

Organized Session
**Applying Health Economics Principles to
Vaccine Programs**

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4.0

**Section introduction: advanced
methods in economic evaluation**

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Advanced Methods in Economic Evaluation of Vaccines and Vaccine Programs

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What Are Health Economic Models?

- **Computer-based simulations** which focus on the population-level impacts of diseases and disease mitigation strategies
- Good models combine the best available data (e.g., epidemiological, clinical, economic) from multiple sources
- Permit comparisons of the current and future epidemiological, clinical, and economic impacts of alternative disease-related interventions
- Can measure the economic and health consequences associated with an intervention

Decision Tree Modeling

- Decision tree models are the simplest type of health economic model
- They are useful for modeling instantaneous or one-time probabilistic events

HepB_CEA-Tree_PartA

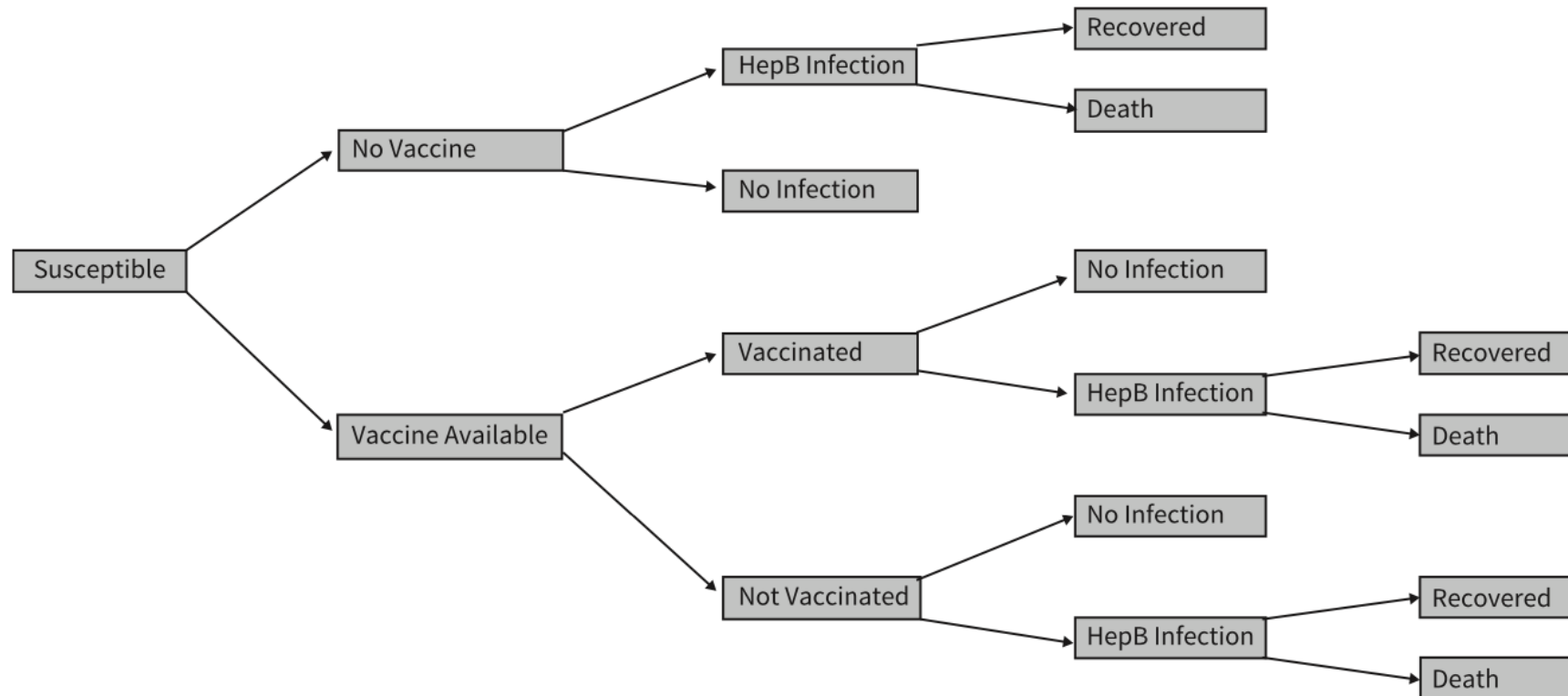


Fig. 3.7.1 Example hepatitis B vaccine decision tree for conducting economic evaluation.

