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Uncertainty and Healthcare Decision Making: A Dangerous Combination?

Incorporating risk aversion

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Disclosures

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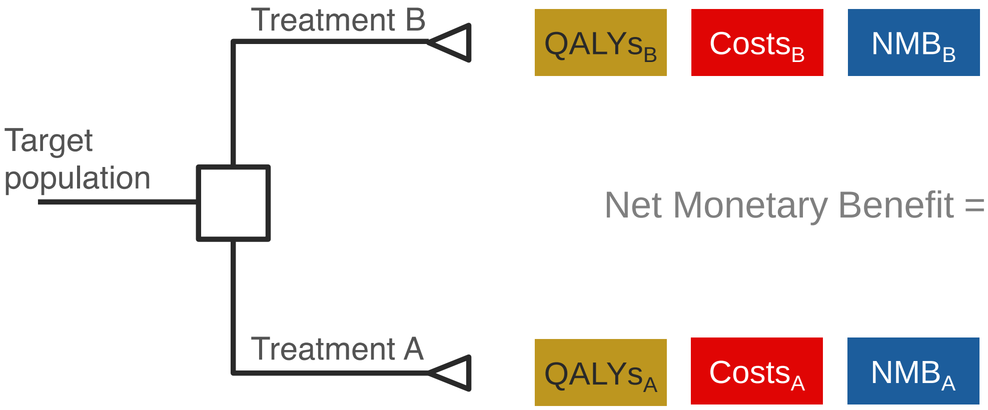
- Part-time employee Precision Medicine Group (Chief Scientist – Precision HEOR)
- Stockholder Precision Medicine Group

Uncertainty

- Parameter uncertainty
- Structural uncertainty

- Uncertainty individuals face regarding health outcomes

Conventional cost-effectiveness analysis



Net Monetary Benefit = Willingness-to-pay * QALYs - Costs

Treatment A			Treatment B			Incremental NMB
QALYs	Costs	NMB	QALYs	Costs	NMB	
4	20,000	380,000	6	200,000	400,000	20,000

Willingness-to-pay for a QALY is 100k

Incorporating risk aversion

	Mean	Variance
Physical	health outcomes	health outcomes *risk*
Financial	healthcare spending	healthcare spending *risk*
Full value	**Conventional value**	**Value of risk reduction “Value of insurance”**

Source: Lakdawalla D, Malani A, Reif J. The insurance value of medical innovation. Journal of public economics. 2017 Jan 1;145:94-102.

