Estimating marginal benefits of healthcare spending in the Netherlands

Part of a national project on displacement of care

(Funded by the National Health Care Institute (ZIN))

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Outline presentation

1. Background
2. Methods
3. Estimates of marginal spending in the Netherlands
4. Relevance for Policy
5. Discussion

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Background

- This research deals with establishing ***empirical*** thresholds

Burden of illness	Maximal marginal cost (€) per QALY
0.1- 0.4	€ 20,000 per QALY
0.41 - 0.7	€ 50.000 per QALY
0.71-1.0	€ 80.000 per QALY

Source: National Health Care Institute (ZIN)

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Simple theoretical model: a portfolio approach

Figure 1: Displacement due to market imperfections

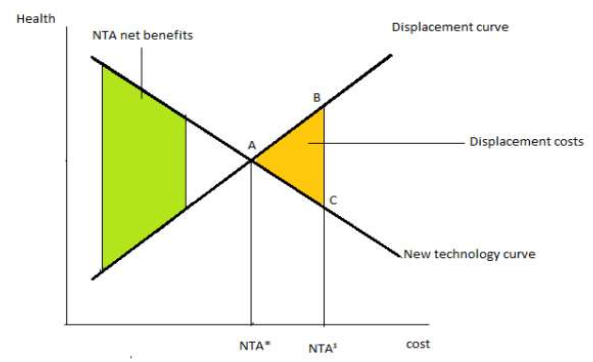

Figure 1: in optimum, new technology is adopted until the marginal value of the new technology equals the marginal value of displacement, which is at NTA*. In case of excessive NTA, for some new technologies the value is lower than the value of the displaced care. Excessive displacement costs are equal to the colored triangle ABC in figure 1.

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Estimating marginal benefits of healthcare spending in the Netherlands

- Aim: to estimate what an additional euro spend on hospital care is worth in terms of extra QALYs
- This could be viewed as cost effectiveness threshold: new technologies should at least match the threshold (benefits per euro spend at the margin); (otherwise health care becomes less efficient)
- We are interested in the **position** of the threshold
- Displacement of valuable care or displacement of valuable alternative spending

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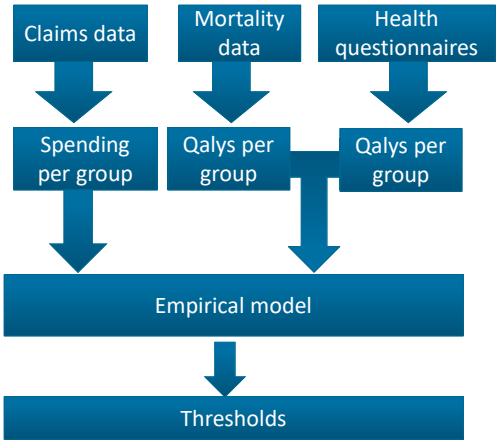
How do we estimate thresholds?

Claims (VEKTIS) 2012-2014
CBS mortality records 2010-2015
CBS quality of life 2010-2015

Healthy life expectancy (CBS)
Disease burden (Hoeymans et al., 2014)
EQ5D QALYS (Lamers et al., 2006)
LYOL costs (Van Baal et al., 2011)

Production function specification
Fixed effects panel estimation
Bootstrapped standard errors
Monte Carlo uncertainty modeling

Elasticity expressed in cost per QALY
Per gender, age group and disease group



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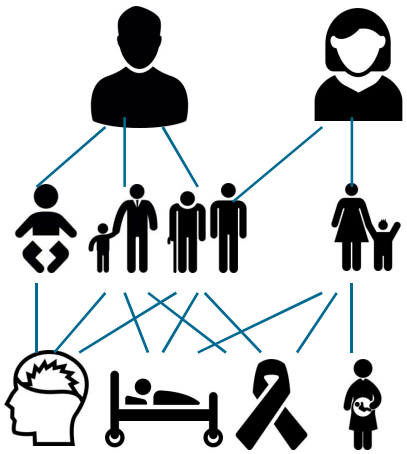
7 million patients