Then, Why Do We Need Advanced Modeling Approaches? 5

- But decision trees are limited in capturing the effects of time spent in various health states characterizing a disease process (e.g., healthy, sick, or dead)
- Advanced modeling approaches are needed to account for **long-term consequences** of vaccination programs
- Allow extrapolation of clinical evidence over a short time frame to a longer time frame to capture **time-dependency**

Types of Health Economic Models

- Health economic models can be classified based on:
 - **Type of change of the state variables**
 - Discrete
 - Continuous
 - **How the system is being observed**
 - Static
 - Dynamic
 - **Aggregation level**
 - Aggregate level (i.e., compartmental or cohort)
 - Individual level
 - **Degree of randomness**
 - Deterministic
 - Stochastic

Markov Modeling

- Markov assumption (Andrey Markov, 1906): *All future states are independent of all past states*
 - No “memory” of the past – ***memoryless property***
- A Markov model depicts transitions between health statuses over time, based on prior probabilities of assumed outcomes
- Health statuses are represented as a series of finite, discrete health states
- Can be used to keep track of the costs and effectiveness outcomes associated with time spent in a particular health status



Andrey Andreyevich Markov
06/14/1856 – 07/20/1922

Example of a Markov Model: Hep B Vaccination Transitions

- Ovals represent health states
- Directed arrows connecting the health states represent the directions of the transitions between states
- Each arrow is associated with a state transition probability, $T(s, s')$

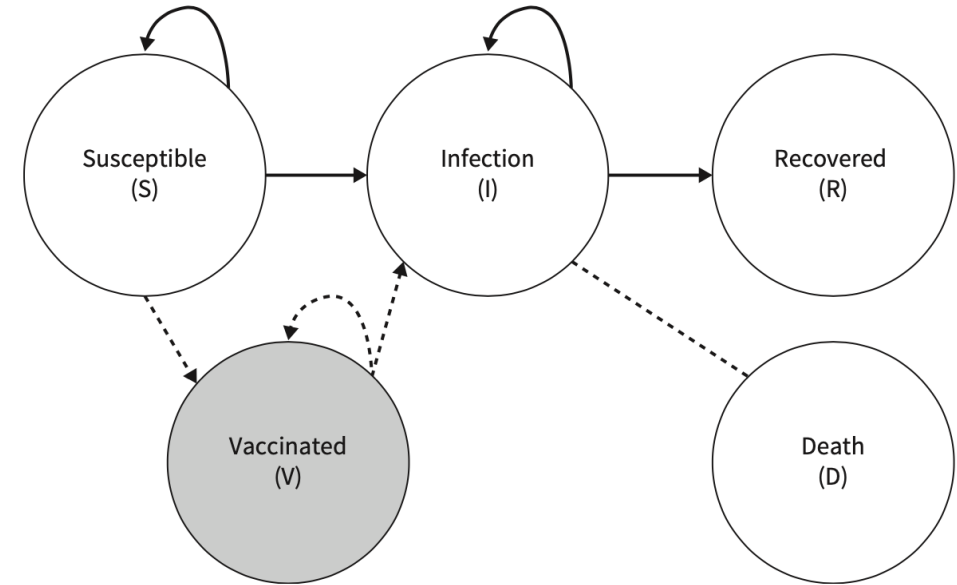


Fig. 4.1.1 State transition diagram of the hepatitis B vaccine Markov model. The states of the model are represented by the circles; the transitions between health states are represented by the arrows.

