Tax revenue gains and societal net-monetary benefit associated with implementing lung cancer screening in the United Kingdom

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Introduction

- Overall, lung cancer (LC) deaths account for 21.0% of all cancer deaths in the United Kingdom (UK). In 2019, 60.9% of all LC were diagnosed at Stages III/IV [1].
- There is evidence that one-year LC survival decreases considerably for each level of increase in cancer staging [2].
- Early diagnosis through screening, along with effective treatment, might impact on economic behaviours, increase productivity and sustain household earnings at the pre-diagnosis levels with positive fiscal implications for government cashflows.

Objectives

- Estimate the fiscal impact of implementing a LC screening (LCS) programme in the UK based on the NELSON study outcomes [3].
- Assess how early LC detection influences lifetime earnings and quality adjusted life-years (QALY) gains.

Methods

- A population cohort fiscal analysis was modelled alongside a cost-effectiveness analysis of annual screening rounds of low dose volume computed tomography for LC versus no screening [4].
- The baseline characteristics of the screening participants were sourced from the NELSON study [3]. The model assumes annual screens until the age of 74 years old, based on recommendations for Europe [5].
- Those diagnosed with LC entered a specific state-transition Markov model, according to the stage at diagnosis. In each Markov state, all individuals enter as progression-free and are at risk of progression or death at any 3-month cycle, over lifetime. The lifetime risk of progression and death were sourced from the literature [6-11] and projected by cancer stage at diagnosis for each cohort.
- Quality-adjusted life years (QALYs) were estimated using health state utilities from the CanCORS study [12] and valued at £20,000 per QALY according to the lowest threshold recommended by the current process of health technology evaluations from the National Institute for Health and Care Excellence (NICE) [13]. In contrast, the UK Treasury uses a higher threshold of £70,000 when assessing societal benefits [14].
- The fiscal model is based on the labour market status of those diagnosed with LC, and their subsequent fiscal relationship with the government. The employed population diagnosed with LC are assumed to go on sick leave while on treatment. After that, a proportion of progression-free survivors will return to work (RTW). Those who have progressed are assumed not to RTW. Those who do not RTW move to unemployment, long-term sickness or to early retirement. RTW transitions were sourced from a multicentre cross-sectional study, depending on the stage at diagnosis [15] – Table 1. At the state pension age (SPA, 67 years old), all non-working individuals transition to the state pension fiscal state [16].

Table 1. Labour market and fiscal state transitions

Employed patients who are progression-free, per stage at diagnosis	Proportion returning to work after sick leave
Stage I	53%
Stage II	63%
Stage III	38%
Stage IV	41%
Non-employed patients	Proportion moving to each fiscal state
Early retirement	47%
Disability pension	39%
Unemployment	7%
Other inactive	7%

- Direct and indirect taxes were included as the government's source of revenue.
- Direct taxes were estimated by applying the mean tax wedge (30.8%) [17] to the age-specific earnings from employment and the mean income tax (15.9%) [18] to taxable state benefits (Employment and Support Allowance [ESA], Jobseeker's allowance [JSA] and State Pensions) and other earnings.
- Revenue from indirect taxes on consumption were estimated by multiplying the mean indirect tax rate of the gross income (12.4%) [18] to all earnings and state benefits.
- Data on earnings, taxes and state benefits were based on the UK general population, from national official sources [19-22].
- On the government's expenditure side, the model considered recruitment, screening, diagnostic and treatment costs as well as state benefits provided to those unable to work and/or in need of a carer.
- Recruitment, screening, diagnostic and treatment costs of LC patients were based on the Yorkshire Lung Screening Trial (YLST), on NHS HRG tariffs and on the literature [23].
- LC patients under the SPA who were non-employed before diagnosis or who become non-employed after sick leave may be entitled to ESA or to Personal Independence Payment (PIP). Those unemployed are entitled to the JSA for a maximum of six months. All non-employed people with LC cancer due to long-term sickness, early retirement or due to other reasons are assumed to receive ESA or PIP, according to the proportion of ESA and PIP transfers provided by the UK Government due to Neoplasms. After the SPA, all non-working people are entitled to State Pensions and stop receiving ESA and PIP [22].
- After the SPA, non-autonomous people with cancer are also entitled to the Attendance Allowance (AA). Due to the lack of data on people with LC in Stage I/II, it was assumed that only a small proportion would need a carer after progression (5%). The proportion of people with LC in Stages III/IV entitled to AA was based on the proportion in need of a carer in the literature [24].
- The societal net benefit (SNB) from screening was estimated as the sum of societal gains and the fiscal balance for the government.
- Societal gains were estimated by the added earnings from employment and monetized incremental QALYs, according to the equations below.

$$SNB = Social\ Surplus + Fiscal\ Balance$$

$$Social\ Surplus = Incremental\ earnings\ from\ employment + Monetized\ incremental\ QALYs$$

$$Incremental\ earnings\ from\ employment = NPV\ of\ earnings\ from\ employment_{Screeening} - NPV\ of\ earnings\ from\ employment_{Non-Screening}$$

$$NPV\ of\ earnings\ from\ employment_j = \sum_{t_0}^{t} \frac{Earnings\ from\ employment_t}{(1+r)^t}$$

$$Monetized\ incremental\ QALYs = Value\ of\ a\ QALY \times Incremental\ QALYs$$

$$Incremental\ QALYs = NPV\ of\ QALYs_{Screeening} - NPV\ of\ QALYs_{Non-Screening}$$

$$NPV\ of\ QALYs_j = \sum_{t_0}^{t} \frac{QALYs_t}{(1+r)^t}$$

QALY, quality adjusted life-years; NPV, Net present value; r, annual discount rate (3.5%); SNB, Societal net benefit; t, time.

