,203
5	373	253	373	1	1000		52.2	37.98	₹ 27,68,558
6	306	225	468	1	1000		44.3	32.15	₹ 23,40,781
7	252	195	552	1	1000		37.2	27.00	₹ 19,64,213
8	207	167	625	1	1000		31.1	22.55	₹ 16,39,189
9	170	141	688	1	1000		25.9	18.75	₹ 13,62,422
10	139	119	741	1	1000		21.5	15.54	₹ 11,28,987
11	114	99	785	1	1000		17.8	12.85	₹ 9,33,450
12	94	82	822	2	1000		14.7	10.61	₹ 7,70,480
13	77	68	853	2	1000		12.1	8.75	₹ 6,35,157
14	63	56	879	2	1000		10.0	7.21	₹ 5,23,099
15	52	47	900	2	1000		8.2	5.93	₹ 4,30,499
Total							650	478	₹ 3,50,07,270

$$ICER = \frac{Total\ Sorafenib_{costs} - Total\ BSC_{costs}}{Total\ Sorafenib_{QALYs} - Total\ BSC_{QALYs}}$$

Markov Model: Example 1

Bahuguna P et al (2011). Applied Health Economics Health Policy

Markov Model: Example 2

Bahuguna P et al (2011). Applied Health Economics Health Policy

Markov Model: Example 3

Legend:
- → Mortality
- - - → Shift among HIV/STD sero-types
- ☐ Female sex workers
- — Sex act
- → Sex act with possible STD transmission
- ○ Clients of sex workers
- →› Sex act with possible HIV transmission
- →›› Sex act with possible HIV and STD transmission
- ⬠ General Population

