Spillover effects of medical innovations: A generic and scalable approach to measure the societal value of avoided informal care time

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Background

Informal care plays a vital role in delivering comprehensive care to both adult and pediatric patients. However, providing consistent informal care can significantly impact informal caregivers' available time for other activities, and may ultimately affect their productivity. This, in turn, can have wider societal consequences, contributing to strained household incomes and labour shortages, and hindering economic growth.

Objective

The aim of this research was to complement our existing methodology (VBA Health Cluster, Abdel-Wahab M et al. 2024)[1,2] for evaluating health-induced productivity gains of medical interventions (Social Impact) by quantifying the additionally avoided productivity loss of informal caregivers.

We aimed to estimate the reduction in caregiving hours resulting from therapeutic interventions that improve patients' health-related quality of life, and how this, in turn, affects informal caregivers' productivity. These productivity gains are valued in monetary terms and arise from the additional time available to informal caregivers that can potentially be redirected towards other productivity activities.

Methodology

We developed a methodology to project the impact of improved patient quality of life in terms of annual QALYs gained, resulting from a medical intervention, on the reduction of caregiving time for their caregivers. To achieve this, we adapted the model proposed by Rowen et al. (2016)[3] which establishes the relationship between patients' EQ-5D scores, and the corresponding number of caregiving days based on a large patient cohort (~40,000 individuals) across various disease areas, controlling for patient characteristics. The constant gradient resulting from the linear regression of the model predictions by age group and ICD-10 chapter allowed to derive the avoided care time irrespective of the patient's health condition prior to treatment. This calculation can be performed by utilizing only the incremental QALYs (Figure 1).

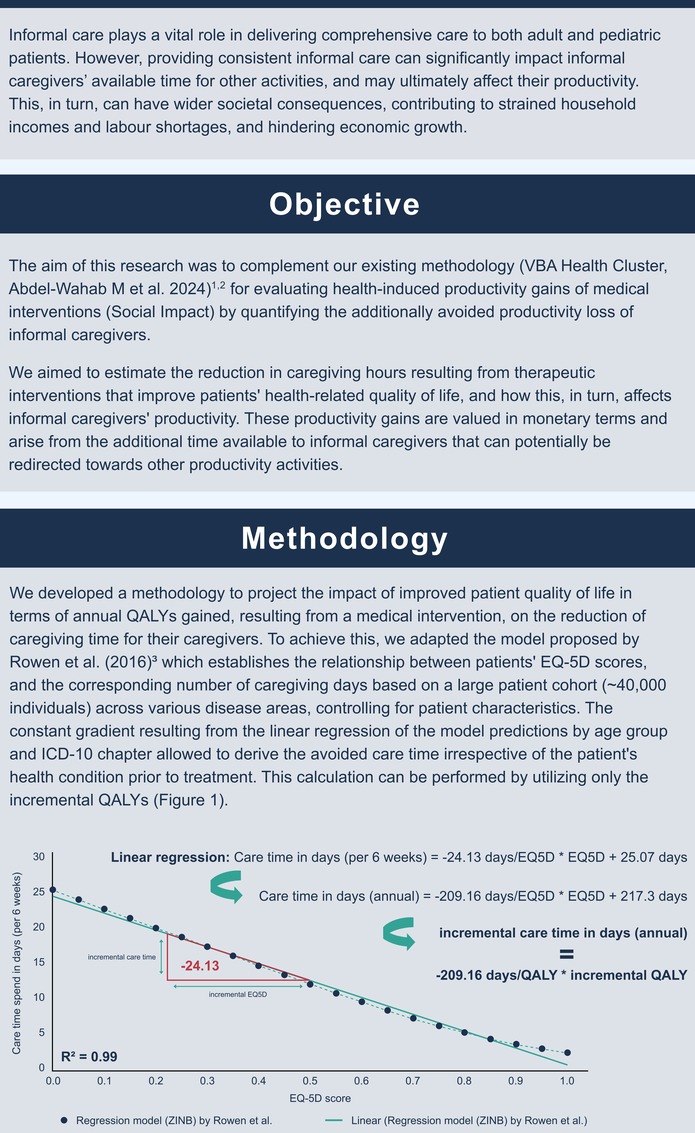

Figure 1: Linear regression on the predictions of the zero-inflated negative binomial (ZINB) model to describe the relationship between informal care time and EQ5D score. The ZINB was the preferred model by Rowen et al. 2016 to best predict the distribution of the informal care dependent variable. Example parameter set for a 39 year old female patient with multiple sclerosis (ICD-10 chapter G).

Instead of assuming that caregivers devote full time to informal care (i.e., 8 hours per day), the relationship was adjusted using average caregiving time estimates per day of 2.5 hours as reported in Gheorghe et al. (2019)[4]. Additionally, a so called "QALY-trap" correction factor, motivated by the work of Mott et al. (2023)[5], was established. To account for interventions primarily affecting the length of life, where additional caregiving may be required over a longer life span, the correction factor was calculated as the average value between two extreme scenarios: incremental QALYs derived solely from quality of life and from length of life, respectively.

This resulted in a 50% reduction of the initial EQ-5D–caregiving time gradient. These three adjustments allowed us to estimate changes in caregiving hours per day resulting from patients' incremental QALYs gained due to a medical intervention.

