Measuring the spillover effect of cancer on family members' health: A US-based Empirical Analysis

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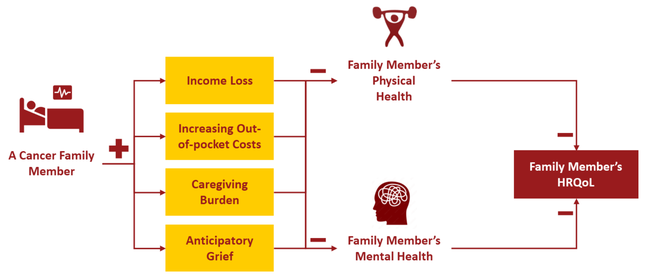
BACKGROUND

- Cancer affects not only patients' health but also the well-being of their family members, imposing substantial physical, emotional, and financial burden. This effect intensifies as patient health declines.
- Understanding and incorporating spillover effects into cost-effectiveness analyses (CEAs) is crucial for accurately assessing the value of cancer treatments.
- However, the lack of systematic data on cancer-related spillover effects remains a significant barrier.



*HRQoL: Health-Related Quality of Life

OBJECTIVE

- This study aims to build up an indirect measurements for family spillover effect that estimate health-related quality of life (HRQoL) loss among family members as a function of patients' HRQoL decline.
- The research question for this study is: how large is family member's HRQoL loss based on patients' HRQoL. For example, if one cancer patients' EQ-5D is 0.7, the family member's EQ-5D loss would be 0.1 based on indirect measurements on the population level.

METHODS

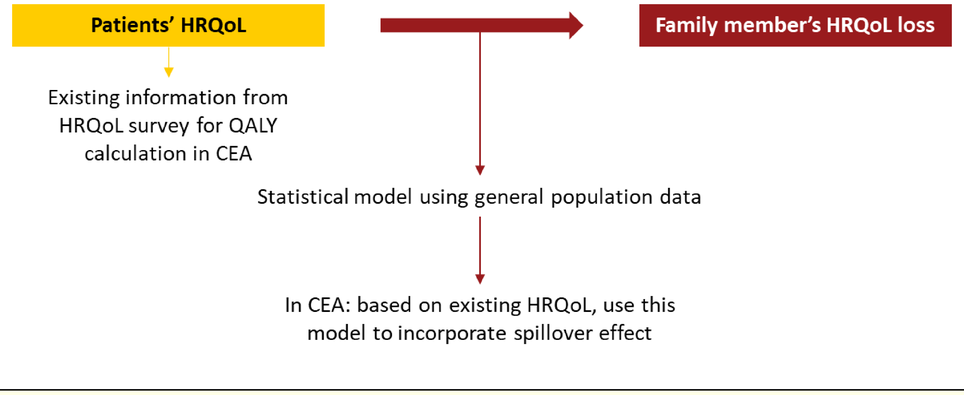
- We leveraged data from the Medical Expenditure Panel Survey from 2008 to 2019 to create a panel dataset of cancer patients and their family members.
- EQ-5D and VAS scores are transformed based on Gradient Boosting Machine (GBM) from SF-12v2 and VR-12 survey in MEPS.
- Families with cancer patients were included in treatment group while families without cancer patients served as a control group. HRQoL outcomes were measured using EQ-5D and VAS scores.
- A zero-one inflated beta regression model was employed to assess the association between family members' and patients' HRQoL scores, cancer status, patients' age and sex, adjusting for other demographic characteristics. The fitted regression model was then used to predict family HRQoL loss across varying levels of patient HRQoL loss and age.

$$g(u_{ij}) = \beta_0 + X_{ij}^T\beta + W_{ij}^T\gamma + Z_{ij}^T\eta$$

Main independent variables: Cancer indicator, patients' HRQoL, age and sex

Interaction terms of main independent variables

Control variables: family members' geographic characteristics, patients' other diseases indicators



RESULTS

Figure 1: EQ-5D and VAS loss trend of family members by patients' HRQoL loss, age and sex