- Gender (2)
- 5-year age group (21)
- (ICD-10 based)Disease group (400)
- 11.000+ realistic and workable patient groups (as male 80-85 diabetes)



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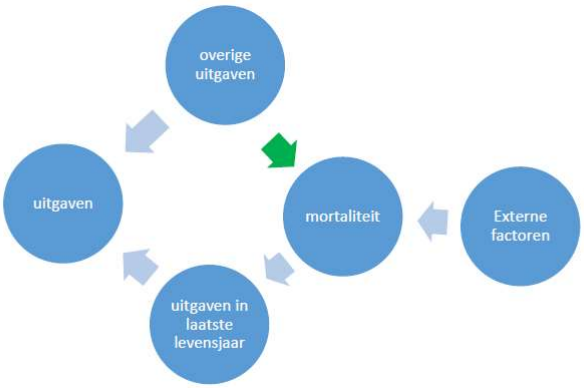
Spending and causality



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From mortality to QALYs

- Each death averted renders healthy life years based on general population (depending on age group)
- …. Mortality corrected for burden of illness (DALYs) of survivors …. (assuming disease with a higher burden generates less **healthy** life years)
- …. and discounted (1.5%) to disease corrected healthy life years valued at the current year… == QALYs

From morbidity to QALYs

- In the most optimal scenario, patients return to the quality of life of non patients (those that did not visit a hospital during a particular year)
- EQ-5D (mapped) QoL difference between patients and non-patients is the measure of morbibity decrease or QoL gain
- Changes in this QoL difference over time reflect health sector morbidity gains related/due to extra spending

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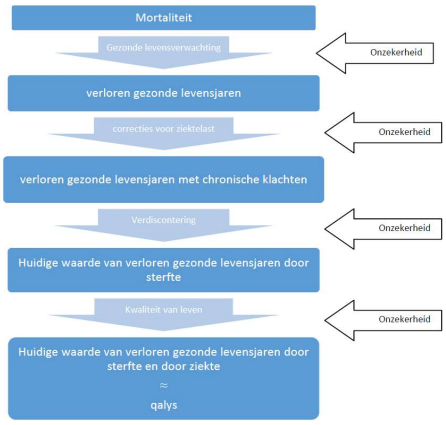
From Mortality and morbidity to QALYs



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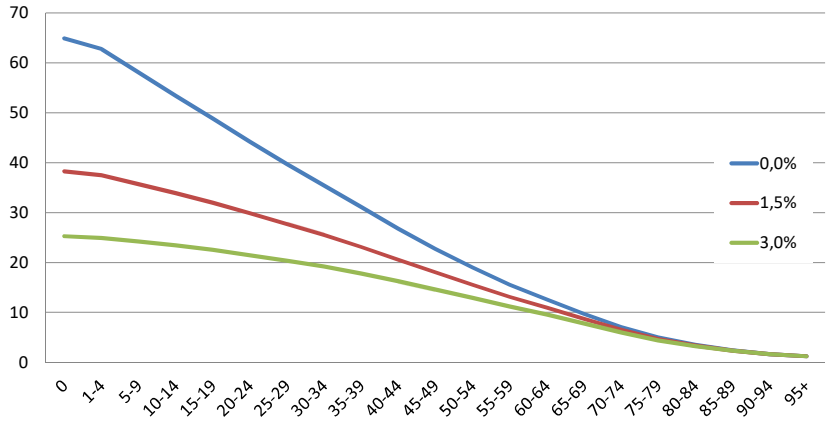
Impact discounting on healthy life years