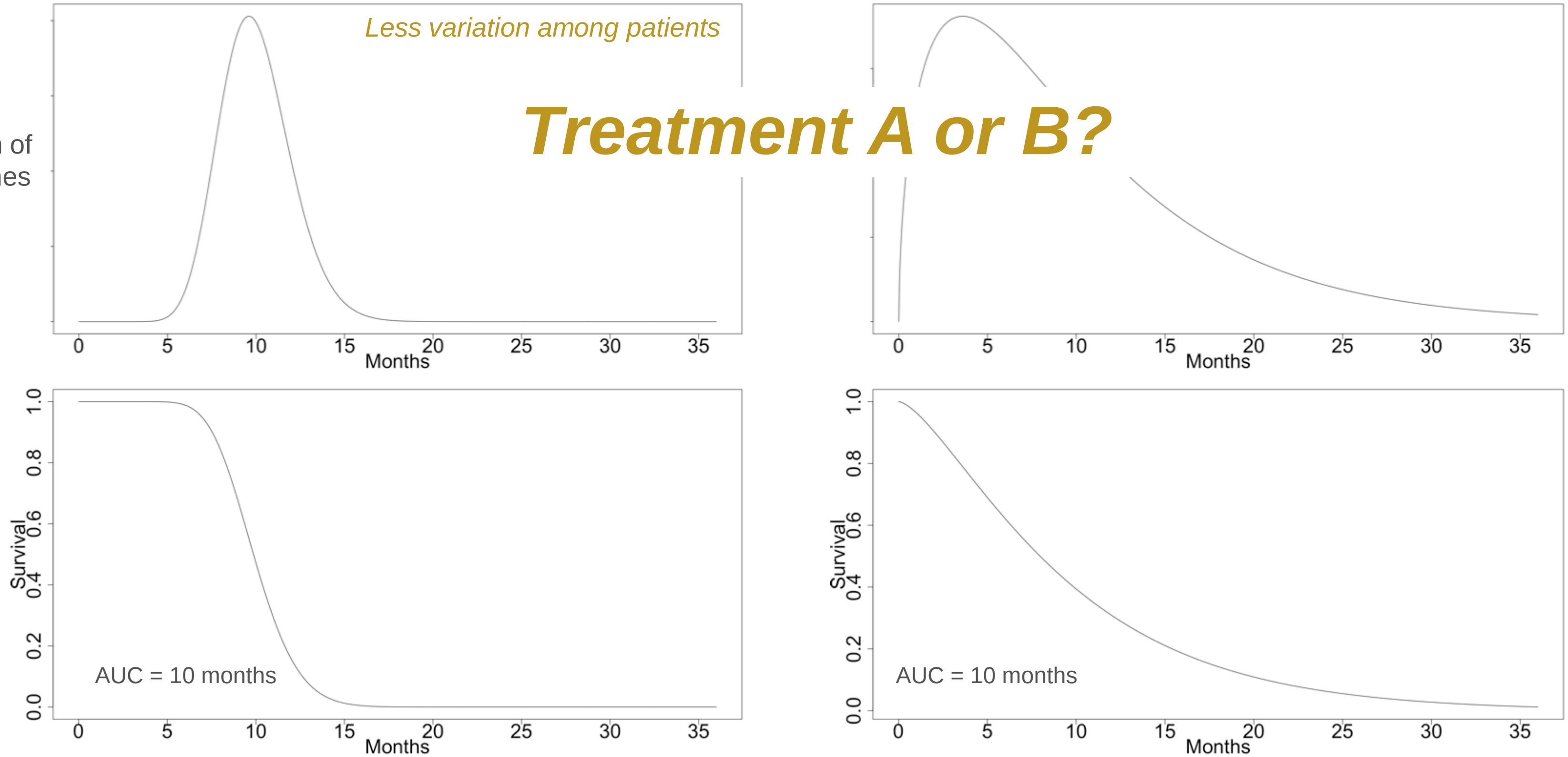
Variability in outcomes: ‘individual uncertainty’

Treatment A: Mean survival of 10 months

Treatment B: Mean survival of 10 months

Distribution of survival times

Survival curve



Source: Garrison LP, Jansen JP, Devlin NJ, Griffin S. Novel approaches to value assessment within the cost-effectiveness framework. Value in Health 2019;22(6S):S12-S17

Risk preference and certainty equivalent

- Utility function: $u(x) = x^{\eta}$
  - risk averse: $\eta < 1$
  - risk loving: $\eta > 1$

- The certainty equivalent, α_{AB}, for treatment *B* relative to *A* is computed by solving:

$$\int u(x - \alpha_{AB}) f_B(x) dx = \int u(x) f_A(x) dx$$

"How much do I need to subtract from x with B to make A and B equally valuable"

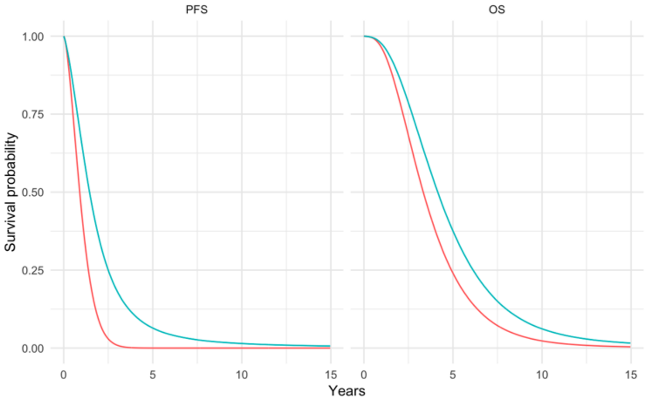
- Impact of risk-aversion/risk-loving on value can be calculated as is the difference between the certainty equivalent and difference in expected x with *A* and *B*:

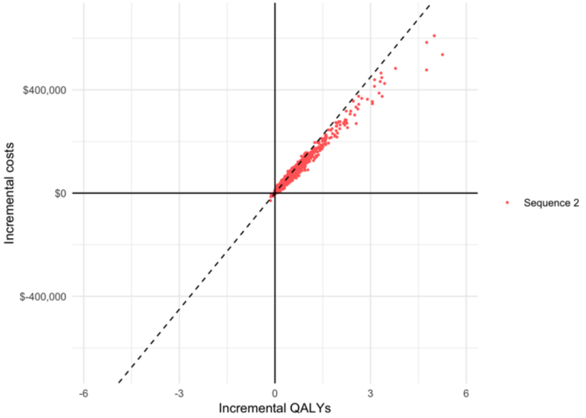
$$V_R = \alpha_{AB} - [E_B(x) - E_A(x)]$$

