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Use of Whole Disease Models and Pathway Models: Benefits and Risks

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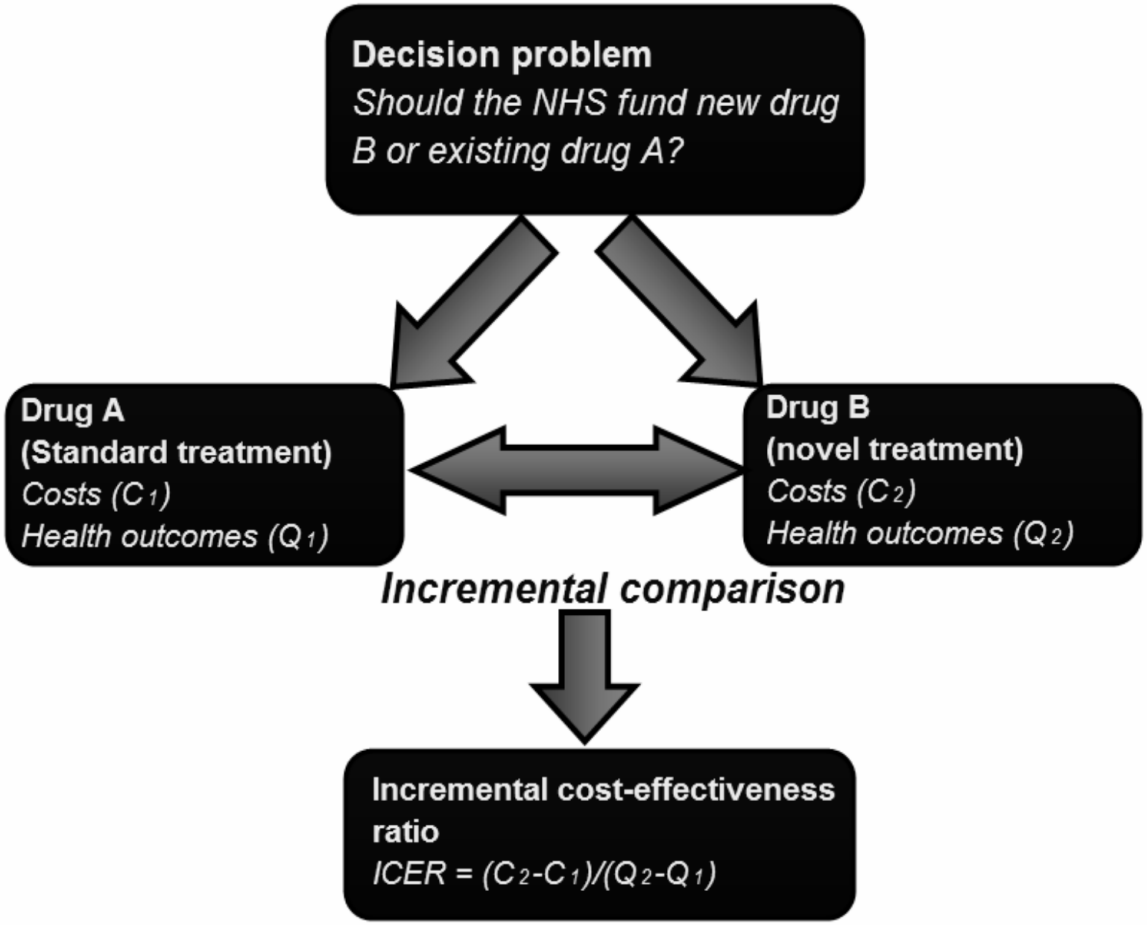
Conventional "piecewise" health economic models



- Theoretical approach to maximising health gains.
- Threshold determined by CE of last technology purchased
- Conventional models project forward from single decision node at an isolated point in clinical pathway
- Comparison against threshold or threshold range