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Assumptions and Model

- We relate changes in health outcomes (Q) per patient group over time to changes in spending (C) for patient groups over time (2012-2014).
- We define health outcomes per patient group as an unknown function of Spending and number of patients (N) (Need). So we want to know the relation of C on Q conditional exogenic health trends ((un)healthy behaviour induces a (un)healthier population, so (more)less patients)
- We assume diminishing marginal returns
- We not necessarily assume constant elasticities of substition (as Cobb-Douglas)
- We assume that the production function is behaving normally at relevant intervals
- We assume linearity in the parameters
- Therefore we choose a translog production function

$$\log(Q_{it}) = \alpha_1 + \alpha_2 T_{it} + \beta_1 Log(C_{it}) + \frac{1}{2}\beta_2 Log(C_{it})^2 + \theta_1 Log(N_{it}) + \frac{1}{2}\theta_2 Log(N_{it})^2 + \beta_3 Log(C_{it}) Log(N_{it}) + \varepsilon_i + \epsilon_{it}$$

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Elasticity of spending and Threshold

- The marginal effect of increased spending can therefore be obtained by evaluating the outcome elasticity of spending at the arithmetic mean.
- The elasticity of spending (e) is obtained by:

$$e = \frac{\delta \log(Q_{i,t})}{\delta \log(C_{i,t})} = \beta_1 + \beta_2 Log(\bar{C}_{i,t}) + \beta_3 Log(\bar{N}_{i,t})$$

- Next, the marginal effect of extra spending is calculated as a **threshold** value at the arithmetic mean:

$$\frac{\delta(C_{i,t})}{\delta(Q_{i,t})} = \frac{\bar{C}_{i,t}}{\bar{Q}_{i,t} * e}$$

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Results: overall threshold

	specificatie 1: alle patiëntgroepen	specificatie 2: patiëntgroepen met sterfte
Aantal patiëntgroepen	11079	3713
Geschatte elasticiteit	-0,156	-0,208
Gemiddeld aantal QALYs	145,7	346,2
Gemiddelde uitgaven	€ 1.678.091	€ 4.396.515
Marginale waarde	€ 73.600	€ 61.100
95%-betrouwbaarheidsinterval	€ 59.200-€ 88.100	€ 50,500- € 71,800

E**lasticity of spending of -0.1561** (If spending increases by 1%, QALYs lost decrease by about 0,16%).

Translating the mean elasticity of spending to a marginal effect (QALY) at the arithmetic mean results in a **threshold of € 73,626** (at 1.5% discount rate; **€66,500** at 0%)

We use bootstrapping to calculate the confidence intervals. We find a 95% confidence interval around the threshold value between € 59,178 and €88,076.

This is consistent over age groups and robust to alternative specifications

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Transformation uncertainty

Tabel 3. Uitkomsten Monte-Carlo simulaties

Onzekerheid	Variatie in marginale waarde	standaarddeviatie
gezonde levensverwachting	€ 69.400 - € 75.800	€ 877
kosten laatste levensjaar	€ 59.900 - € 80.800	€ 2,767
ziektegerelateerde QALYs	€ 69.700 - € 75.100	€ 732
ziektelast	€ 66.800 - € 70.500	€ 517
alle onzekerheid	€ 56.600 - € 79.000	€ 2,789

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Results per patient group

- **Male vs Female (Effect of longer female longevity?)**

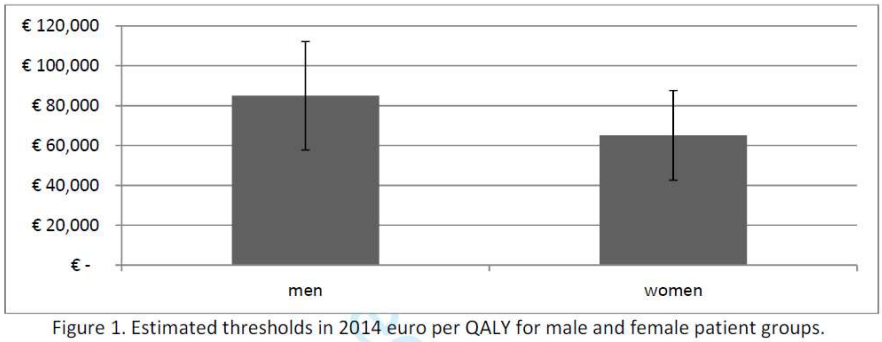

Figure 1. Estimated thresholds in 2014 euro per QALY for male and female patient groups.

