13. Expected value of sample information

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Bayesian Methods in Health Economics, Lausanne

Summary

- Expected Value of Sample Information
- Expected Net Benefit of Sampling
  - Trial costs
  - Challenges/Discussion

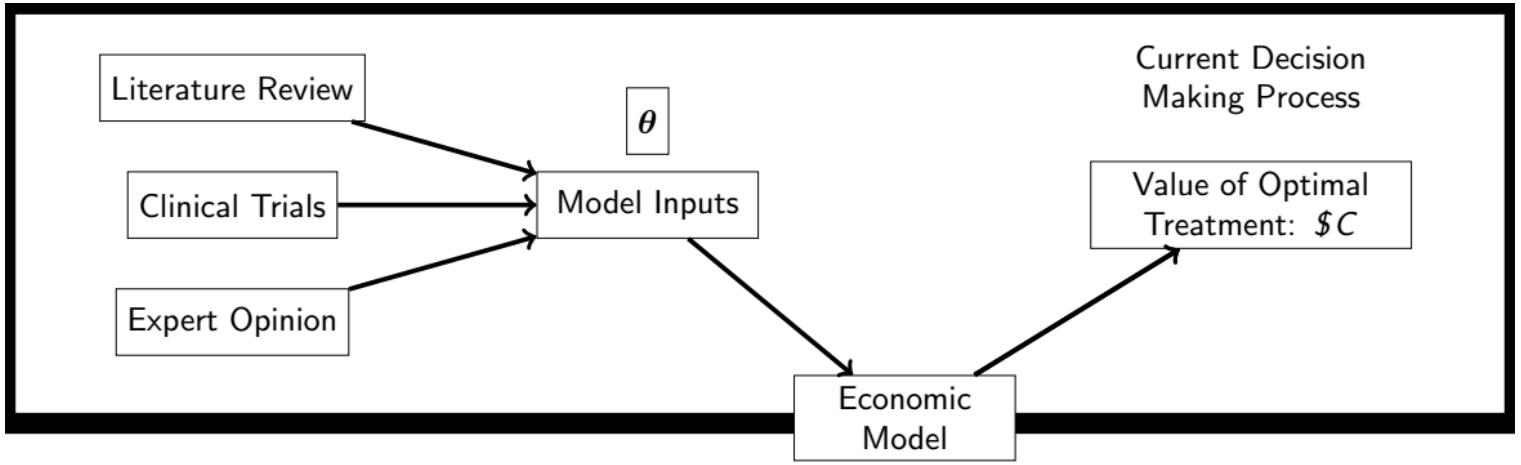
References

Bayesian Methods in Health Economics, chapter 5.4 Book website (CRC) Book website Code

Evidence Synthesis for Decision Making in Healthcare, chapter 12 Book website

Bayesian Cost-Effectiveness Analysis with the R package BCEA, chapter 4.3 Book website (Springer) Book website

