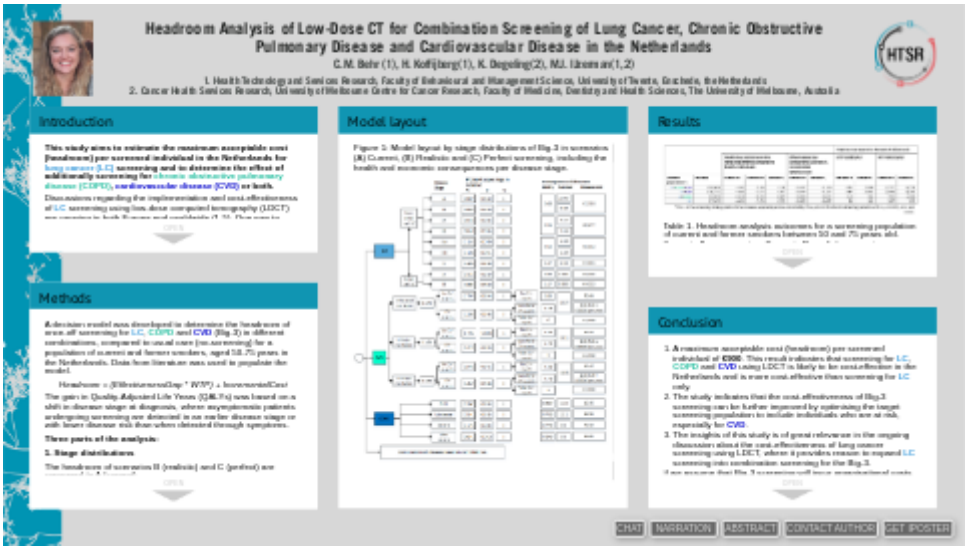
Headroom Analysis of Low-Dose CT for Combination Screening of Lung Cancer, Chronic Obstructive Pulmonary Disease and Cardiovascular Disease in the Netherlands



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INTRODUCTION

This study aims to estimate the maximum acceptable cost (headroom) per screened individual in the Netherlands for lung cancer (LC) screening and to determine the effect of additionally screening for chronic obstructive pulmonary disease (COPD), cardiovascular disease (CVD) or both.

Discussions regarding the implementation and cost-effectiveness of **LC** screening using low-dose computed tomography (LDCT) are ongoing in both Europe and worldwide (1-5). One way to potentially increase economic viability is by introducing combination screening. Whether extending **LC** screening with screening for **COPD** and **CVD** is beneficial can be investigated in a headroom analysis.

METHODS

A decision model was developed to determine the headroom of once-off screening for **LC**, **COPD** and **CVD** (Big-3) in different combinations, compared to usual care (no-screening) for a population of current and former smokers, aged 50-75 years in the Netherlands. Data from literature was used to populate the model.

$$Headroom = (EffectivenessGap * WTP) + IncrementalCost$$

The gain in Quality-Adjusted Life Years (QALYs) was based on a shift in disease stage at diagnosis, where asymptomatic patients undergoing screening are detected in an earlier disease stage or with lower disease risk than when detected through symptoms.

Three parts of the analysis:

1. Stage distributions

The headroom of scenarios B (realistic) and C (perfect) are compared to A (current)

- A: Current stage distributions as found in the Netherlands, no-screening.
- B: The realistic stage distribution when screening is implemented.
- C: The hypothetical perfect screening scenario, where all patients are detected in the first disease stage.

2. Varying target populations

The effect of screening different subgroups on the headroom of screening may be substantial. Therefore, the headroom is calculated for two easily identifiable groups, which are high-risk groups of the Big-3 (6).