An alternative approach – Whole Disease Models

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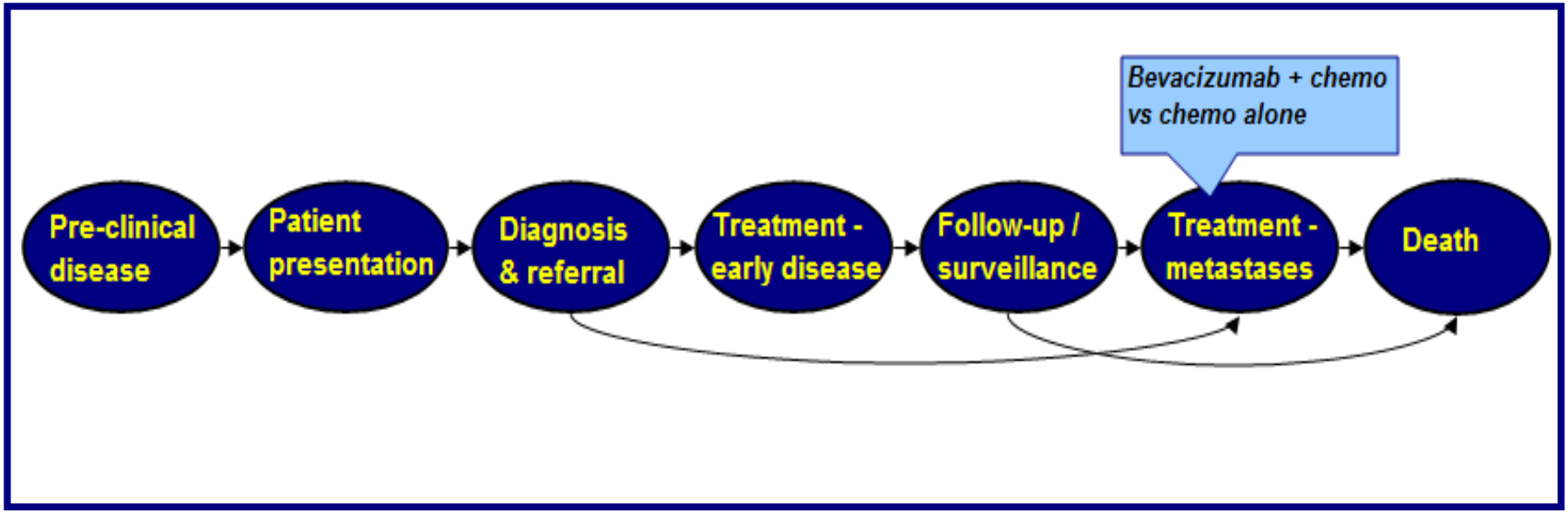
- System-level model of whole disease and treatment pathways
- Captures progression of entire disease from preclinical natural history phase through to diagnosis, early stage treatment and late stage treatment
- Ability to evaluate multiple interventions together or separately using a single model → more complex decision rules
- Conceptually moving decision node around pathway