Expected value of **sample** information



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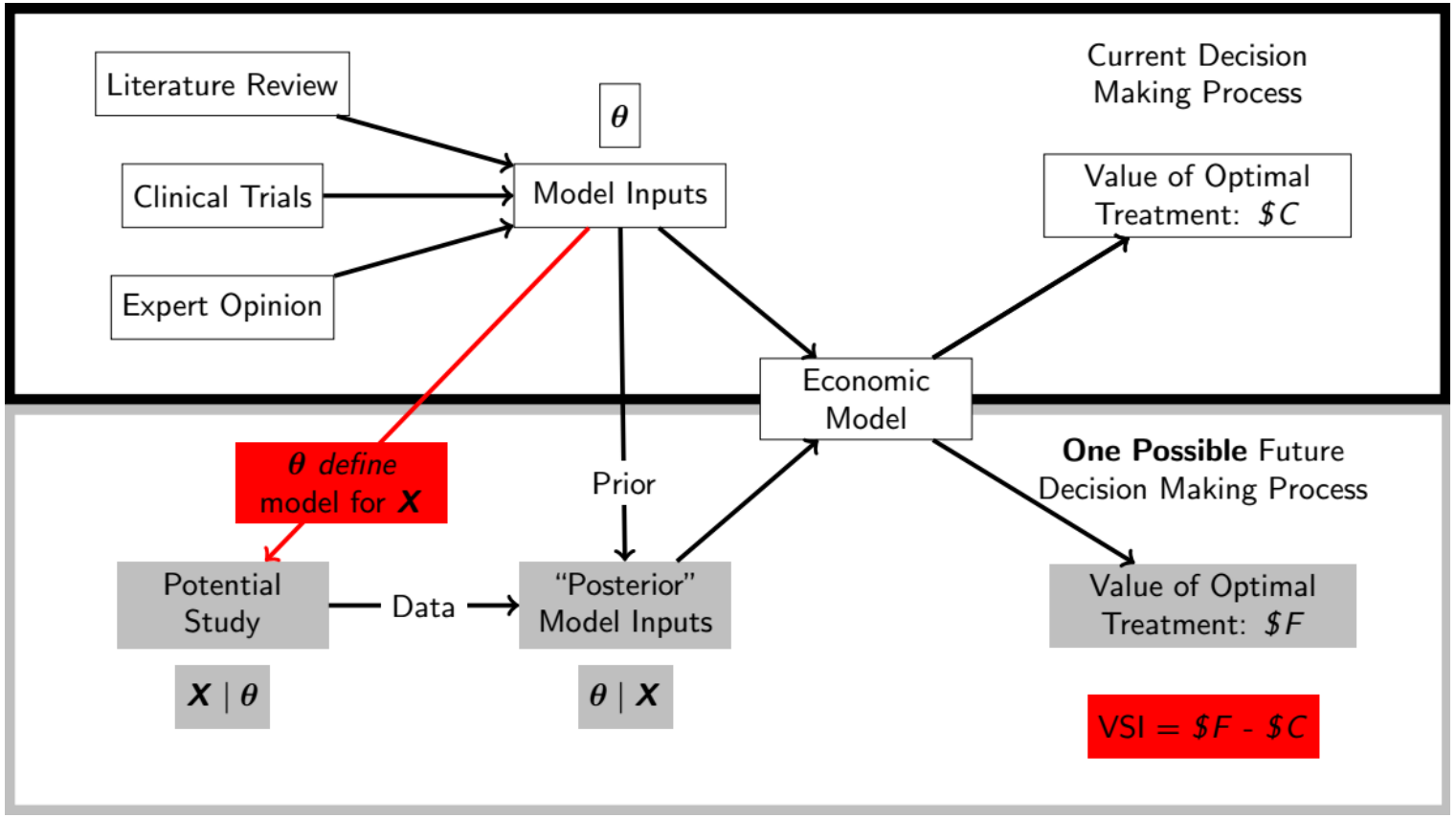

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   Population EVSI $=$ EVSI $\times$ prevalence $\times$ time horizon

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2. **Population EVSI**

   $$\text{Population EVSI} = \text{EVSI} \times \text{prevalence} \times \text{time horizon}$$

NB: Whether or not the study is worth it depends on its **Expected Net Benefit of Sampling** (ENBS)

$$\text{ENBS} = \text{Population EVSI} - \text{Cost of the study}$$

- Only studies where expected benefits outweigh study costs are a good use of resources
- Choose the design with greatest ENBS:
  – No value of a study design with ENBS < 0
  – There is value in a study where ENBS > 0... even if it not the maximum ENBS

Example: Attendance at breast cancer screening

Setup

Based on Richards et al 2001

- Cluster randomised 2×2 factorial trial
- 24 practices randomised
- None, Flag, Letter, Both

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Inputs

- Decision tree model
- Evidence on efficacy before Richards et al based on systematic review of similar types of intervention
- Other model inputs from routine data sources (Toms 2004) and cohort study (Wolstenholme 1998)
- Prevalence: 300,000 per year eligible for 1st invitation to screening
  - 30,000 in low-uptake practices as sensitivity analysis
- Time horizon = 10 years, 3.5% discount rate
- Willingness to pay per QALY = £20,000