Table 4.1.1 Illustrative state transition probabilities for the vaccination scenario

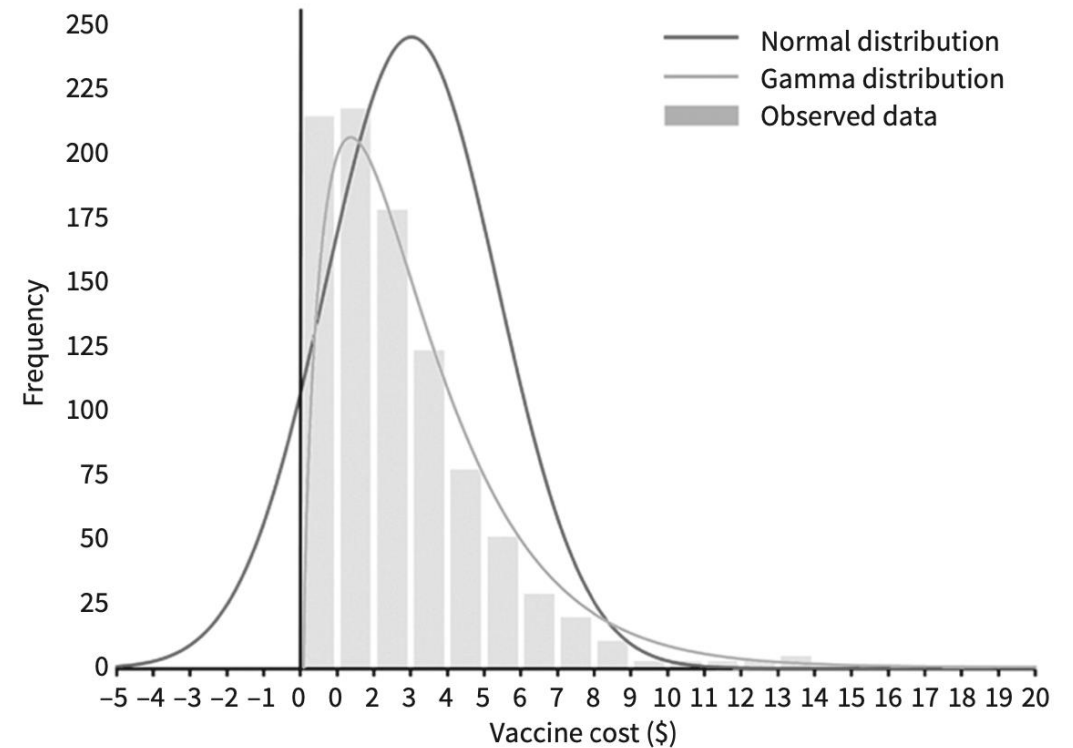
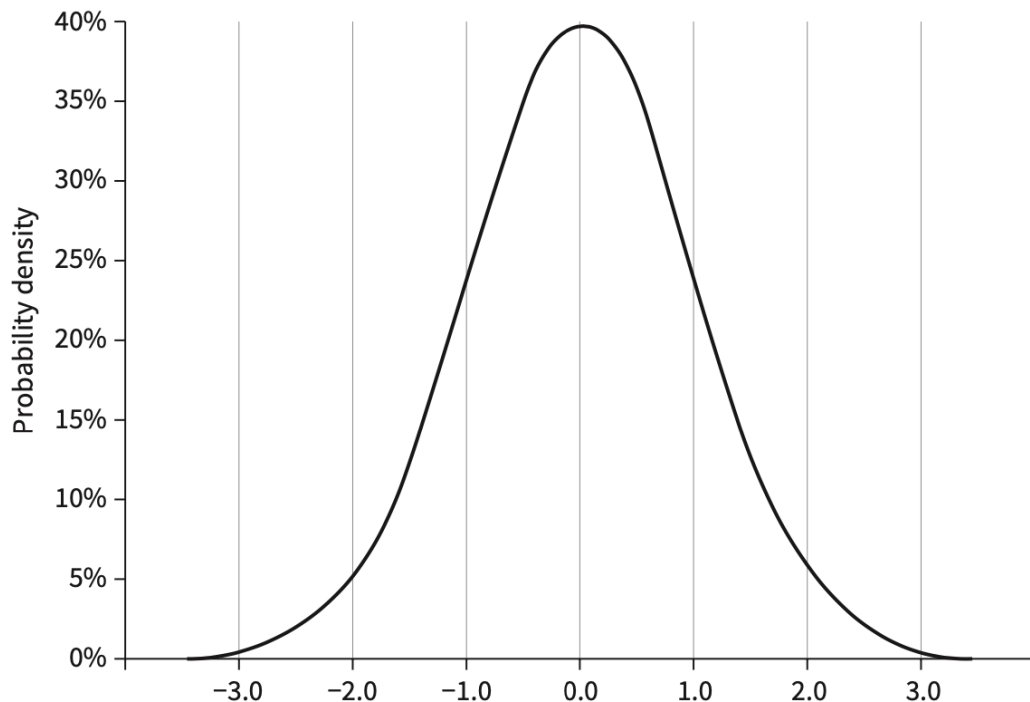
	S	V	I	R	D	Check
Susceptible (S)	0.198	0.100	0.700	0.000	0.002	1.000
Vaccinated (V)	0.000	0.998	0.000045	0.000	0.002	1.000
Infected (I)	0.000	0.000	0.129	0.865	0.006	1.000
Recovered (R)	0.000	0.000	0.000	0.998	0.002	1.000
Deaths (D)	0.000	0.000	0.000	0.000	1.000	1.000