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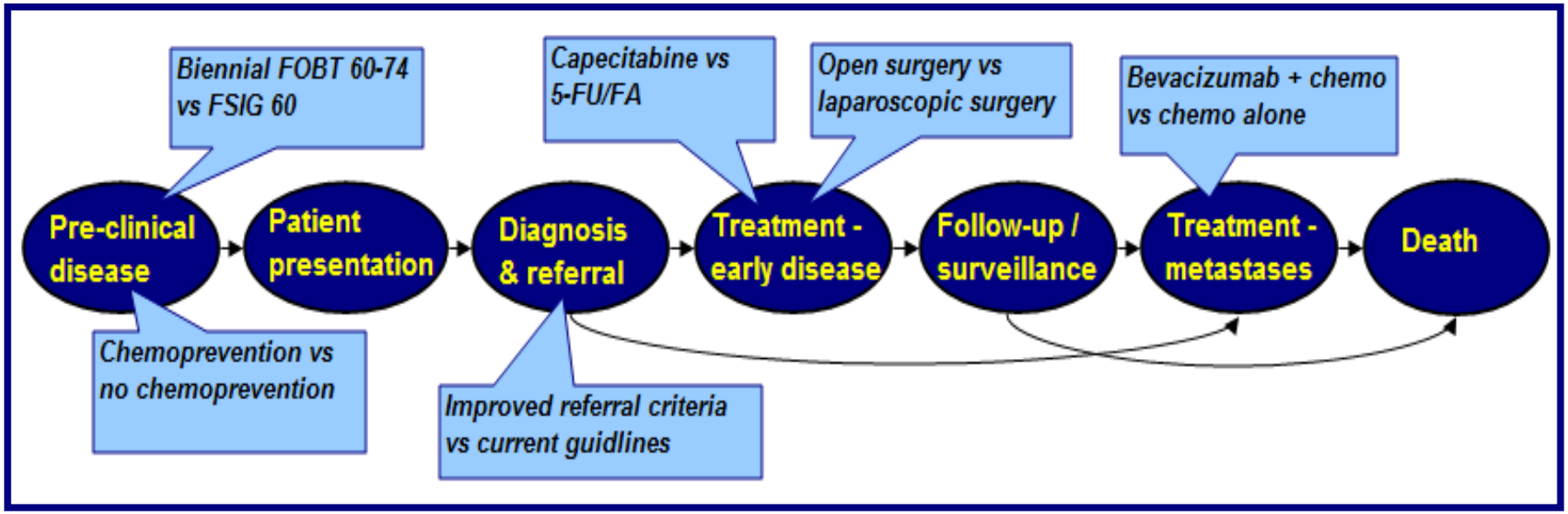

Bowel Cancer Whole Disease Model

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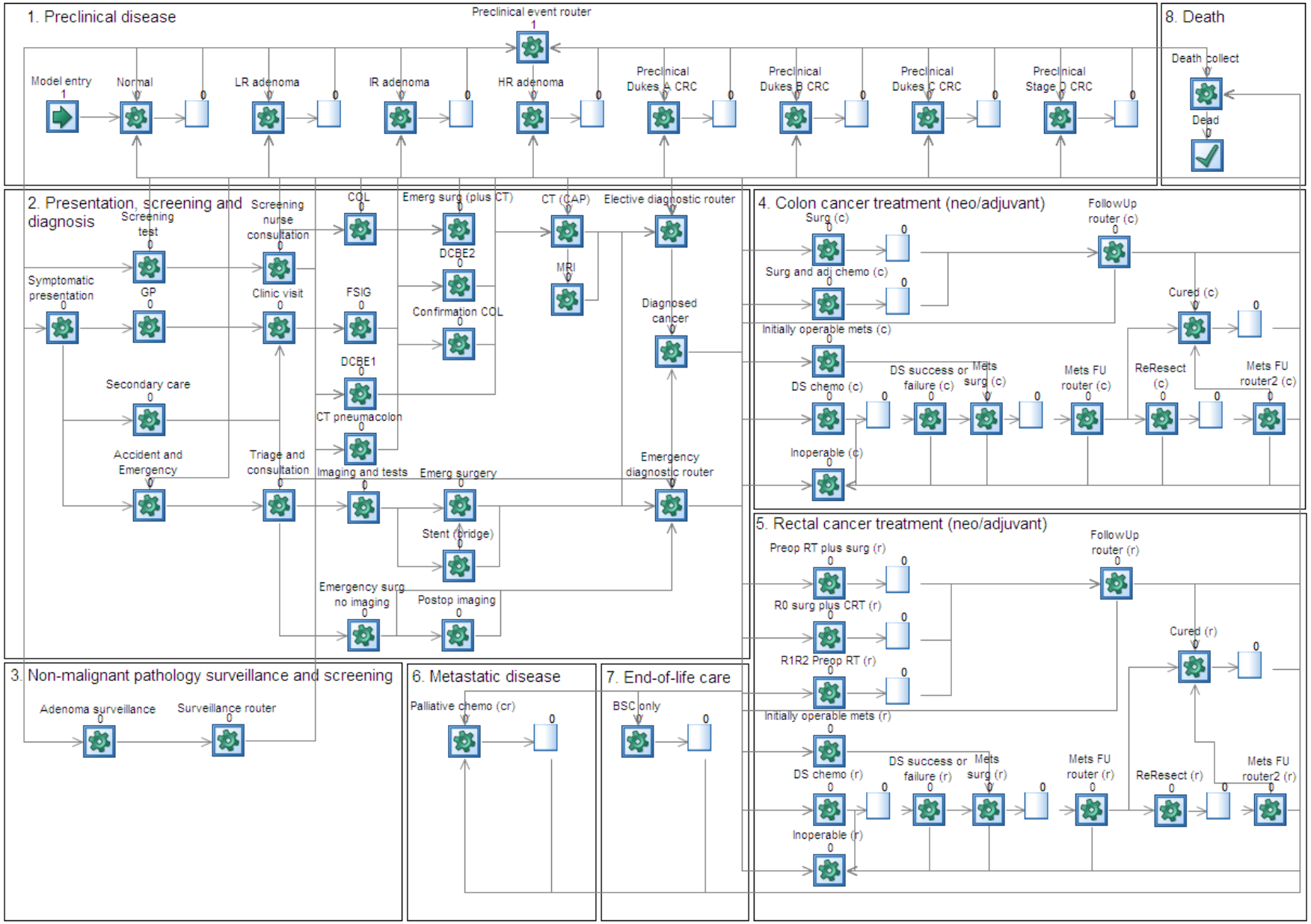