Prinja S et al (2011). Sex Transm Inf.
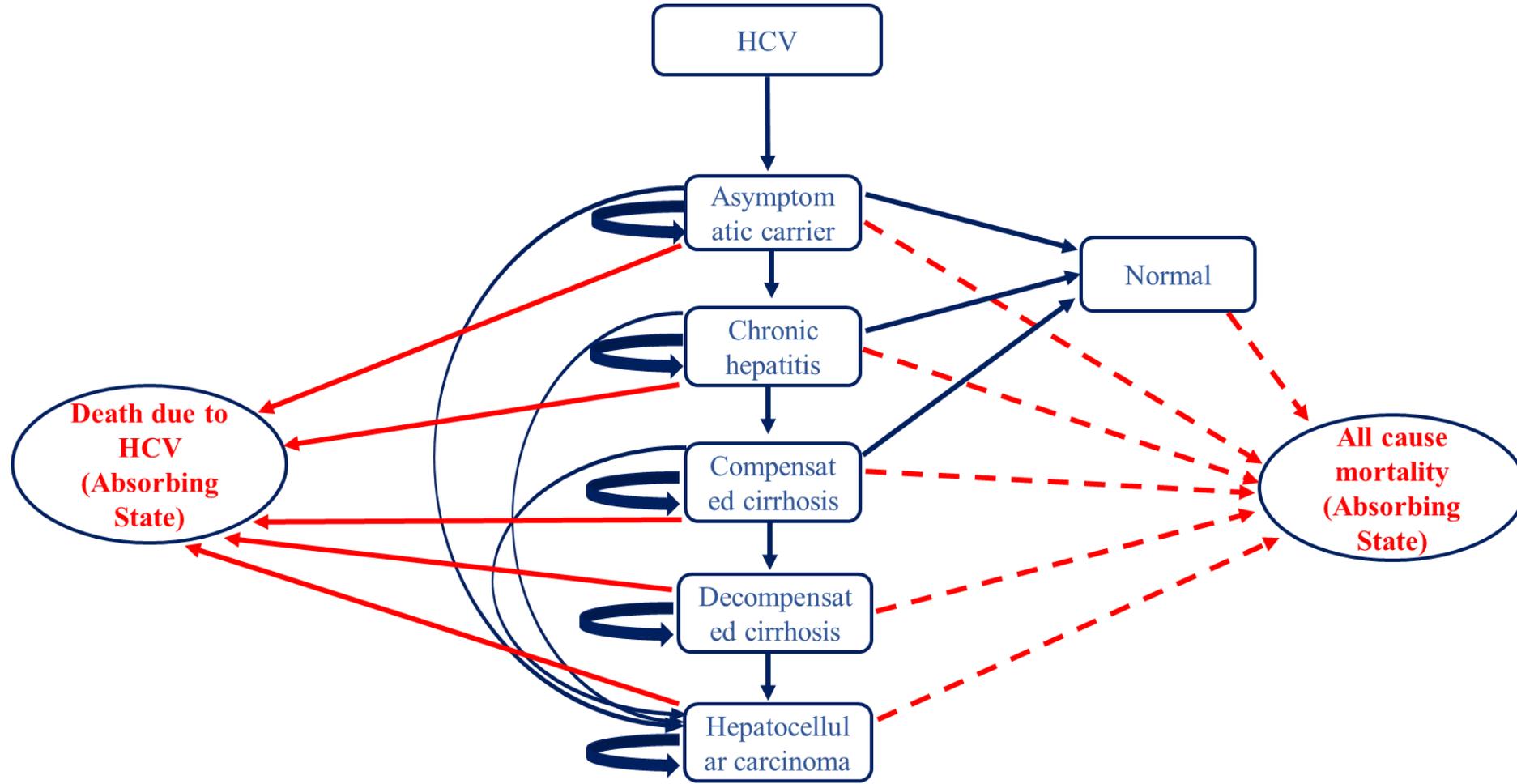