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Results per patient group

- **Age groups compared (Is there an effect of discounting?)**

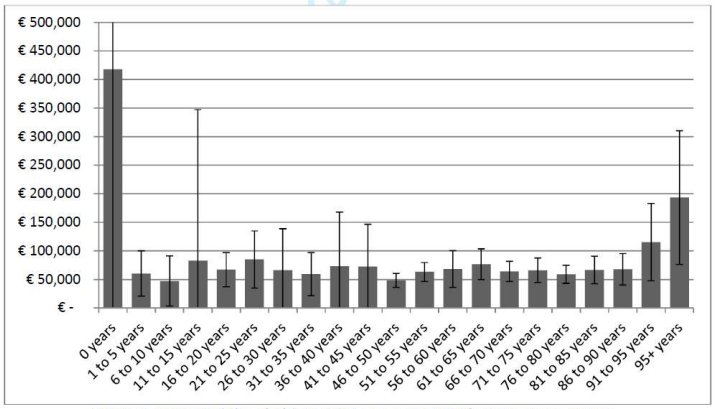

Figure 2. Estimated thresholds in 2014 euro per QALY for 5-year age groups.

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Results per patient group

- **Disease categories compared**

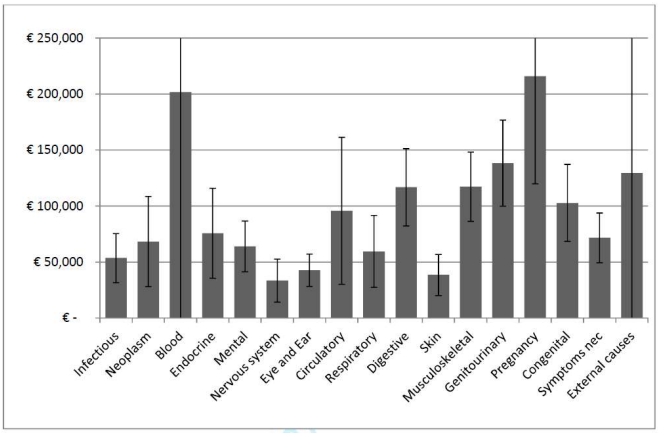

Figure 3. Estimated thresholds in 2014 euro per QALY for patient groups within ICD-10 categories.

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Effect on Health of an additional spending of €1.000.000

Categorie	grenswaarde	Uitgaven-elasticiteit	Investering bij 1 miljoen extra uitgaven	Aantal QALYs winst
infectieziekten	€ 53.500	5,8%	€ 58.041	1,08
nieuwvormingen	€ 68.300	26,6%	€ 266.065	3,89
bloedziekten	€ 201.800	6,1%	€ 60.882	0,30
endocriene aandoeningen	€ 75.700	6,8%	€ 68.312	0,90
psychische aandoeningen	€ 64.000	6,4%	€ 63.985	1,00
zenuwziekten	€ 33.500	5,9%	€ 58.779	1,76
oog- en oorziekten	€ 42.700	0,3%	€ 3.124	0,07
hart- en vaatziekten	€ 95.700	2,6%	€ 26.438	0,28
longziekten	€ 59.600	2,8%	€ 28.354	0,48
gastrointestinale ziekten	€ 116.800	5,9%	€ 58.778	0,50
huidziekten	€ 38.500	4,1%	€ 40.515	1,05
botspierziekten	€ 117.200	0,0%	€ -	0

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Relevance for Policy

- The National Health Care Institute regards this research as a validation for their threshold/reference value (€80.000)
- The National Health Care Institute will use the opportunity cost calculator, POINT 1.0 (build on the basis of this results of this study) in the appraisal of expensive medicines
- Can be used as input for Value based pricing
- This research offers the potential to prioritize hospital care related spending (based on marginal benefits per disease category)
- It also offers the potential to prioritize research in disease area's in the hospital sector
- Should we focus on sectoral cost-effectiveness and limit the alternative investment opportunities to the specific sector?

