Cost-Effectiveness of Volume Computed Tomography in Lung Cancer Screening: A Cohort Simulation Based on NELSON Study Outcomes

Pan X[1,2], Dvortsin E[2], Baldwin DR[3], Groen HJM[1], Ramaker D[2], Ryan J[4], Velikanova R[5], Oudkerk M[2], Postma MJ[1]

[1]University of Groningen, Groningen, NH, Netherlands, [2]The institute for DiagNostic Accuracy, Groningen, Netherlands, [3]University of Nottingham, Nottingham, Netherlands, [4]AstraZeneca, Cambridge, CAM, UK, [5]Asc Academics, Groningen, GR, Netherlands

EE304

Introduction

- Lung cancer remains the leading cause of cancer-related death worldwide [1].
- In the United Kingdom (UK), approximately 35,157 lung cancer deaths occur every year, accounting for 21% of all cancer related deaths [2].
- Among lung cancer patients, approximately 50% are diagnosed at stage IV, with a 5-year survival rate of 2.9%, while only 15% are identified at stage I, with a corresponding 5-year survival rate of 56.6% [2]
- The NELSON study is the largest European randomized lung cancer screening trial, and the latest NELSON study publication in February 2020 reported a lung cancer mortality reduction of 24-33% for high-risk individuals [3]

Objective

- To evaluate the cost-effectiveness of lung cancer screening (LCS) with volume-based low-dose computed tomography (CT) versus no screening for an asymptomatic high-risk population in the United Kingdom (UK) utilising the long-term insights provided by the NELSON study.

Methods

- A cost-effectiveness analysis was conducted to compare 17 rounds of annual LCS with volume CT versus no screening for a lung cancer high-risk population, based on the volumetric protocol of the NELSON study.
- High-risk population was defined as individuals aged 50-74 years with a heavy smoking history [4].
- A de novo economic model, based on the UK National Health Service (NHS) perspective was developed comprising two components:

1. A decision tree was used to simulate the identification and workup diagnoses for lung cancer patients based on the NELSON study outcomes (Figure 1)
2. A state-transition Markov model simulated the treatments and long-term survival for lung cancer patients by stage at initial diagnosis (Figure 2)

- 17 annual rounds of screening reflected the difference in average age in NELSON (58 years) and the upper range of the screening protocol (74 years)
- Outcomes estimated include the number of lung cancers identified, lung cancer mortality, costs, quality-adjusted life years (QALYs), and the incremental cost-effectiveness ratio (ICER) and estimated over a lifetime.
- Main input parameters are outlined in Table 1 and Table 2.