In a next step we made assumptions about the opportunity cost of time, i.e., how the newly available time for caregivers, resulting from the medical intervention, is redistributed across substitutable activities such as paid work, unpaid work, and leisure (Figure 2). These assumptions are based on time use patterns reported in the UN Time Use Statistics for paid and unpaid work[6], as well as the OECD's Time Use Database for leisure time (OECD 2024)[7].

As a final step, the productivity gains per caregiver resulting from the medical intervention were estimated. These gains were valued by using the Gross Value Added (GVA) measure. Additionally, spillover effects along the value chain were considered.

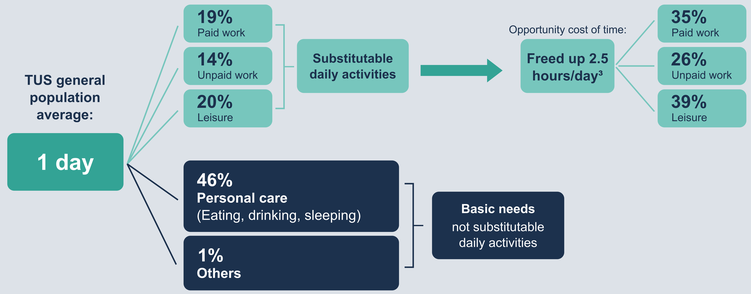

Figure 2: Opportunity cost of time – example with average time spend on daily activities in OECD and other countries[7]
TUS: Time Use Survey

Results

Using the developed methodology, we can link changes in patients' utility to productivity gains for caregivers resulting from any medical intervention for which incremental QALY data are available. Taking multiple sclerosis patients following treatment with Siponimod as an example (Schur et al. 2021)[8] we estimated that the reduced time spent on informal care results in a productivity gain for carers of $530 GVA per patient in the Netherlands and $708 GVA in Canada in 2024, which is additional 7.3% and 7.5% of patients' Social Impact (SI), respectively (Figure 3).

Canada shows a slightly higher SI, mostly attributed to the somewhat younger caregiver population and higher GVA per economically active person.

Case Example

Health benefit

Annual QALY gained per patient (undiscounted) from Siponimod treatment[8]: **0.0697**

Calculation of avoided caregiving time by patient age group

Age distribution of multiple sclerosis patients in the Netherlands[9]		Annual QALY gained per patient and age group
<20:	0.85%	0.0006
20–59:	62.40%	0.0435
≥60:	36.75%	0.0256

Avoided caregiving hours per annual QALY gained

Caregiving days by age group (Rowen et al. 2016)[3]		Correction factor		Caregiving hours per day (Gheorghe et al. 2019)[4]			
× 123.88 days	×	(0.5)	×	2.5h/day	=	0.092	19.69
× 209.15 days	×	(0.5)	×	2.5h/day	=	11.26	
× 262.84 days	×	(0.5)	×	2.5h/day	=	8.34	

Caregiving time distribution by caregiver age

Avoided caregiving hours	Age distribution of caregivers in the Netherlands[10]		Avoided caregiving hours per caregiver's age group
19.69	20–59:	65%	12.73
	≥60:	35%	6.96

*GVA per hour is based on TUS → E.g. Annual GVA[11] / hours spent on paid work per year [6]

Country effects in GVA per hour[11]

Direct effects from paid work	Indirect effects from paid work	Induced effects from paid work	Direct effects from unpaid work
71$	35$	21$	11$

Average proportion of time per day by activity[6,7]

Paid work: 29.4%
Unpaid work: 26.2%
Leisure: 44.4%

Social Impact of avoided caregiving time for Siponimod in the Netherlands: Direct, indirect and induced effects from paid work

Age of caregivers	Avoided caregiving hours	Paid work share	GVA per hour (from paid work)		SI of avoided caregiving time
20–59:	12.73	× 0.294	× 71$		= 264$
			× 35$	indirect	= 131$
			× 21$	induced	= 77$

Social Impact of avoided caregiving time for Siponimod in the Netherlands: Direct effects from unpaid work

Age of caregivers	Avoided caregiving hours	Unpaid work share	GVA per hour (from unpaid work)	SI of avoided caregiving time
>20 (20–59 & ≥60):	19.69	× 0.262	× 11$	= 57$

Figure 3: Example calculation of the avoided caregiving time and the resulting Social Impact (SI) for an average patient with multiple sclerosis treated with Siponimod in the Netherlands in 2024.

Conclusion

Informal care plays a crucial yet often underrepresented role in patient care. Our approach integrates the caregiver's perspective into economic evaluations as a conservative estimate, thereby quantifying the broader Social Impact of medical interventions. By offering a holistic framework, we provide a comprehensive understanding of how alleviating the burdens on both patients and caregivers can enhance societal well-being and drive economic growth.

Outlook

One of the key components of the methodology is that the relationship between patient utility and caregiving time is dependent on the disease in question (ICD-10 chapter specific). Further methodological refinements would enhance the estimation precision of the model. For instance, this could include incorporating different correction factors for interventions that primarily improve length of life rather than quality of life, as well as adjusting for varying levels of caregiving hours per day at the lowest patient utility scores.

Funding and conflict of interest

This work was funded by Novartis Pharma AG, Basel, Switzerland

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