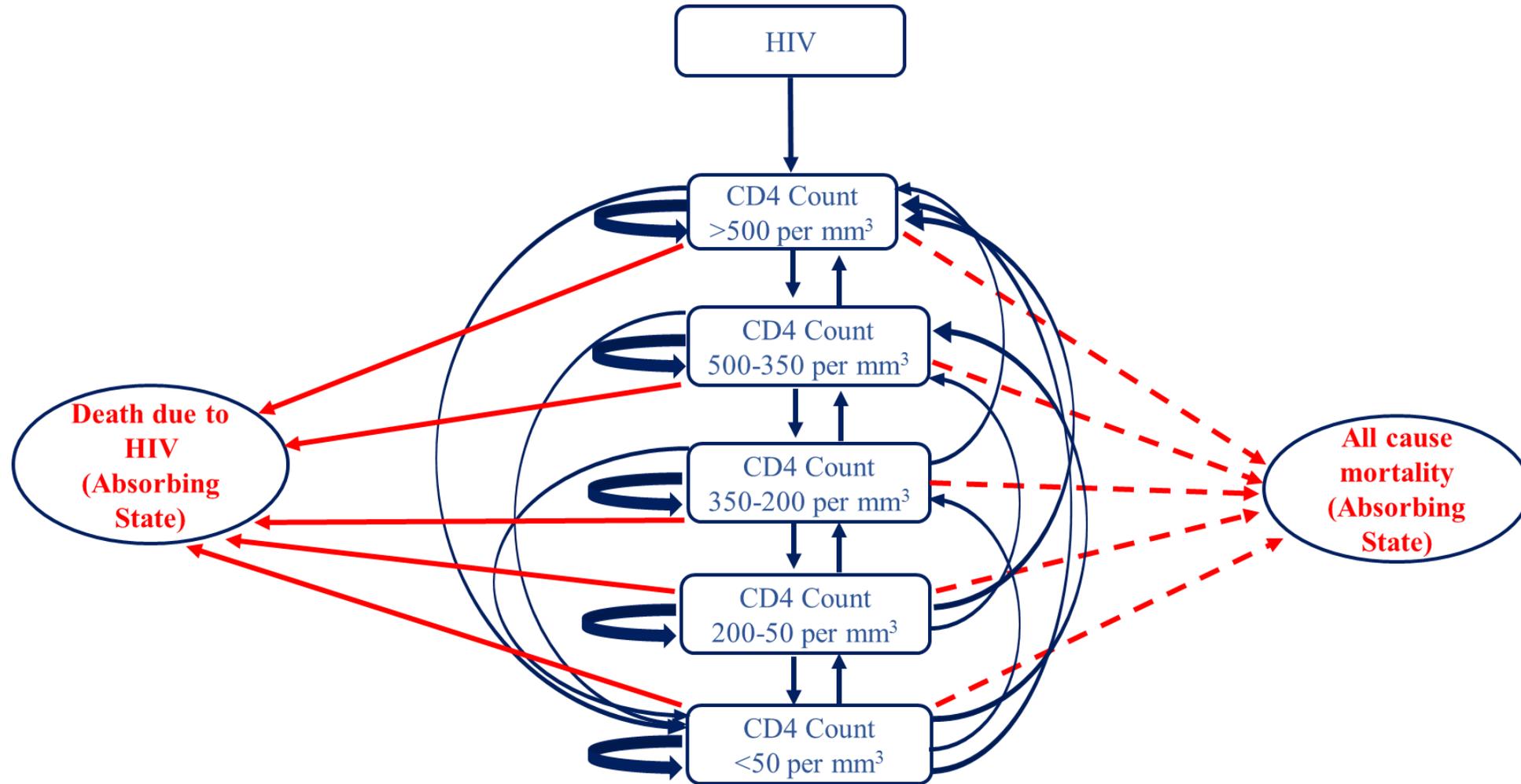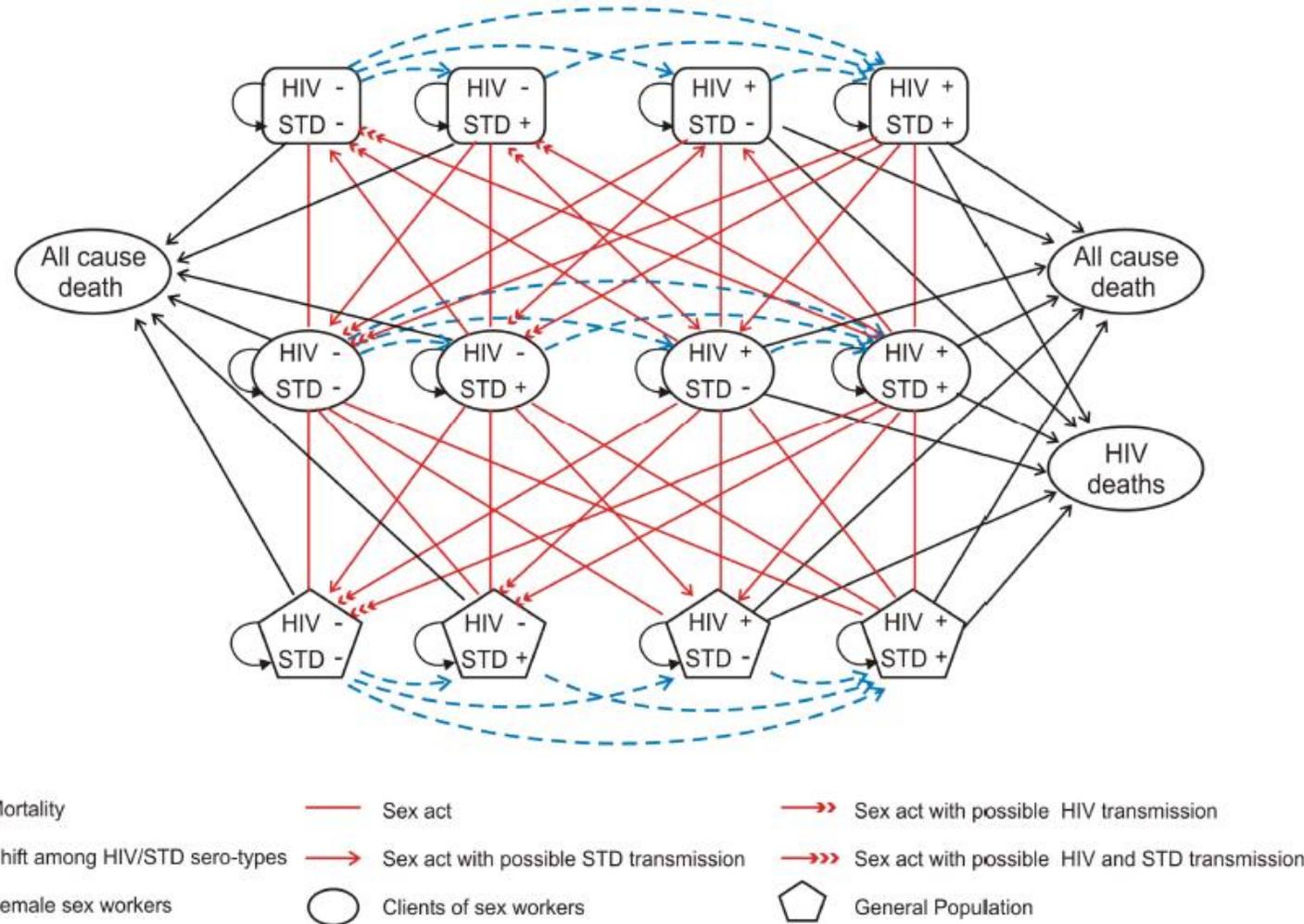
Limitations of Markov Model