Table 1: Survival and health state utility parameters

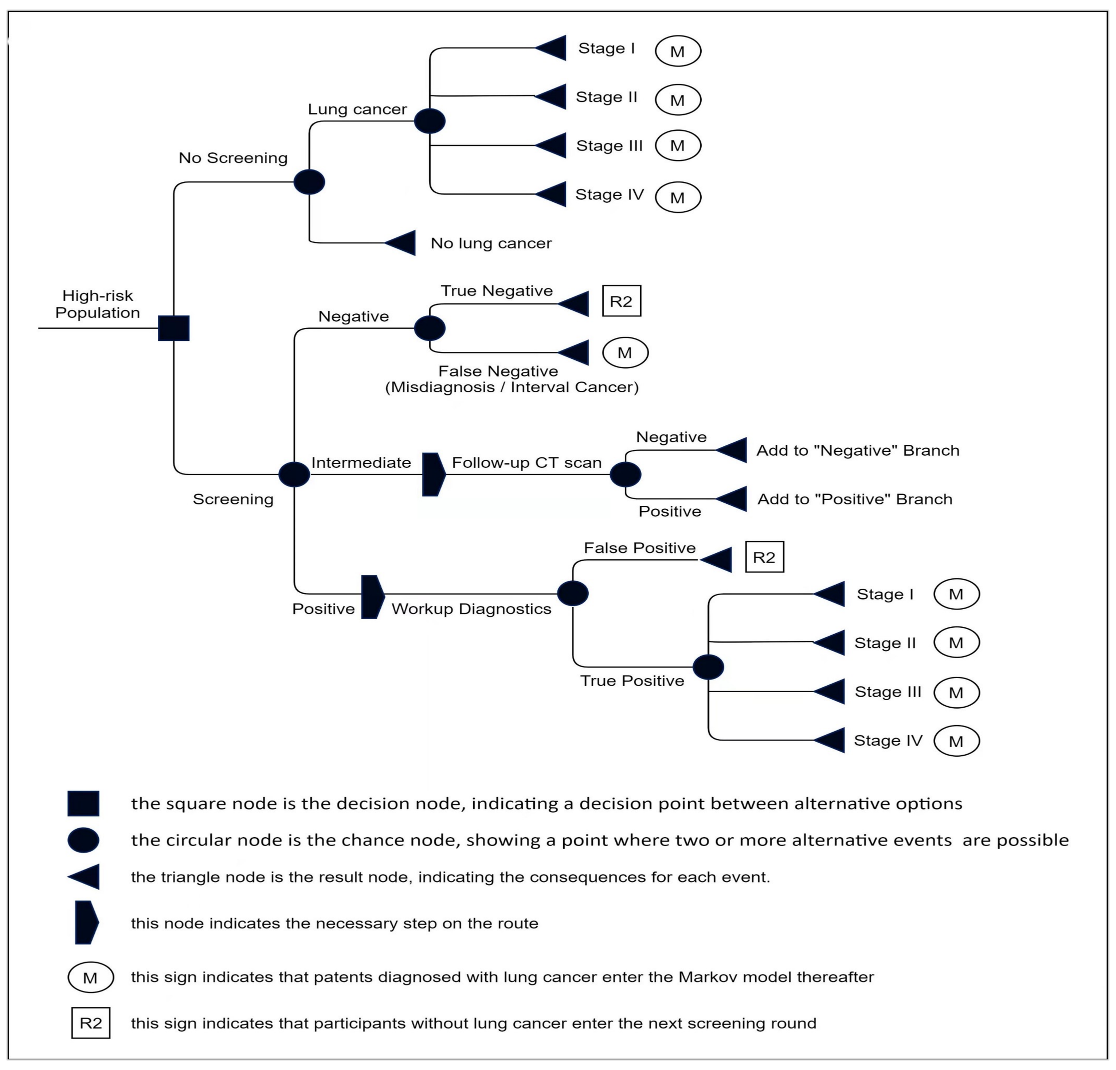
Stage	5 year overall survival [5]	1 year disease / progression free survival [6-10]	Health state utility [11]
I	78.63%	87.80%	0.71
II	54.90%	87.80%	0.68
III	29.24%	41.77%	0.67
IV	5.74%	36.17%	0.66

Table 2: Key cost inputs

Resource	Cost
CT scan [12]	£89.00
Diagnostic cost (screening arm) [4, 12-14]	£404.76
Diagnostic cost (non-screening arm) [4, 12-14]	£619.76

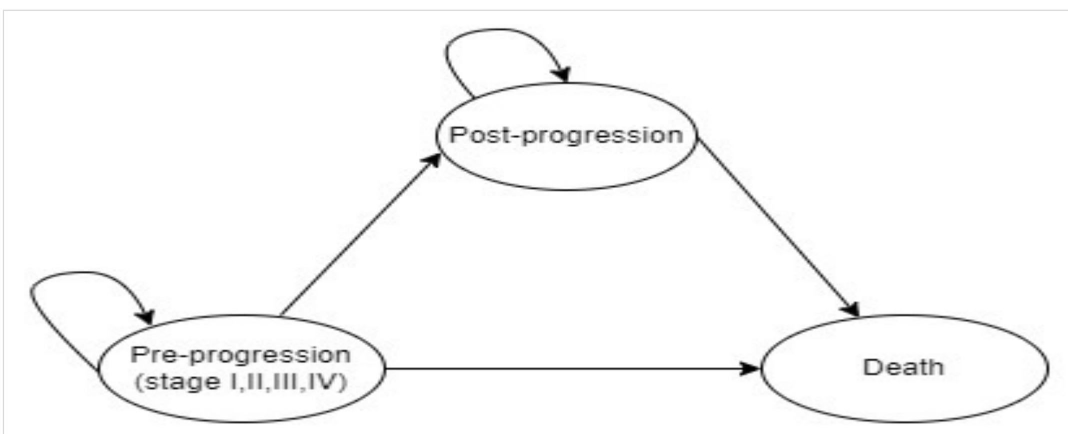
- All cause, background mortality was applied to those not diagnosed with lung cancer [15].
- The 46.5% uptake of LCS was based on the uptake rate observed in the local UK Lung Screening Trial [16]
- The LCS adherence rate was assumed to be 100%.