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POINT 1.0: input veld

P.O.I.N.T.	Presentatie van de Opportuniteitskosten van Introductie van Nieuwe (medische) Technologieën
Versie 1.0	

☑ toelichting

Budgetimpact nieuwe technologie	84,4	Miljoen euro
Kosteneffectiviteit nieuwe technologie	403.000	Euro per QALY

☑ meer opties

Parameters	
1. Open of gesloten budget	gesloten
2. Toestaan non-lineairiteit	ja
3. Engelse verdringingswaarden	nee
4a. Extra verdringing binnen ziektecategorie	0%
4b. ICD-hoofdstuk nieuwe technologie	alle hoofdstukken
5. Berekening uitgaven-elasticiteit	historisch
6. Eigen referentiewaarde	per QALY

Voor uitgebreide toelichting, zie document: Handleiding bij POINT 1.0

De uitkomsten worden berekend op basis van het rapport Verdringingseffecten binnen het Nederlandse zorgstelsel: op weg naar transparantie (te verschijnen) -->

<-- Vul hier de budgetimpact in miljoenen euro's in

<-- Vul hier de kosteneffectiviteitsratio (ICER) in van het nieuwe geneesmiddel

1. Bij een open budget (standaard) gaat het nieuwe geneesmiddel ten koste van andere investeringen, bij een gesloten budget gaat het nieuwe geneesmiddel ten koste van bestaande zorg.

2. Bij non-lineairiteit heeft een hogere budgetimpact effect op de drempelwaarde. Als non-lineairiteit niet wordt toegestaan is sprake van een lineaire relatie tussen uitgaven en uitkomsten, en heeft de budgetimpact geen invloed.

3. Standaard worden de empirische waarden uit het Nederlandse onderzoek naar verdringing gebruikt. In de VK wordt een andere metodologie gebruikt, die lagere drempelwaarden oplevert.

4a. Standaard nemen we aan dat de kosten van een nieuwe technologie over de hele ziekenhuiszorg wordt verdeeld. Het percentage van de kosten die binnen een afdeling extra wordt verdrongen kan worden verhoogd.

4b. Kies het betreffende ICD-hoofdstuk van de nieuwe technologie

5. Standaard wordt budgetdruk verdeeld op basis van historische verandering in uitgaven tussen 2012 en 2014. Alternatief is om budgetdruk proportioneel aan totale uitgaven over categorieën te verdelen.

6. Hier valt een eigen referentiewaarde in te vullen, bijvoorbeeld 80.000 euro per QALY.

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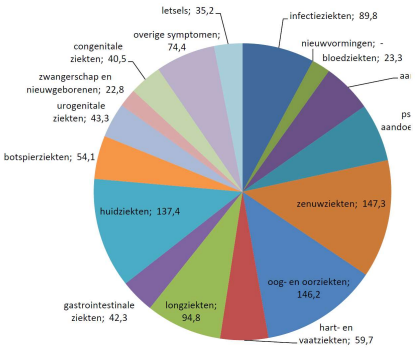
POINT 1.0: output veld

Uitkomsten

Aantal gewonnen QALYs	209
Aantal verloren QALYs	1145
Drempelwaarde	€ 73.711
Is de toelating kosteneffectief?	nee
Vereiste prijsdaling	82%

Netto gezondheidseffect	
-936	QALYs



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Discussion

- **Demand side**: through establishing Willingness To Pay for a QALY gained; Research estimates a WTP of between € 13.000 and € 110.000 per QALY (Bobinac et al. 2010; Bobinac et al. 2014; Nimdet et al. 2015).
- **Supply side**; econometric approach using claimsdata, mortality and quality of life data to determine the marginal benefits of spending; For example Claxton et al., 2015 find £13.000 per QALY.
- Higher threshold than UK, but (more) consistent with US (Hall & Jones, 2005), Switzerland (Felder, 2006) and US (Baumgardner, 2018)
- Baumgardner found for neoplasms a range of $69.000-$228.000 per additional QALY depending on cancer type

- Consistent with findings of the qualitative study
- Self-fulfilling prophecy (€80.000 at the margin)

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