(1) Current smokers over the age of 18 in the Netherlands

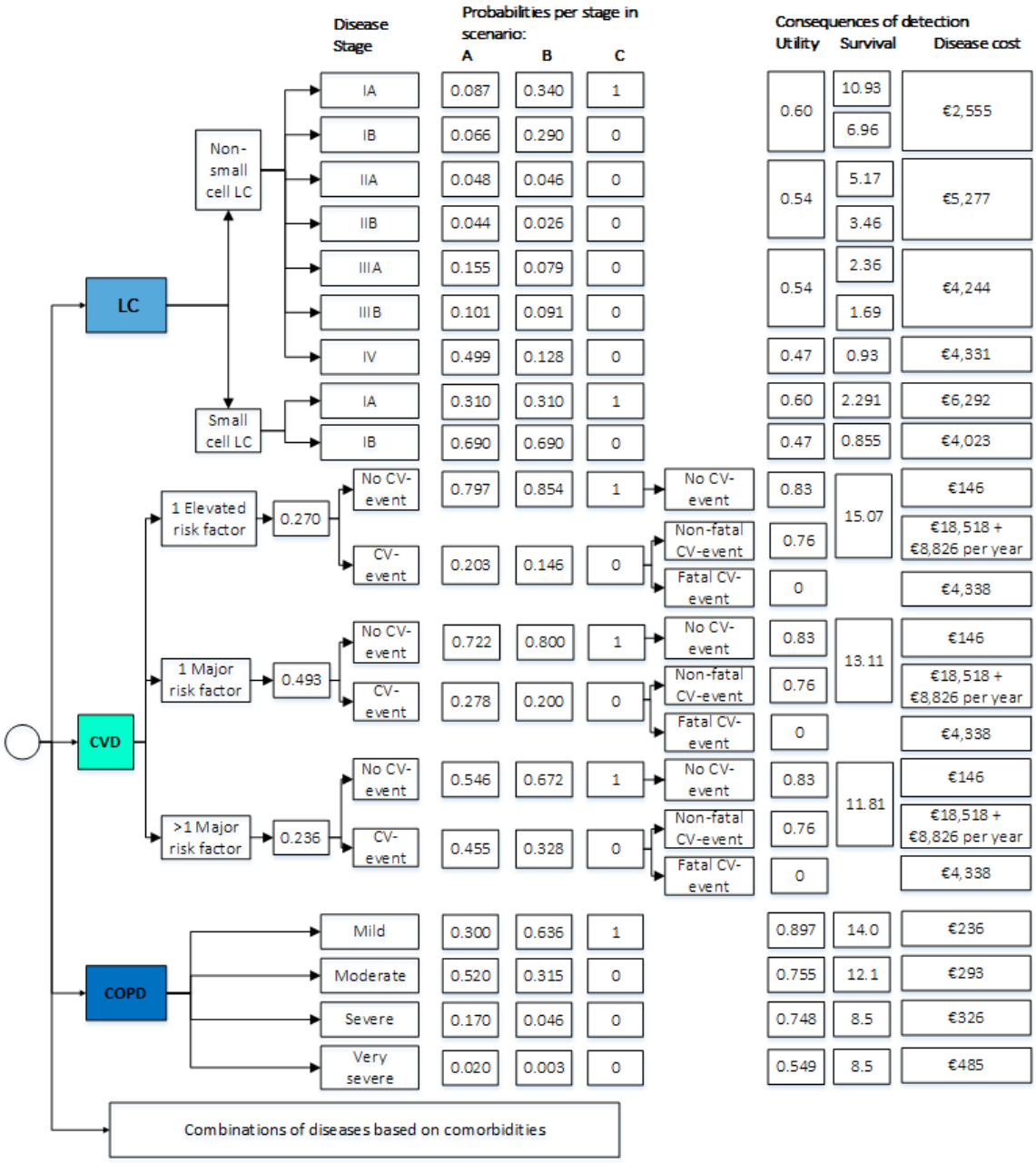
(2) Individuals, 60 years and older in the Netherlands

3. Varying incidence rates

- Why: For the stage distributions and varying target populations, above, the target screening populations focus on individuals with a high risk for **LC**. This is logical when considering the expansion of **LC** screening, but might not be the most cost-effective approach for combination screening. Although **COPD** and **CVD** have risk factors similar to those of **LC** and thus have an overlapping high-risk group, the target screening population could also focus on a population with higher risks and subsequently higher incidence rates for **COPD** or **CVD**. An indication of whether this is true can be shown, by calculating the headroom value for multiple combinations of incidence rates for the three diseases.
- What: Here, the headroom will be calculated for a range of **LC** incidence rates, in combination with a range of **COPD** and **CVD** incidence rates separately.

MODEL LAYOUT

Figure 1: Model layout by stage distributions of Big-3 in scenarios (A) Current, (B) Realistic and (C) Perfect screening, including the health and economic consequences per disease stage.