Dealing with Uncertainty and Heterogeneity – Probabilistic Sensitivity Analysis (PSA)

- Different types of uncertainties:
 - Methodological uncertainty
 - Structural uncertainty
 - **Parametric uncertainty** – uncertainty in model input parameters
- Parametric uncertainty is best handled via probabilistic sensitivity analyses
 - PSA involves running a decision model multiple times
 - Each run of the model can be referred to as an iteration
 - Key parameters are included as draws from probability distributions

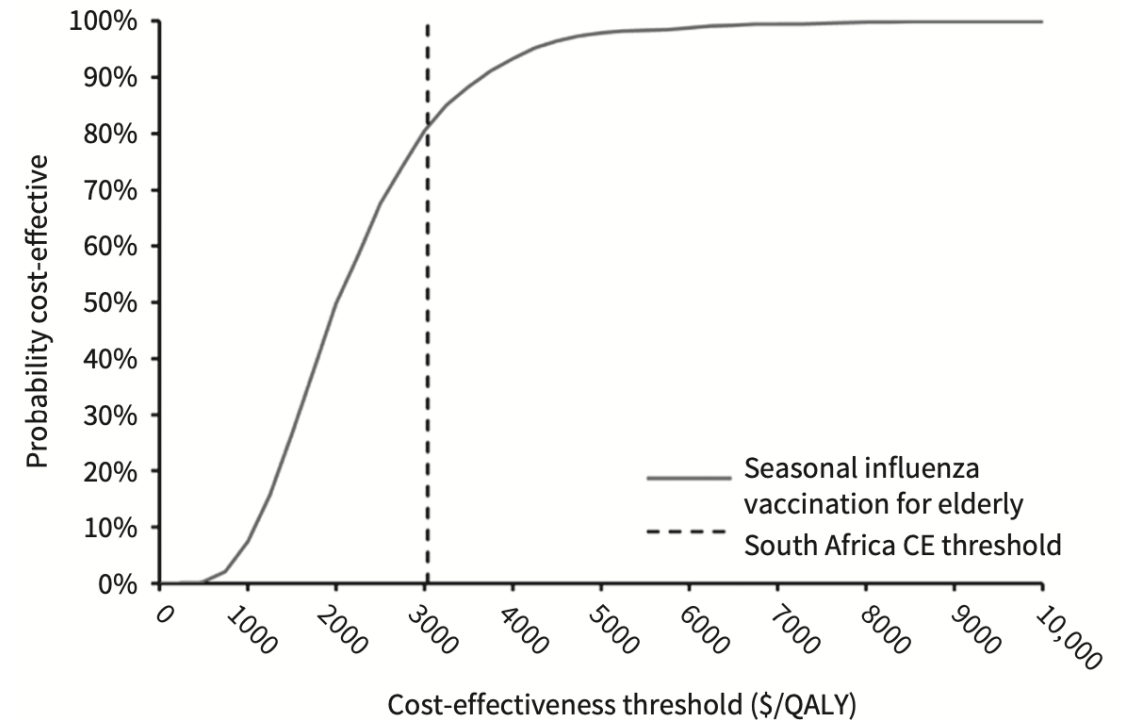
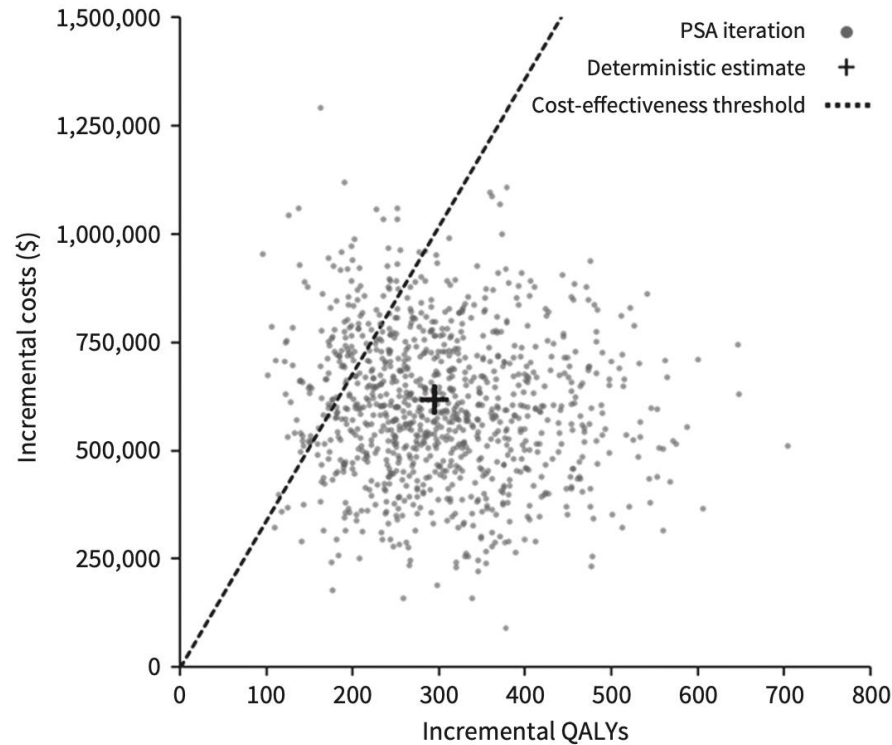
Which Distributional Assumptions to Use?