➢ Difficult to include interactions

➢ Memory-less feature

Uncertainty Analysis: CE Plane
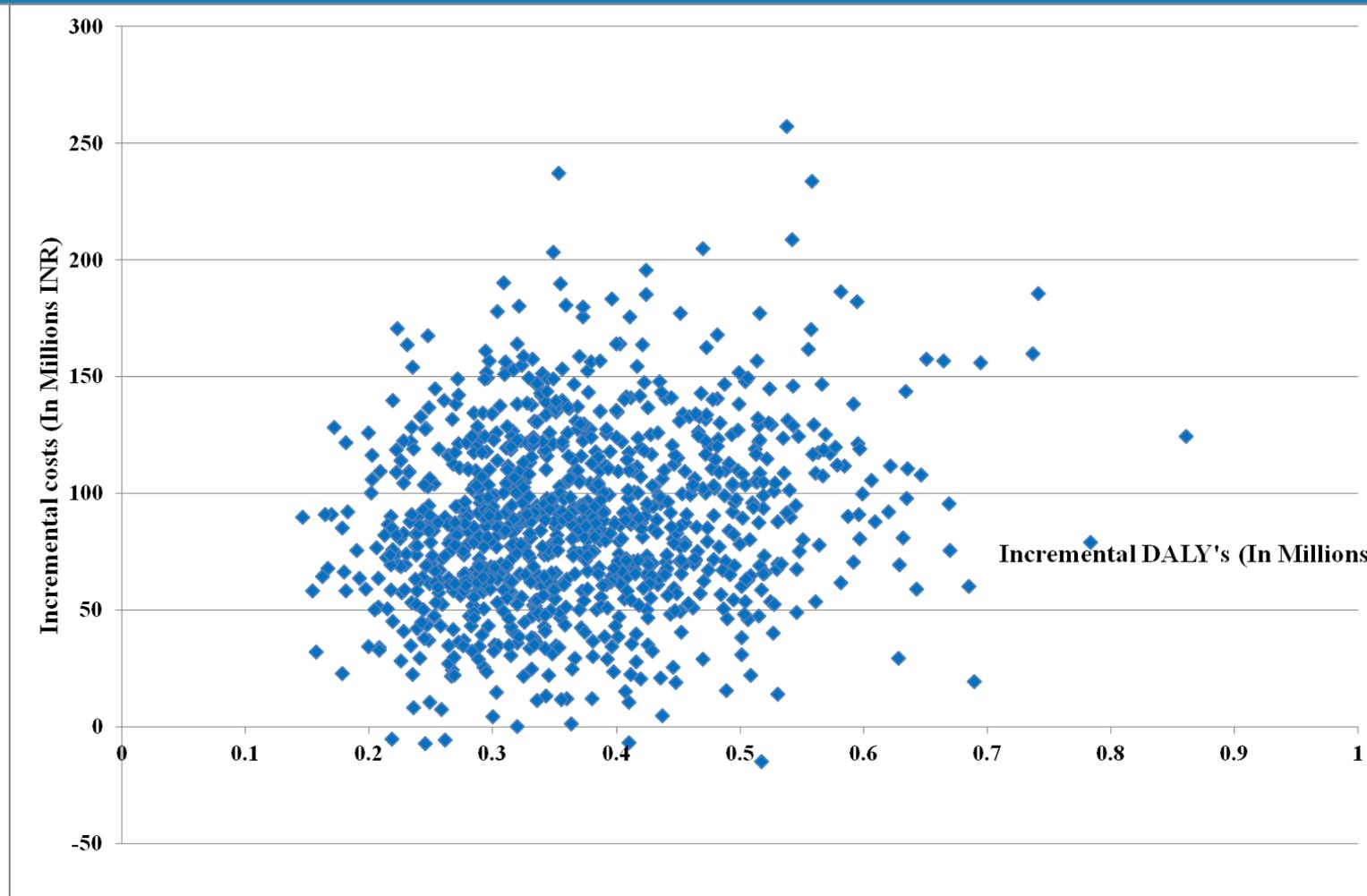
Uncertainty Analysis:
Cost Effectiveness Acceptability Curve