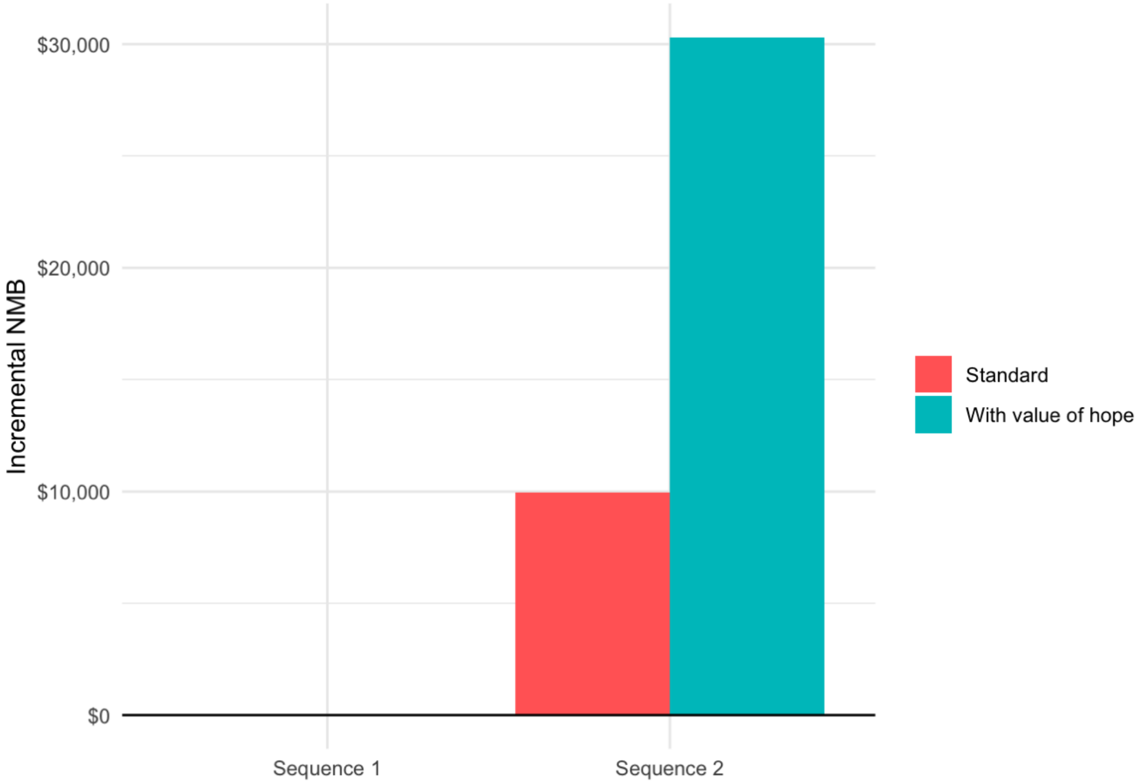
Source: Incerti D, Jansen JP. A Description of the IVI-NSCLC Model v1.0; last updated January 31, 2019; available from https://innovationvalueinitiative.github.io/IVI-NSCLC/modeldoc/model-doc.pdf.

https://innovationvalueinitiative.github.io/IVI-NSCLC/

CEA EGFR+ NSCLC; incorporating 'value of hope'







Source: Incerti D, Jansen JP. A Description of the IVI-NSCLC Model v1.0; last updated January 31, 2019; available from https://innovationvalueinitiative.github.io/IVI-NSCLC/modeldoc/model-doc.pdf.

Incorporating risk aversion among healthy individuals

$$dV = k \cdot dh - dc$$

$$dV_c = \pi(k \cdot dh - dc)$$

$$dV_F^{NHI} = \overbrace{\pi(k \cdot dh - dc)}^{\textit{Conventional value}} + \overbrace{\overbrace{\pi(1-\pi)\,\varphi\, k \cdot dh}^{\textit{Reduction in physical risk}} - \overbrace{\pi(1-\pi)\,\varphi\, dc}^{\textit{Increase in financial risk}}}^{\textit{Insurance value without health insurance}}$$