RESULTS

		Health loss in QALYs over the remaining lifetime compared to healthy individuals			Effectiveness Gap compared to Scenario A (incremental QALY/person)		Headroom compared to Scenario A (€/person) WTP €20k/QALY		WTP €80k/QALY	
Disease population*:	Patients	Scenario A	Scenario B	Scenario C	Scenario B	Scenario C	Scenario B	Scenario C	Scenario B	Scenario C
LC+COPD+CVD	155,966	-4.95	-3.90	-2.28	0.047	0.120	954	2,586	3,777	9,778
LC+CVD	136,752	-4.86	-3.75	-1.97	0.044	0.114	884	2,461	3,496	9,283
LC+COPD	43,666	-5.24	-4.54	-3.87	0.009	0.017	214	391	743	1,420
LC	13,262	-4.45	-3.59	-2.52	0.003	0.007	91	181	287	623

*The + in the screening strategy refers to the diseases separately and as comorbidity. Thus, LC+COPD refers to detecting patients with LC, or COPD, or LC and COPD.

Table 1. Headroom analysis outcomes for a screening population of current and former smokers between 50 and 75 years old. Scenario A, no screening; Scenario B, realistic screening; Scenario C, perfect screening.

		Health loss in QALYs over the remaining lifetime compared to healthy individuals			Effectiveness Gap compared to Scenario A (incremental QALY/person)		Headroom compared to Scenario A (€/person) WTP €20k/QALY		WTP €80k/QALY	
Disease population*:	Patients	Scenario A	Scenario B	Scenario C	Scenario B	Scenario C	Scenario B	Scenario C	Scenario B	Scenario C
LC+COPD+CVD	108,665	-5.56	-4.42	-2.87	0.041	0.097	828	2,052	3,292	7,840
LC+CVD	77,963	-5.17	-4.00	-2.25	0.030	0.075	605	1,627	2,404	6,144
LC+COPD	51,250	-6.36	-5.27	-4.24	0.019	0.036	402	761	1,514	2,924
LC	6,044	-4.95	-3.85	-2.52	0.002	0.005	57	115	189	407

*The + in the screening strategy refers to the diseases separately and as comorbidity. Thus, LC+COPD refers to detecting patients with LC, or COPD, or LC and COPD.

Table 3. Headroom analysis outcomes for the smoking population of the Netherlands. Scenario A, no screening; Scenario B, realistic screening; Scenario C, perfect screening.

		Health loss in QALYs over the remaining lifetime compared to healthy individuals			Effectiveness Gap compared to Scenario A (incremental QALY/person)		Headroom compared to Scenario A (€/person) WTP €20k/QALY		WTP €80k/QALY	
Disease population*:	Patients	Scenario A	Scenario B	Scenario C	Scenario B	Scenario C	Scenario B	Scenario C	Scenario B	Scenario C
LC+COPD+CVD	220,366	-5.06	-3.89	-2.06	0.059	0.150	1,150	3,214	4,659	12,232
LC+CVD	201,796	-4.93	-3.75	-1.83	0.054	0.142	1,058	3,038	4,291	11,529
LC+COPD	37,316	-6.17	-5.08	-4.01	0.009	0.018	207	395	761	1,495
LC	8,822	-4.95	-3.85	-2.52	0.002	0.005	57	115	189	407

*The + in the screening strategy refers to the diseases separately and as comorbidity. Thus, LC+COPD refers to detecting patients with LC, or COPD, or LC and COPD.

Table 4. Headroom analysis for individuals over 60 years of age in the Netherlands. Scenario A, no screening; Scenario B, realistic screening; Scenario C, perfect screening.