Figure 1: Decision tree for lung cancer screening with volume computed tomography



- In the no screening arm, lung cancer patients were diagnosed through clinical presentation, while in the screening arm, eligible population would go through a volume CT scan.
- Screening participants who eventually had a negative baseline scan (either directly, after an indeterminate follow-up scan, or being a confirmed false positive scan after diagnostic work-ups) entered the next screening round (R2) in the next year, as annual screening is recommended for LCS.

Figure 2: State-transition Markov model based on the natural history of lung cancer



- Patients enter the Markov model in the pre-progression state and transitioned to the post-progression state, then the death state over time.
- Background mortality was also considered in the model to adjust for other causes of death.
- Individuals were assumed to be in one of three mutually exclusive health states at any given time: a) pre-progression; b) post-progression; or c) death (both lung cancer deaths and background mortality).

Results

- With a 46.5% uptake rate, 1,306,960 individuals were screened
- Compared to no screening, 17 annual rounds of volume CT screening resulted in 96,100 more lung cancer cases detected in early cancer stages, where they can be treated more effectively with a curative intent, and 74,953 fewer cases in later cancer stages, averting 64,839 premature lung cancer deaths (Figure 3).
- Using a lifetime time horizon, the total QALYs gained were 386,773 at an additional cost of approximately £3,322 million, resulting in an ICER of £8,589 per QALY. The QALYs gained per patient diagnosed was 2.9. The cost-effectiveness acceptability curve is presented in Figure 4.
- Estimates were robust to sensitivity analysis.

Figure 3: Shift in lung cancer diagnoses and mortality through lung cancer screening after 17 annual rounds

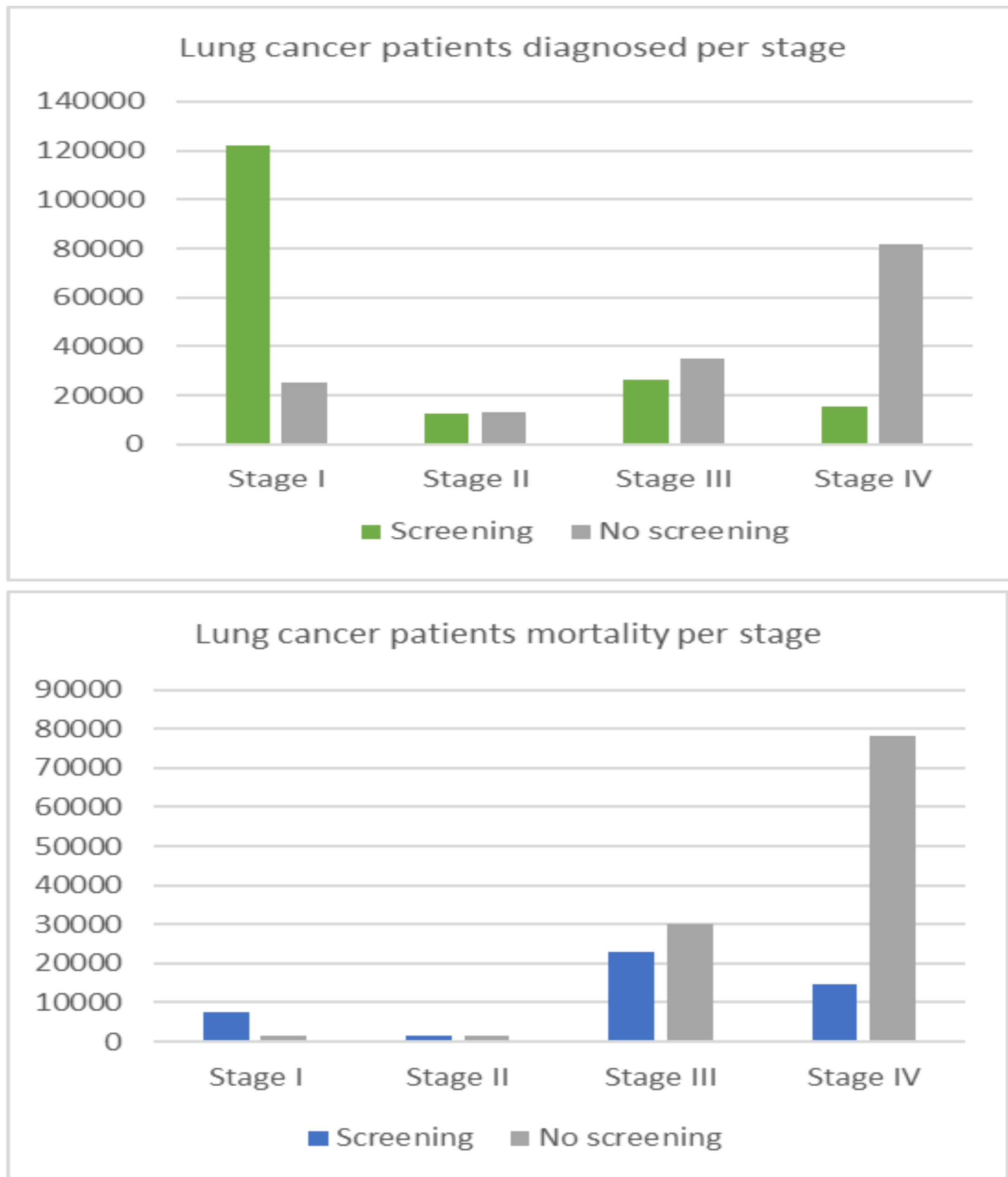
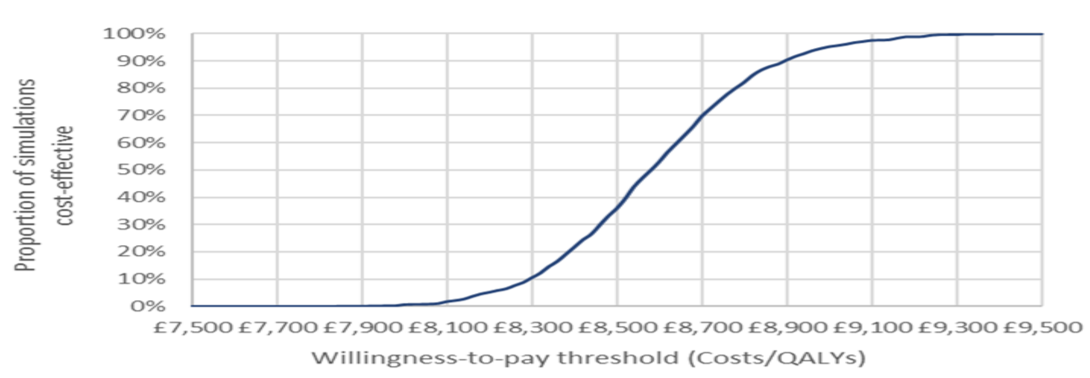