$$\varphi = \frac{\frac{u_c^s}{u_c^w} - 1}{\pi \frac{u_c^s}{u_c^w} + 1 - \pi}$$

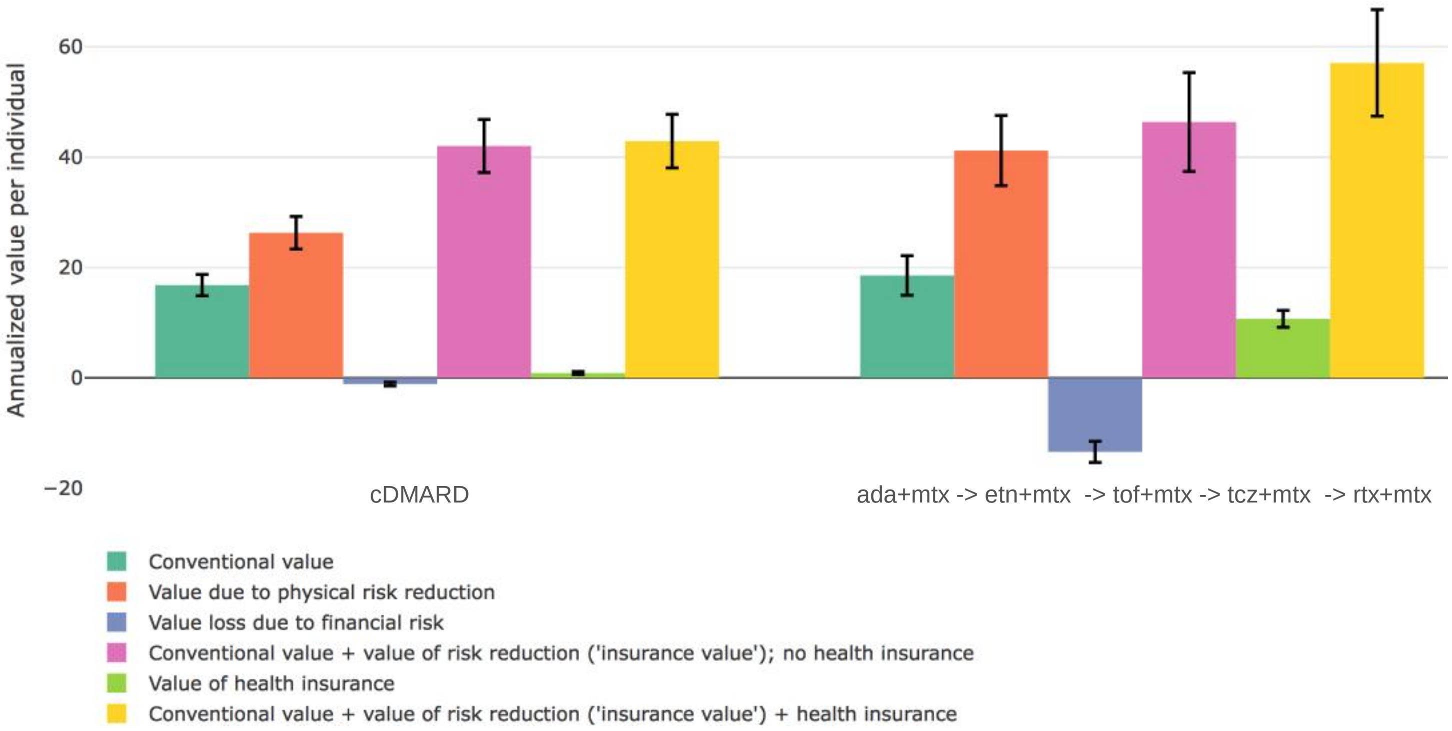
$$dV_F^{NHI} = (k \cdot dh - dc)\,[\pi + \pi(1-\pi)\,\varphi]$$

$$dV_F^{WHI} = (k \cdot dh - dc)\,[\pi + \pi(1-\pi)\,\varphi] + \overbrace{\rho\ \pi(1-\pi)\,\varphi\, dc}^{\textit{Value of health insurance}}$$

Source:
Lakdawalla D, Malani A, Reif J. The insurance value of medical innovation. Journal of public economics. 2017 Jan 1;145:94-102.
Incerti DI, Curtis JR, Shafrin J, Lakdawalla DN, Jansen JP. A flexible open-source decision model for value assessment of biologic treatment for rheumatoid arthritis. Pharmacoeconomics 2019;37:829-843.