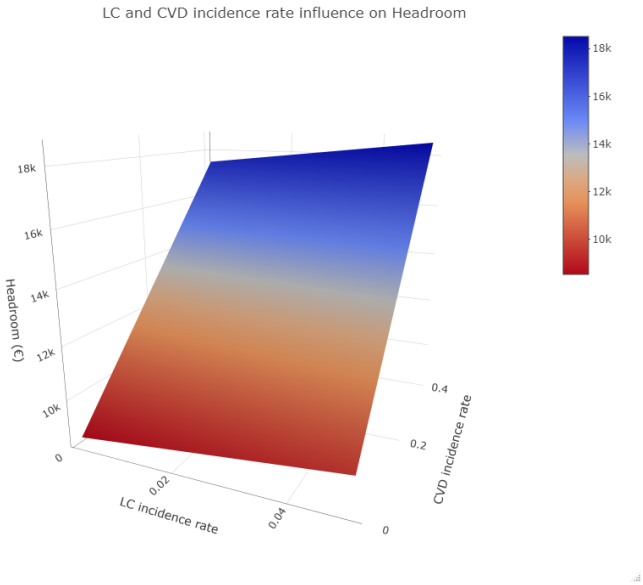


Figure 2: The influence of **CVD** incidence rate on the headroom

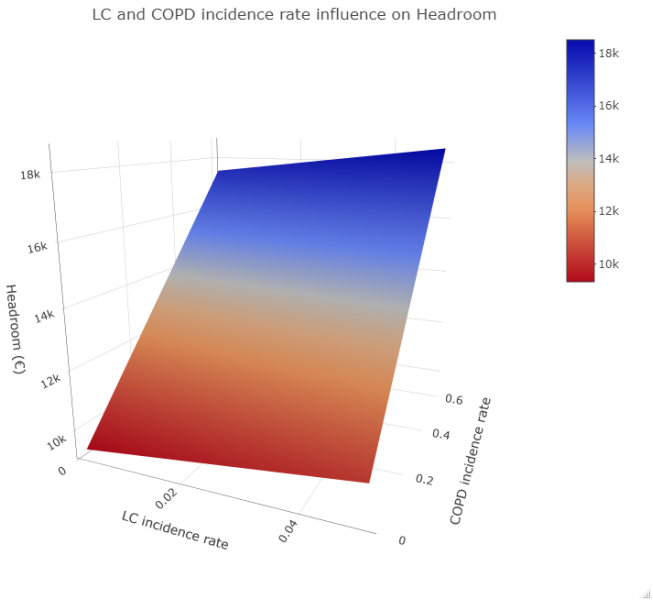


Figure 3 The influence of **COPD** incidence rate on the headroom

CONCLUSION

1. A maximum acceptable cost (headroom) per screened individual of **€900**. This result indicates that screening for **LC**, **COPD** and **CVD** using LDCT is likely to be cost-effective in the Netherlands and is more cost-effective than screening for **LC** only.
2. The study indicates that the cost-effectiveness of Big-3 screening can be further improved by optimising the target screening population to include individuals who are at risk, especially for **CVD**.
3. The insights of this study is of great relevance in the ongoing discussion about the cost-effectiveness of lung cancer screening using LDCT, where it provides reason to expand **LC** screening into combination screening for the Big-3.

If we assume that Big-3 screening will incur organisational costs comparable to a cost of €420 for breast and cervical cancer screening (10), a headroom of €90 for **LC** screening compared to no-screening with a realistic stage shift and a WTP of €20k/QALY seems to be in contrast with studies from various countries concluding that **LC** screening in itself is cost-effective. However, higher WTP thresholds were applied in these studies, ranging between 21-85k€/ life year gained (LYG) and 30-140k€/QALY (1–5). With a WTP of €80k/QALY the headroom for **LC** screening increases to €300 per screened individual for organisational. Hence, our results for **LC** screening align with those from previous studies.

References

1. Snowsill T, Yang H, Griffin E, Long L, Varley-Campbell J, Coelho H, et al. Low-dose computed tomography for lung cancer screening in high-risk populations: a systematic review and economic evaluation. Health Technol Assess (Rockv) [Internet]. 2018;22(69):1–276. Available from: http://10.0.12.238/hta22690

2. Black WC, Gareen IF, Soneji SS, Sicks JD, Keeler EB, Aberle DR, et al. Cost-Effectiveness of CT Screening in the National Lung Screening Trial. N Engl J Med [Internet]. 2014;371(19):1793–802. Available from: http://10.0.4.32/nejmoa1312547

3. Hofer F, Kauczor H-U, Stargardt T. Cost-utility analysis of a potential lung cancer screening program for a high-risk population in Germany: A modelling approach. Lung Cancer [Internet]. 2018;124:189–98. Available from: http://10.0.3.248/j.lungcan.2018.07.036