From threshold-based analyses…

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Topic	Option	Cost (£)	QALY	Inc. cost (£)	Inc. QALY	ICER (QALY) (£)
Baseline service		103,857,495	14,636,083	–	–	Dominated
A	CT colonography	97,517,419	14,636,253	−1,297,809	2471.96	Dominating
	FSIG→BE	107,471,657	14,636,087	–	–	Dominated
	Baseline (COL)	103,857,495	14,636,083	–	–	Dominated
	FSIG→COL	98,815,228	14,633,781	–	–	–
C	TEMS	100,445,898	14,636,331	−3,411,597	248.55	Dominating
	Radical resection	103,857,495	14,636,083	–	–	–
D_1	Baseline	103,857,495	14,636,083	207,617	140.94	1,473
	No CT scan	103,649,878	14,635,942	–	–	–
D_2	Baseline	103,857,495	14,636,083	207,617	140.94	1,473
	No stenting	103,649,878	14,635,942	–	–	–
E	All preop CRT	104,494,625	14,636,396	1,197,601	66.22	18,084
	All preop RT	103,297,024	14,636,329	–	–	–
	Baseline	103,857,495	14,636,083	–	–	Dominated
	No preop adjuvant tx	104,333,702	14,635,990	–	–	Dominated
F	Simultaneous resection	103,757,024	14,636,083	−100,471	0.00	Dominating
	Baseline (staged)	103,857,495	14,636,083			
G	All preop CRT	104,494,625	14,636,396	1,197,601	66.22	18,084
	All preop RT	102,896,369	14,636,329	–	–	–
	Baseline	103,857,495	14,636,083	–	–	Dominated
H	Adjuvant chemotherapy	103,358,231	14,636,137	−499,264	53.58	Dominating
	Baseline	103,857,495	14,636,083	–	–	–
I	Baseline	103,857,495	14,636,083	−189,507	149.38	Dominating
	No adjuvant chemotherapy	104,047,002	14,635,934	–	–	–