- Distributional assumptions should reflect the data generating process of the parameter, as reported by the supporting evidence
- Costs generally are best fitted by Gamma or Log-normal distributions
- Health utilities are best characterized by the Beta distribution



Representation of PSA Results

- PSA results can be depicted in the CEA plane and the cost-effectiveness acceptability curve (CEAC)



Value of Information (VOI) Analysis

- Results from a PSA can be used to estimate the value of further research
- VOI analysis quantifies the gains in expected health benefit associated with reducing uncertainty in model input parameters

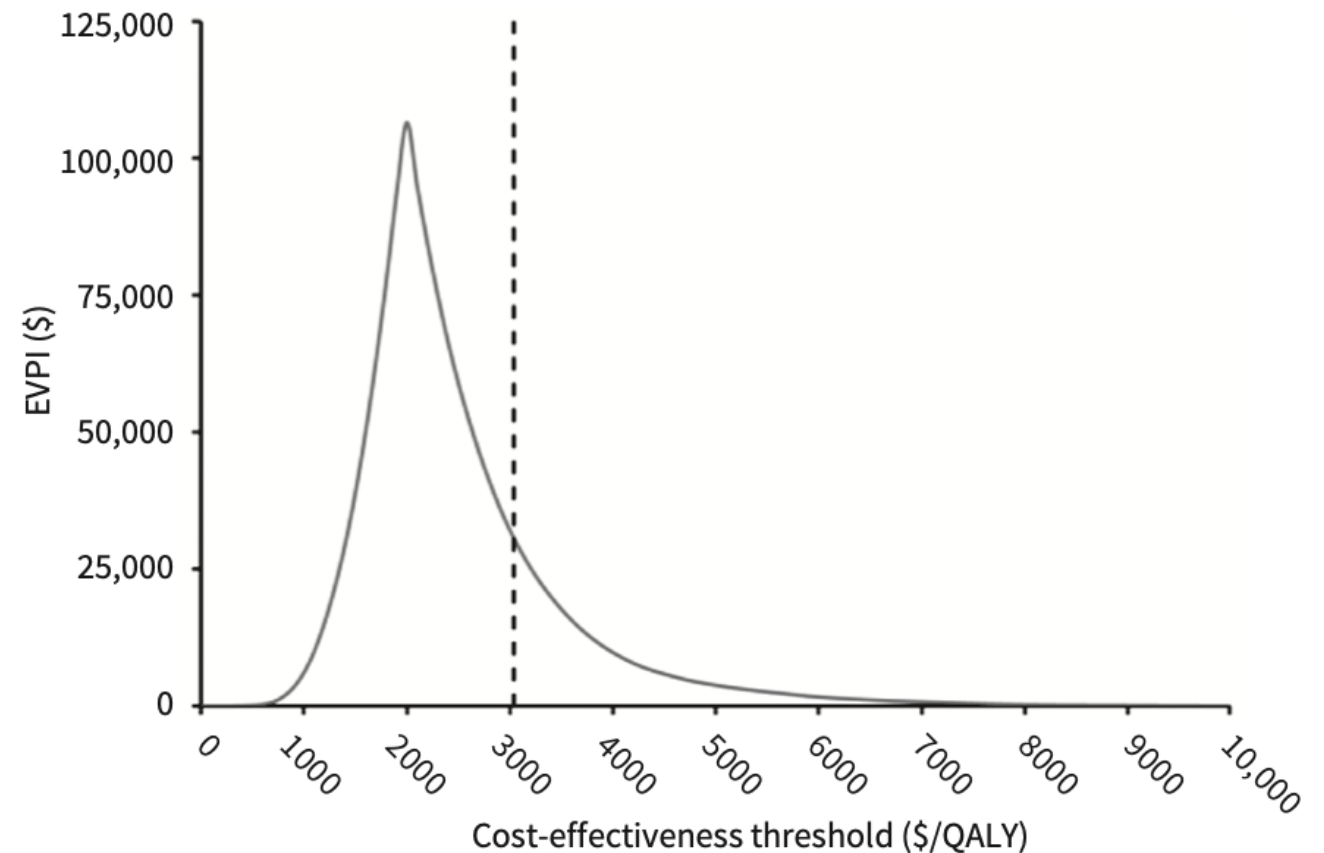
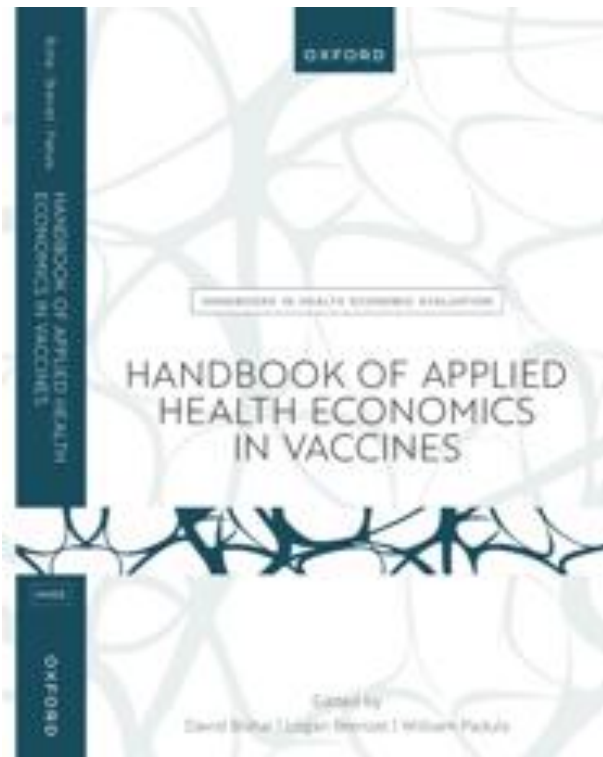


Fig. 4.3.6 Expected value of perfect information versus cost-effectiveness threshold.

The Handbook of Applied Health Economics in Vaccines



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