$$Fiscal\ Balance = NPV\ of\ fiscal\ benefits_{Screening} - NPV\ of\ fiscal\ benefits_{Non-Screening}$$

$$NPV\ of\ fiscal\ benefits_j = \sum_{t_0}^{t} \frac{Tax_t - Transfers_t}{(1+r)^t}$$

$$Tax_t = Direct\ tax_t + Indirect\ tax_t + Social\ security\ contributions_t$$

$$Transfers_t = Recruitment\ costs + Screeening\ costs_t + Diagnostic\ costs_t + Treatment\ costs_t + State\ benefits_j$$

j, Screening status (Screening or Non-Screening cohort); NPV, Net present value; QALY, quality adjusted life-years; r, annual discount rate (3.5%); t, time.

Results

- The detailed government costs, tax revenue gains and societal gains from implementing a LCS programme in the UK are shown in Table 2.

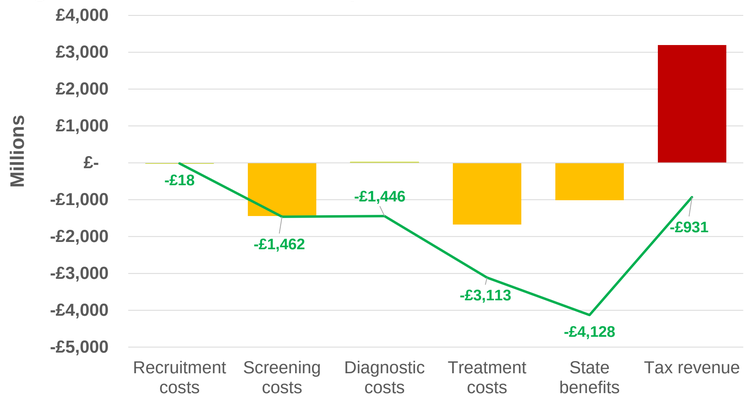
Table 2. Total government costs (–), tax revenue (+) and societal gains (+) from implementing a LCS programme in the UK

	Screening	Non-screening	Costs/Gains
Recruitment costs	–£ 18 M	-	
Screening costs	–£ 1,444 M	-	£ 3,113 M Government costs with the screening programme
Diagnostic costs	–£ 146 M	£ 163 M	
Treatment costs	–£ 6,710 M	£ 5,043 M	
State benefits	– £ 5,528 M	£ 4,513 M	£ 1,015 M Government costs with state benefits
Tax revenue	+ £ 8,450 M	£ 5,254 M	£ 3,196 M Tax revenue gains
Earnings from returning to work	+ £ 3,775 M	£ 2,387 M	£ 1,388 M Societal gains
Monetary value of QALY gains	+£ 703,601 M	£ 695,700 M	£ 7,900 M Societal gains
Health system efficiency gains (Number of LC diagnosis)	356,414	335,266	21,148 Diagnoses

QALY, quality adjusted life-years; LC, Lung cancer; M, million.

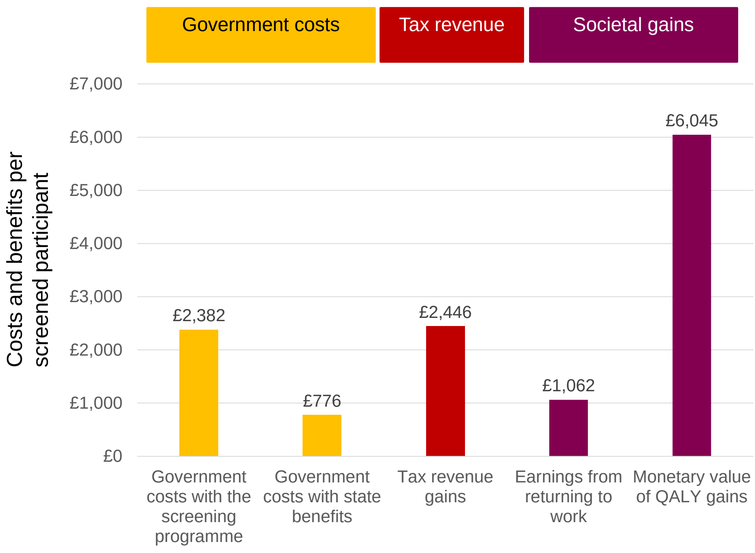
- The NPV of the fiscal balance was estimated as a cost of £931 million to the UK government (Figure 1).

Figure 1. Overall fiscal consequences and fiscal balance.



- The tax revenue exceeded the total healthcare costs from the screening programme (recruitment, screening, diagnostic and treatment costs), with a fiscal return on investment (ROI) of 1.03 (103%).
- Societal gains from screening implementation are estimated at £1,388 million from returning to work earnings and QALY gains are valued at £7,900 million.
- The societal net-benefit was valued at £8,357 million (£6,394 per screening participant).
- Results per screening participant are presented in Figure 2.

Figure 2. Government costs, tax revenue and societal gains from implementing a LCS programme in the UK, per screening participant



Conclusions

- Earlier diagnosis, treatment and longevity associated with LCS keep patients economically active for longer and improves lifetime tax revenue for government.
- The tax revenue provides a return of investment of 103%, compensating for the costs of the screening programme.
- Fiscal analysis of health technologies can be used to inform government cross-sectorial impact of healthcare investments and should be included in economic evaluations.

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