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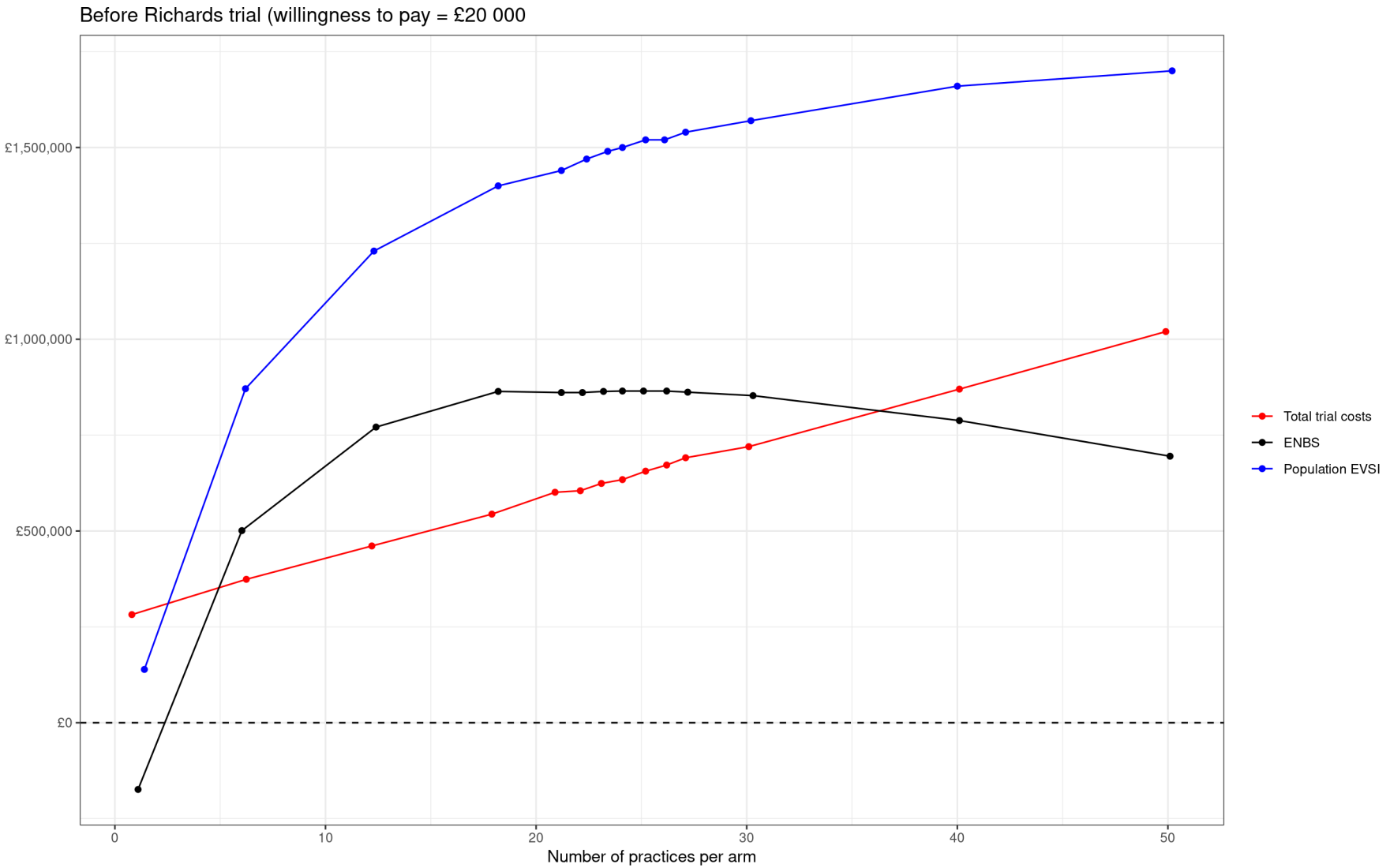