4. ten Haaf K, Tammemägi MC, Bondy SJ, van der Aalst CM, Gu S, McGregor SE, et al. Performance and Cost-Effectiveness of Computed Tomography Lung Cancer Screening Scenarios in a Population-Based Setting: A Microsimulation Modeling Analysis in Ontario, Canada. PLOS Med [Internet]. 2017 Feb 7;14(2):e1002225. Available from: https://doi.org/10.1371/journal.pmed.1002225

5. Tomonaga Y, ten Haaf K, Frauenfelder T, Kohler M, Kouyos RD, Shilaih M, et al. Cost-effectiveness of low-dose CT screening for lung cancer in a European country with high prevalence of smoking—A modelling study. Lung Cancer [Internet]. 2018;121(May):61–9. Available from: https://doi.org/10.1016/j.lungcan.2018.05.008

6. Heuvelmans MA, Vonder M, Rook M, Groen HJM, De Bock GH, Xie X, et al. Screening for Early Lung Cancer , Chronic Obstructive Pulmonary Disease , and Cardiovascular Disease (the Big-3) Using Low-dose Chest Computed Tomography Current Evidence and Technical Considerations. Thorac Imaging. 2019;34(3):160–9.

7. Horeweg N, van der Aalst CM, Vliegenthart R, Zhao Y, Xie X, Scholten ET, et al. Volumetric computed tomography screening for lung cancer: three rounds of the NELSON trial. Eur Respir J [Internet]. 2013 Dec 1;42(6):1659 LP – 1667. Available from: http://erj.ersjournals.com/content/42/6/1659.abstract

8. Volksgezondheidenzorg.nl. Coronaire hartziekten→Cijfers & Context→Huidige situatie [Internet]. 2018 [cited 2019 Nov 12]. Available from: https://www.volksgezondheidenzorg.info/onderwerp/coronaire-hartziekten/cijfers-context/huidige-situatie#node-prevalentie-en-nieuwe-gevallen-coronaire-hartziekten-huisartsenpraktijk

9. Afonso ASM, Verhamme KMC, Sturkenboom MCJM, Brusselle GGO. COPD in the general population: Prevalence, incidence and survival. Respir Med [Internet]. 2011;105(12):1872–84. Available from: http://www.sciencedirect.com/science/article/pii/S0954611111002125

10. Ekwueme DU, Subramanian S, Trogdon JG, Miller JW, Royalty JE, Li C, et al. Cost of services provided by the National Breast and Cervical Cancer Early Detection Program. Cancer [Internet]. 2014 Aug 15;120 Suppl 16(Suppl 16):2604–11. Available from: https://pubmed.ncbi.nlm.nih.gov/25099904

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ABSTRACT

OBJECTIVES

Discussions regarding the implementation and cost-effectiveness of lung cancer (LC) screening using low-dose computed tomography (LDCT) are ongoing. One way to potentially increase economic viability is by introducing combination screening. Whether extending LC screening with screening for chronic obstructive pulmonary disease (COPD) and cardiovascular disease (CVD) is beneficial can be investigated in a headroom analysis. This study aimed to estimate the maximum acceptable cost (headroom) per screened individual for LDCT LC screening and determine how this estimate is impacted by additionally screening for COPD, CVD or both.

METHODS

A decision model was developed to determine the headroom of once-off screening for LC, COPD and CVD (Big-3) in different combinations, compared to usual care (no screening) for a population of current and former smokers, aged 50-75 years in the Netherlands. The effectiveness gap in quality-adjusted life-years (QALYs) gained per screened individual was estimated, which in combination with the disease cost and the willingness-to-pay (WTP) provided the headroom per screened individual. The gain in QALYs was based on a shift in disease stage at diagnosis, where asymptomatic patients undergoing screening are detected in an earlier disease stage or with lower disease risk than when detected through symptoms. Data from literature was used to populate the model.

RESULTS

The maximum acceptable cost per individual for LC screening is €181, adding COPD increases this to €391, adding CVD increases this to €2,461 and screening for the Big-3 to €2,586, for a WTP of €20k/QALY. A more favourable cost-effectiveness is expected when focusing on a target screening population with a substantial risk of COPD and CVD compared to only focusing on LC incidence.

CONCLUSION

Extending LC screening with CVD screening results in larger headroom than adding COPD screening. The headroom is largest for combination screening of the Big-3 but depends heavily on the target screening population.