Prinja S et al (2016). IMNCI CEA (Plos One)
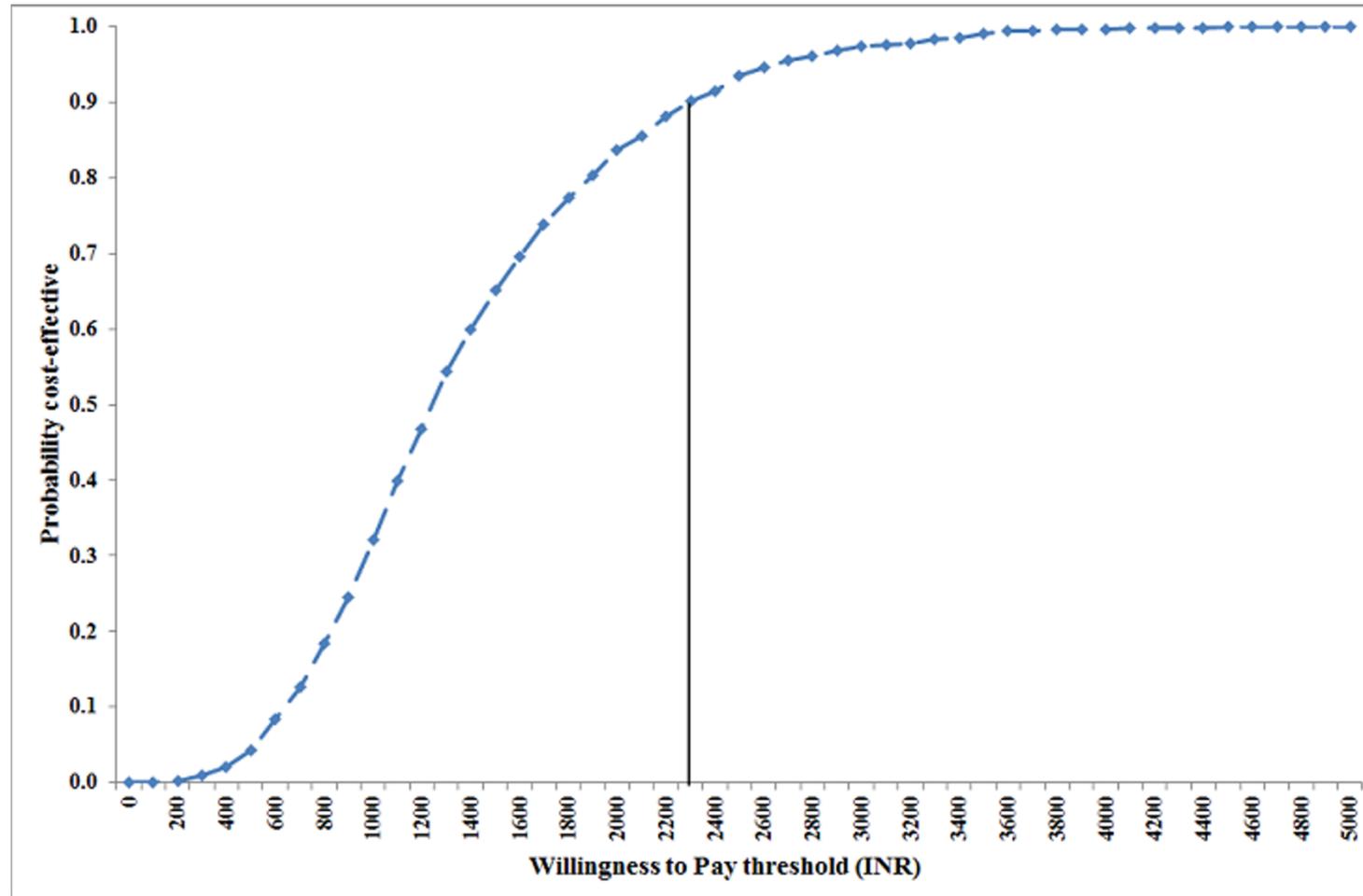
Software Options

- MS Excel
  - Very easy and flexible
  - Advanced analysis requires visual basic

- Other decision analysis softwares
  - TreeAge Pro, R and MATLAB
  - Easy to use
  - Some options not available

Thanks!!
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Suggested Reading:
1.   Gupta N, Verma R, Dhiman RK, Rajsekhar K, Prinja S. Cost-effectiveness analysis and decision modelling: a tutorial for clinicians. Journal of clinical and experimental hepatology. 2020 Mar 1;10(2):177-84.