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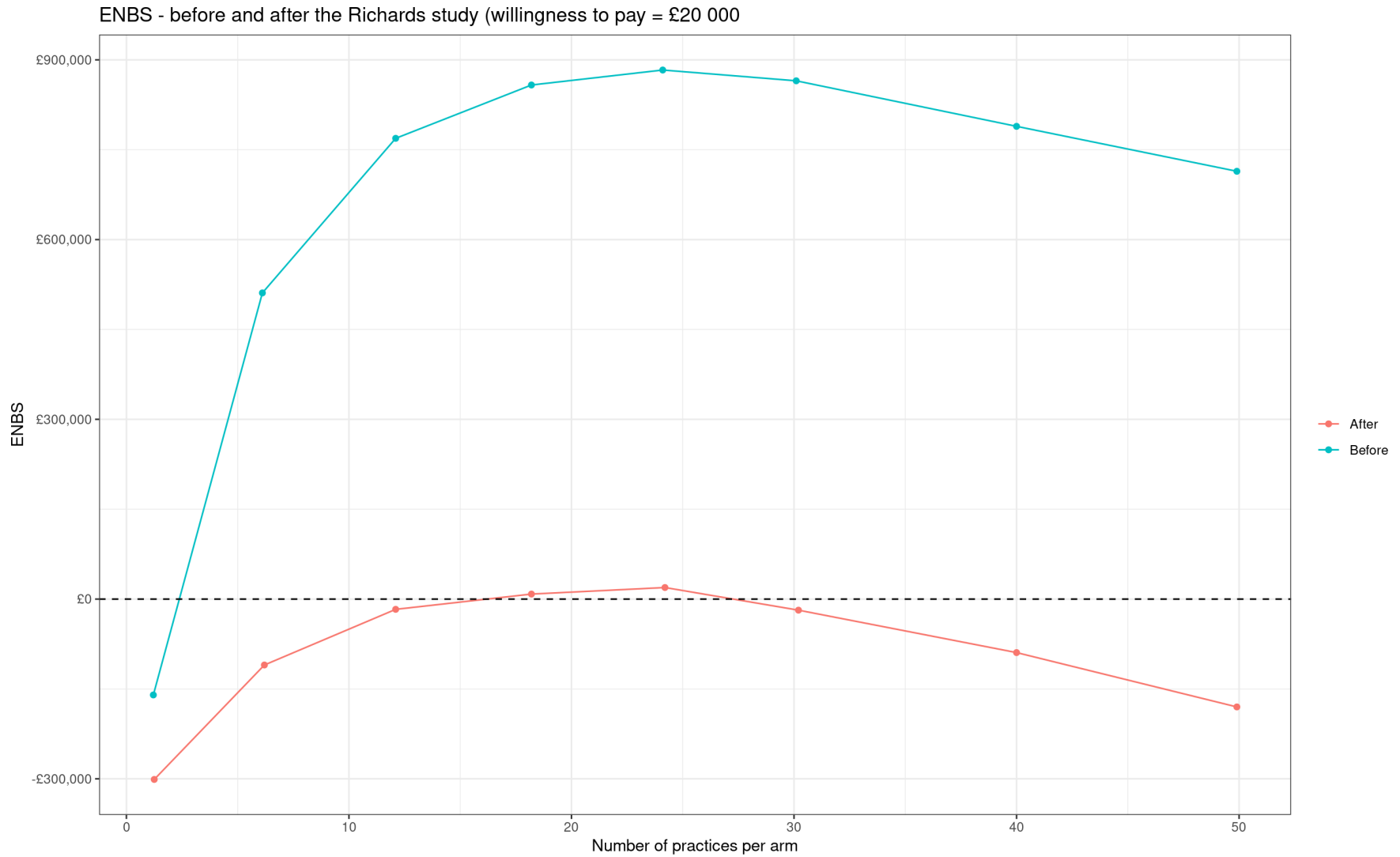