…and some more…

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Topic	Option	Cost (£)	QALY	Inc. cost (£)	Inc. QALY	ICER (QALY) (£)
J	HAI	106,308,256	14,636,105	2,450,761	22.09	110,932
	Baseline	103,857,495	14,636,083	13,111,810	789.47	16,608
	BSC only	90,745,685	14,635,293	–	–	–
M	XELOX→XELIRI	103,548,863	14,636,163	715,860	5.31	134,938.96
	XELOX→FOLFIRI	104,549,675	146,36,163	–	–	Dominated
	FOLFOX→XELIRI	106,494,974	14,636,163	–	–	Dominated
	FOLFOX→FOLFIRI	107,319,353	14,636,163	–	–	Dominated
	XELOX→IRI	102,833,003	14,636,158	4,812,554	251.18	19,159.98
	FOLFOX→IRI	105,779,115	14,636,158	–	–	Dominated
	Baseline	103,857,495	14,636,083	–	–	Dominated
	XELIRI→XELOX	105,324,882	14,636,055	–	–	Dominated
	XELIRI→FOLFOX	106,522,006	14,636,055	–	–	Dominated
	FOLFIRI→XELOX	108,144,085	14,636,055	–	–	Dominated
	FOLFIRI→FOLFOX	109,163,047	14,636,055	–	–	Dominated
	XELIRI→IRI	105,577,225	14,636,039	–	–	Dominated
	XELIRI→XEL	104,368,886	14,636,032	–	–	Dominated
	FOLFIRI→5-FU/FA	107,962,889	146,36,032	–	–	Dominated
	XEL→XELOX	99,033,548	14,635,931	–	–	Ext dom
	5-FU/FA→FOLFOX	102,913,909	14,635,930	–	–	Dominated
	XEL→XELIRI	100,025,257	14,635,920	–	–	Dominated
	5-FU/FA→FOLFIRI	103,711,773	14,635,919	–	–	Dominated
	XEL→IRI	99,239,714	14,635,913	–	–	Dominated
	5-FU/FA→IRI	102,141,844	14,635,913	–	–	Dominated
	XEL→XEL	98,020,449	14,635,906	–	–	–
	5-FU/FA→5-FU/FA	101,704,870	14,635,906	–	–	Dominated
N	Baseline	103,857,495	14,636,083	1,827,129	117.49	15,551
	Relaxed follow-up	102,030,367	14,635,965	–	–	–

BSC, best supportive care; COL, colonoscopy; CRT, chemoradiation; CT, computed tomography; ext dom, extendedly dominated; FOLFIRI, 5-FU/FA plus irinotecan; FOLFOX, 5-FU/FA plus oxaliplatin; FSIG, flexible sigmoidoscopy; 5-FU/FA, 5-fluorouracil plus folinic acid; HAI, hepatic arterial infusion; IRI, irinotecan; preop, preoperative; RT, radiotherapy; TEMS, transanal endoscopic microsurgery; tx, treatment; XELIRI, capecitabine plus irinotecan; XELOX, capecitabine plus oxaliplatin.