CEA RA; Incorporating risk aversion among healthy individuals

$$\frac{u_c^s}{u_c^w} = 2.5$$

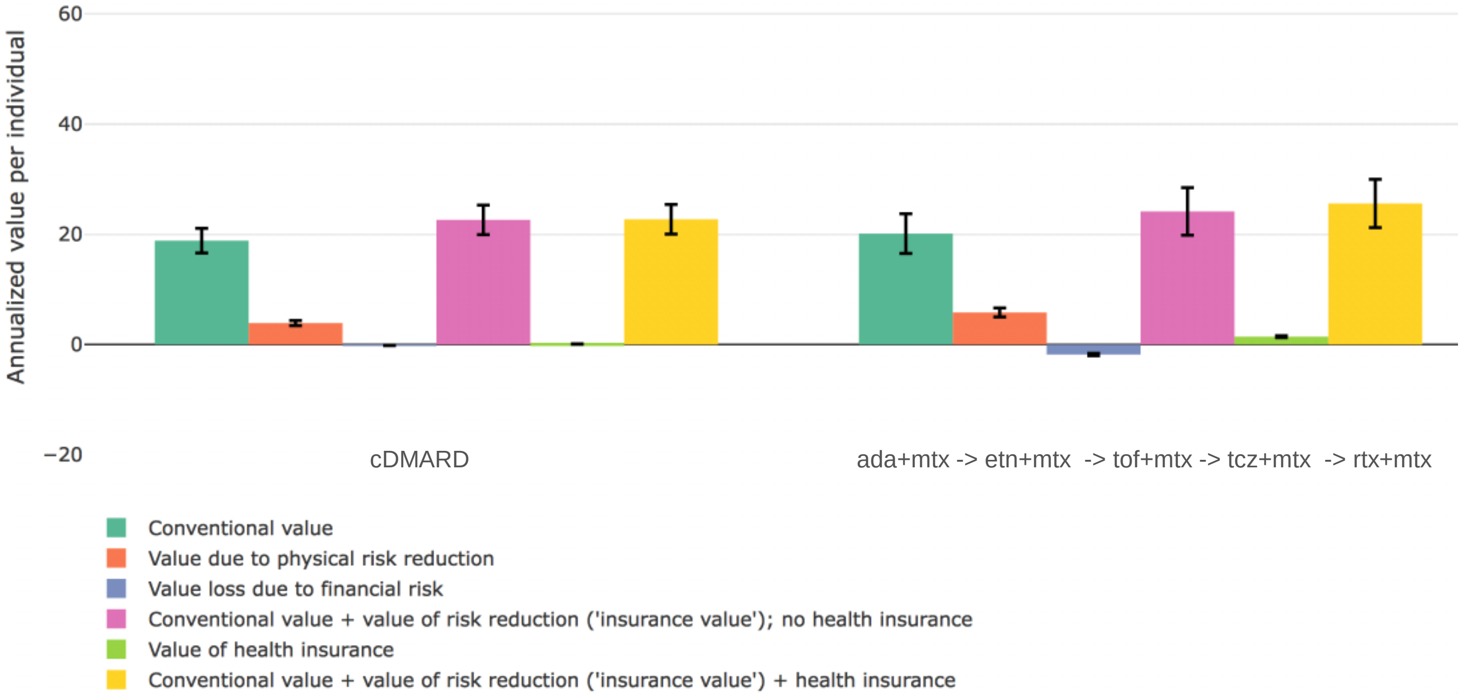


Source: Incerti DI, Curtis JR, Shafrin J, Lakdawalla DN, Jansen JP. A flexible open-source decision model for value assessment of biologic treatment for rheumatoid arthritis. Pharmacoeconomics. 2019;37:829-843.

https://innovationvalueinitiative.github.io/IVI-RA/

CEA RA; Incorporating risk aversion among healthy individuals

$$\frac{u_c^s}{u_c^w} = 1.2$$



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Summary

- Traditional CEA assumes individuals are risk neutral
- When we incorporate risk-aversion
  - Reduction in the dispersion (variance) of the distribution adds value (“Value of insurance”)
  - Increase in the positive skewness of the distribution adds value (“Value of hope”)

- Relevance?
  - When does it make a difference?

- Credibility?
  - Evidence for the required parameters
    - Marginal rate of substitution, risk aversion
  - Structural uncertainty
  - A coherent framework has been proposed recently (Lakdawalla and Phelps 2020)

Lakdawalla DN, Phelps CE. Health technology assessment with risk aversion in health. J Health Econ. 2020 Jul;72:102346.

Thank you

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