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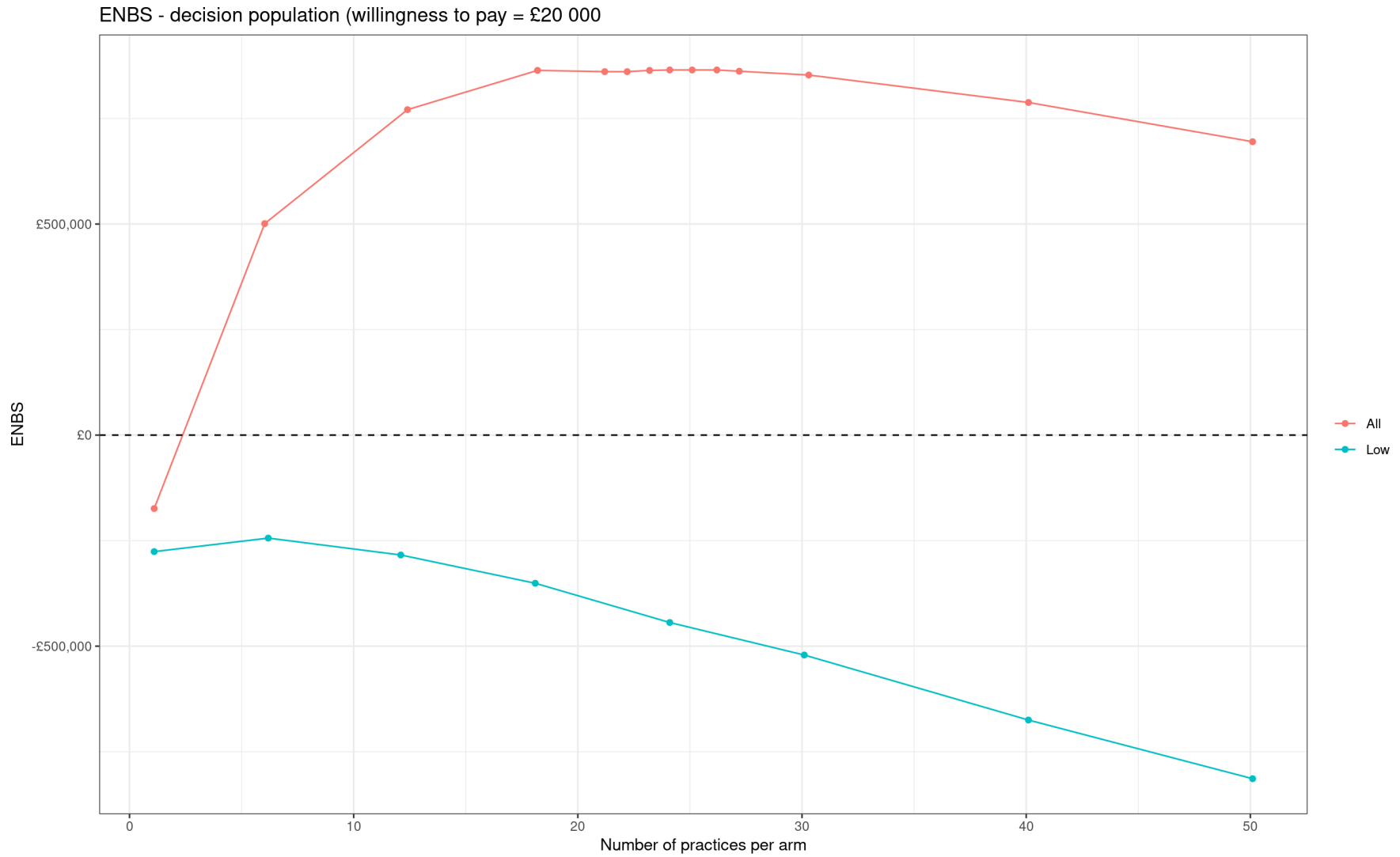