… to more complex decision rules

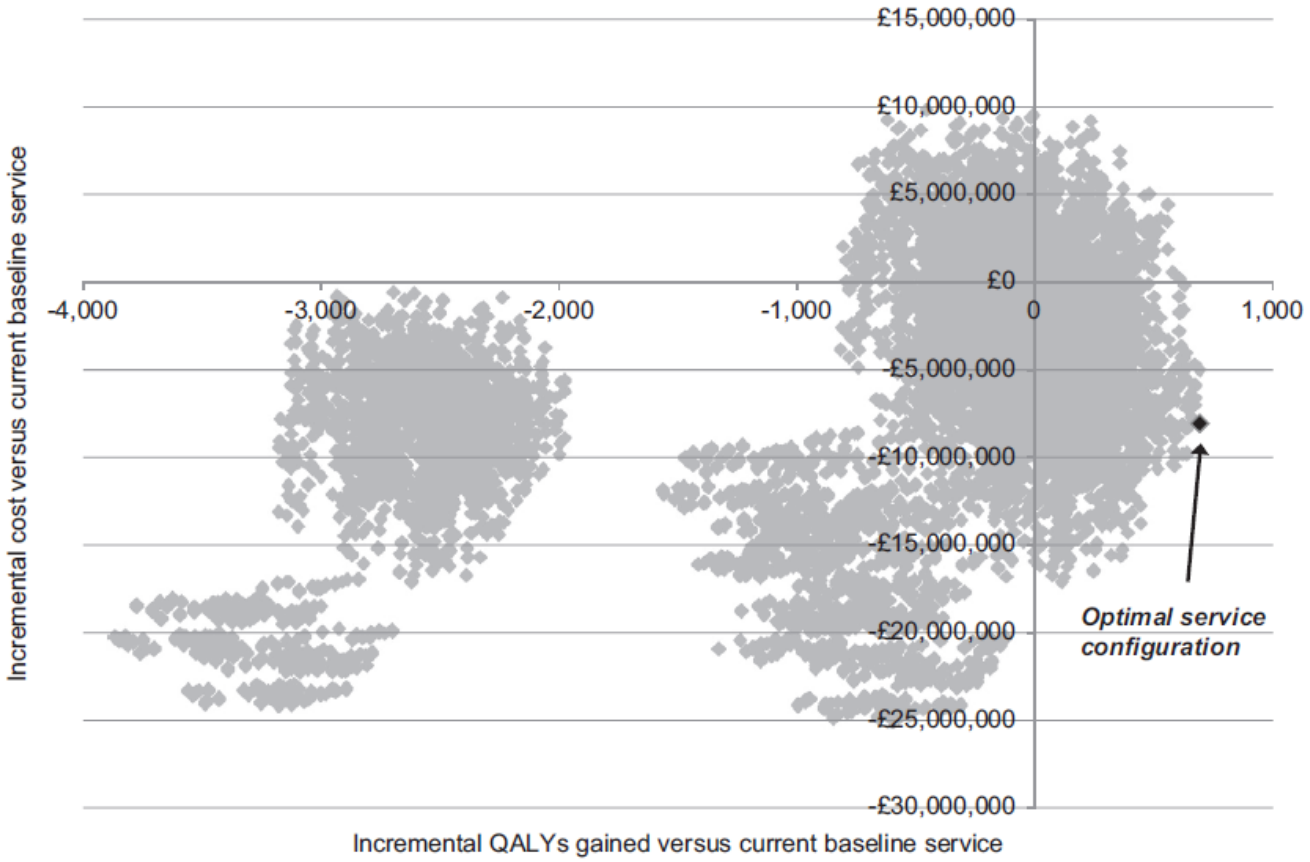

Fig. 3 – Results of the constrained maximization analysis. Optimal service configuration—topic A: CTC; topic C: TEMS; topic D_1: CT scan; topic D_2: stenting; topic E: preoperative chemoradiation; topic F: simultaneous resection; topic G: see topic E; topic H: adjuvant chemotherapy; topic I: adjuvant chemotherapy; topic J: palliative chemotherapy; topic M: XELOX→XELIRI; topic N: intensive follow-up. CT, computed tomography; CTC, computed tomography colonography; QALY, quality-adjusted life-year; TEMS, transanal endoscopic microsurgery.

All results from Tappenden *et al.*, *Value in Health*, 2013

Some other examples

1) Schizophrenia whole disease model (Jin *et al.*, *JAMA Network Open*, 2020)
2) Prostate cancer pathways model (Lord *et al.*, *Health Technology Assessment*, 2013)

- Models developed for academic purposes or as pilot projects to inform guideline topic selection
- Limited experience in applied decision-making → magnitude of risks not fully clear

Big payoffs, but at a cost...

Pros

- Consistency across economic evaluations
- Ability to evaluate many different decision problems across a pathway
- Re-use potential
- Opens up flexibility in terms of decision rules

Cons

- It's quite difficult!
- Requires knowledge of DES
- Time and resources for model development and evidence identification/ synthesis
- Complex calibration
- Model run times
- Model requires upkeep
- Potential for error
- Not generally how HTA is funded

References

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