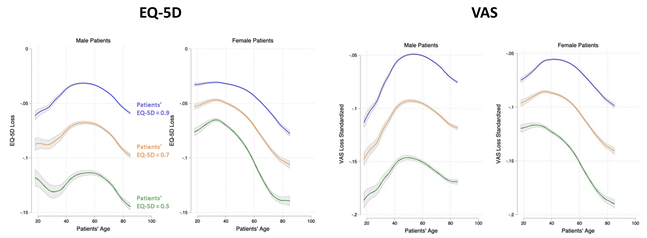
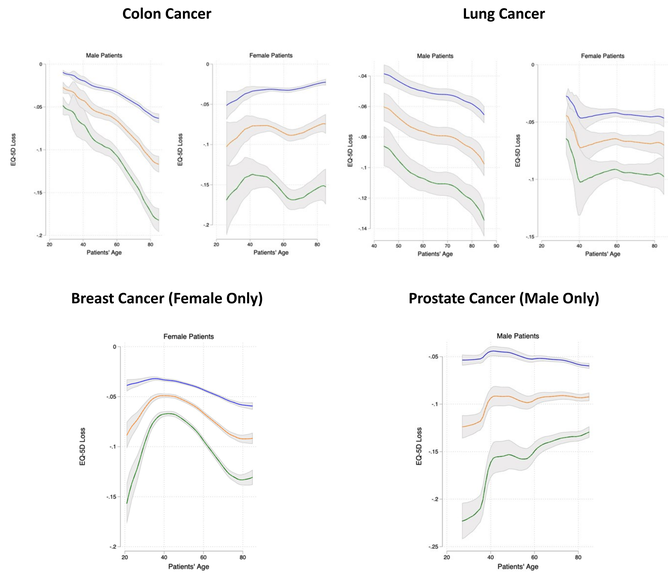


Figure 2: EQ-5D loss trend of family members of main cancer subcategories, by patients' HRQoL loss, age and sex



Key Findings

- The spillover effect will be expanded when patients are with **more severe cancer** and therefore lower HRQoL score.
- Family members' HRQoL loss will be larger when patients are **younger** (<35) and when patients are **getting older** (>60).
- The results for VAS score is similar to EQ-5D, but , but the absolute value (y-axis) is **lower** than EQ-5D and the change of VAS loss is larger than EQ-5D loss. This align with that **VAS is a more conservative method**.
- Figure 2 listed the trend for main cancer subcategories. Parts of them are with larger confidence interval due to sample size limitation. But it is interesting to notice that **different cancer types are with slightly different trends.**
- For example, the spillover effect for lung cancer by female cancer patients **increased first and decreased and then increased again.**
- Some cancer types are gender specific. It is understandable to observe that the spillover effect of prostate cancer is so huge when the patients are younger because they are more severe.

POLICY IMPACT

$$ICER = \frac{\Delta Cost}{\Delta Patient\ QALY + \Delta spillover\ effect}$$

$\Delta spillover\ effect$: *Disutility of family members' × time suffering*

- Drug A can extend both patients' life and utility, but it is the most expensive. After incorporating spillover effect, the ICER decreases $300 per QALY.
- Drug B can extend patients' life but decreases their utility. After including spillover effect, it becomes even more expensive in terms of ICER.
- Drug C cannot extend patients' life but increases their utility. It is cheapest but not as cheap as Drug A under traditional ICER calculation. However, after accounting for spillover effect, it has the lowest ICER.
- Including spillover effect in the CEA model will enhance the effect of improving patients' utility and favor drugs that not only focusing on extend patients' life.

Cancer Therapy	Length of Life (years)	Patient's Utility	Patient QALY	Cost($)	Traditional ICER (per QALY)	Family members' Disutility	Spillover Effect(QALY)	Spillover ICER (per QALY)
Control	3	0.7	2.1	10000		-0.06	-0.18	
A	5	0.9	4.0	25000	$7,900	-0.02	-0.1	$7,600
B	5	0.6	3.0	20000	$11,000	-0.08	-0.4	$15,000
C	3	0.9	2.7	15000	$8,000	-0.02	-0.06	$7,000

LIMITATION

- MEPS data incorporate cancer survivors. Those families with severe cancer patients might not be captured.
- Children (< 17) cancer patients cannot be identified due to privacy protection. Besides, children were not asked for SF-12 questionnaire.
- Updated data (instead of 2003) to bridge SF-12 and EQ-5D could elaborate this study result.

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