Implications for the research design

- There was value in carrying out the Richards trial based on prior evidence
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Implications for the research design

- There was value in carrying out the Richards trial based on prior evidence
  - Sample size could have been larger
- No further value in running a new trial subsequent to the Richards et al trial
- Only considered new study measuring relative intervention effects
  - ... and only one aspect of study design (sample size)
  - Richards et al also collected intervention cost data

Expected value of **sample** information

Jackson et al (2021)

- EVSI measures the value of reducing uncertainty by running a study of **a given design**

$$\text{EVSI} = \text{E}_{\boldsymbol{X}}\left[\max_t \underbrace{\text{E}_{\boldsymbol{\theta}|\boldsymbol{X}}\left[\text{NB}_t(\boldsymbol{\theta})\right]}_{\substack{\uparrow \\ \text{Value of decision based} \\ \text{on } \textbf{sample} \text{ information} \\ \text{(for a given study design)}}}\right] - \max_t \underbrace{\text{E}_{\boldsymbol{\theta}}\left[\text{NB}_t(\boldsymbol{\theta})\right]}_{\substack{\uparrow \\ \text{Value of decision based} \\ \text{on } \textbf{current} \text{ information}}}$$

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  - To find the optimal study design
- Computationally complex
  - Requires specific knowledge of the model for (future/hypothetical) data collection
- Again, recent methods have improved efficiency

  Heath et al (2021)
  - Regression-based (Strong et al, 2015)
  - Importance Sampling (Menzies et al, 2016)
  - Gaussian approximation (Jalal et al, 2015; Jalal and Alarid-Escudero, 2018)
  - Moment matching (Heath et al, 2018)
- Can be used to drive design of new study (eg sample size calculations)

Required inputs and expertise to compute EVSI

Inputs

	Methods			
Requirements	**RB**	**IS**	**GA**	**MM**
Decision-Analytic Model				×
Probabilistic sensitivity analysis	×	×	×	×
Simulations of the expected net benefit conditional on ϕ (required to compute EVPPI)		×		×

Expertise & skills

	Methods			
Requirements	**RB**	**IS**	**GA**	**MM**
Regression methods	×		×	
Specification of likelihoods		×		
Requirement of summary statistics	×		*	
Bayesian updating			*	×

Strengths and limitations of each method

	Methods			
Requirements	**RB**	**IS**	**GA**	**MM**
Can estimate the EVSI with a large number of parameters		×		×
Inaccurate with small sample sizes			×	×
Computational challenge with large proposed studies		×		
Requires a low dimensional summary statistics	×			
Requires accurate EVPPI estimation		×		×
Uses non-parametric regression	×		×	
Quantifies uncertainty in EVSI estimation	×		×	×
Estimates EVSI across sample size			×	×

NICE HTA evaluation methods update (2021)

Next lecture

> *2.16. The use of Expected Value of Perfect Information (EVPI) will **not** be adopted into the NICE methods. Stakeholders raised concerns about this proposal and the majority disagreed with it. It was noted that the added value of EVPI and how it would be used in decision-making was unclear as experiences from other countries suggested that its added value to decision making is minimal. There were concerns that it would add complexity to decision making, and the additional burden for analysts and reviewers may not be worth it. On the other hand, some stakeholders argued that the proposal did not go far enough and should include expected value of partially perfect information (EVPPI) and expected value of sample information (EVSI).*

"Tell me a sad story in just one slide..."

NICE HTA evaluation methods update (2021)

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- Push from industrial representatives, despite attempts at clarifying/simplyfing concepts/guidelines
- CADHT actually say

> *When the decision problem includes consideration of further research to inform future decisions, a value-of-information analysis should be undertaken as part of the reference case. [...] To identify these critical values and correctly quantify the impact of a parameter taking a specific value (on both the probability of an intervention being cost-effective and the expected net benefit), recent methodological work suggests*