Figure 4: Cost-effectiveness acceptability curve (lifetime time horizon, 46.5% uptake)



Conclusions

- Annual LCS with volume-based low-dose CT for a high-risk asymptomatic population is effective at identifying lung cancer at an earlier stage, reducing lung cancer mortality and increasing both years lived and QALYs.
- It is highly cost-effective in the UK from a healthcare system perspective, at a threshold of £20,000 per QALY, representing an efficient use of NHS resources with substantially improved outcomes for lung cancer patients.
- National LCS is recommended for the UK.

References

1. Bray, F., et al. CA. Cancer J. Clin. 2018 68, 394–424.
2. Cancer Research UK: Lung cancer statistics. https://www.cancerresearchuk.org/
3. De Koning, H.J., et al. N. Engl. J. Med. 2020 382, 503–513. https://doi.org/10.1056/NEJMoa1911793
4. Horeweg N, et al. Eur Respir J. 2013 Dec 1;42(6):1659–67.
5. Goldstraw P, et al. J Thorac Oncol. 2016 Jan 1;11(1):39–51.
6. McPherson I, et al. Eur J Surg Oncol [Internet]. 2020;46(10):1882–7.
7. Aupérin A, et al. J Clin Oncol. 2010;28(13):2181–90.
8. Sequist L V., et al. J Clin Oncol. 2013 Jul 1;31(27):3327–34.
9. Gandhi L, et al. N Engl J Med. 2018 May 31;378(22):2078–92.
10. Horn L, et al. N Engl J Med. 2018 Dec 6;379(23):2220–9.
11. Tramontano AC, et al. Med Decis Mak. 2015 Apr 20;35(3):371–87.
12. National Health Service. National Cost Collection for the NHS
13. The National Lung Screening Trial Research Team. N Engl J Med. 2013 May 23;368(21):1980–91
14. Aberle DR, D et al. N Engl J Med. 2013;369(10):920–31.
15. Office for National Statistics (ONS). National life tables, UK.
16. Field JK, et al. Health Technol Assess (Rockv). 2016 May 1;20(40).

Supported by AstraZeneca

Presented at ISPOR, Vienna, 2022