COST-EFFECTIVENESS ANALYSIS OF LUNG CANCER PREVENTION STRATEGIES

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BACKGROUND IN LUNG CANCER
About lung cancer

Lung cancer (LC) is the most common cause of death by cancer and one of the most incident worldwide.

LC does not produce symptoms in its early phase. In advanced phases, the most common symptoms are often confused with those of other causes → late diagnosis.

The most important risk factor is tobacco: >80% of all LC deaths.

Risk increases with age.

LC mortality and incidence in Spain, 2012
Lung cancer prevention

QUIT SMOKING. Not to smoke, or quitting smoking, is the best prevention measure to prevent LC. The risk of developing LC is estimated to be reduced by 80% 15 years after quitting.

SCREENING. Several studies have shown that early detection with low-dose computed tomography (LDCT) in high risk population reduces LC mortality.
To develop a simulation model reproducing the natural history of LC.

To ensure a highly configurable model, being able to run in different study cases and including a variety of input parameters.

To perform a cost-effectiveness analysis comparing the implementation of three preventive strategies in lung cancer (LC) with a no-intervention scenario.
METHODS
**Modeling approach**: Markov-based microsimulation model of lung cancer (LC) to simulate and evaluate preventive strategies on smoking cessation and lung cancer screening.

**Calibration**: Model outputs are calibrated to epidemiologic data from Spain, specifically LC incidence and mortality, and overall mortality.

**Main model outcomes**: quality-adjusted life expectancy, incidence and mortality reduction, and lifetime costs.

**Cost-effectiveness analysis**: health care system perspective, costs and health benefits discounted at a 3% annual rate, incremental cost-effectiveness ratios (ICERs expressed as € per QALY gained).

**Sensitivity analysis**: for age group, frequency, intervention coverage and effectiveness, and costs.
Schematic illustration of the **Markov chain** model:
Schematic illustration of the Markov chain model:

Combined with microsimulated features:
- effect of smoking
- effect of quitting
- diagnosis by screening

Model

Healthy \rightarrow LC I-II \rightarrow LC IIIa \rightarrow LC IIIb-IV \rightarrow Lung cancer (LC) \rightarrow LC death

Other death
Available interventions

Available interventions


The three interventions are combined to design three base case strategies.
Available interventions


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- **High risk**: age 55 to 74 and ≥ 30 packs-year.
Available interventions


The three interventions are combined to design three base case strategies.

- **High risk**: age 55 to 74 and $\geq 30$ packs-year.
Available interventions


The three interventions are combined to design three base case strategies.

- **High risk**: age 55 to 74 and ≥ 30 packs-year.
- **Potentially at risk**: age < 55 and high-risk smoking habits.
RESULTS
## Results

### Base Case Analysis

<table>
<thead>
<tr>
<th>BASE CASE STRATEGIES</th>
<th>Risk reduction (%)</th>
<th>Cost per person (€)</th>
<th>QALY per person</th>
<th>ICER (€/QALY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No intervention</td>
<td></td>
<td>338.536</td>
<td>23.31332</td>
<td></td>
</tr>
<tr>
<td>Strategy 1 (BI@55+3xSCR-HR@55&amp;56&amp;57)</td>
<td>1.7%</td>
<td>335.849</td>
<td>23.31839</td>
<td>*CS</td>
</tr>
<tr>
<td>Strategy 2 (IT@55+3xSCR-HR@55&amp;56&amp;57)</td>
<td>3.2%</td>
<td>349.369</td>
<td>23.32060</td>
<td>**Dom</td>
</tr>
<tr>
<td>Strategy 3 (IT@35 +3xSCR-HR@55&amp;56&amp;57)</td>
<td>6.3%</td>
<td>339.092</td>
<td>23.33203</td>
<td>238</td>
</tr>
</tbody>
</table>

*CS: cost-saving  
**Dominated: more costly and less effective than other strategies or with higher ICERs than more effective strategies

**Coverage:** 18% (patients attending in primary health care services with smoking habits in Spain)  
**Effectiveness:** 20% for brief intervention, 39.77% for intensive treatment, 60.4 for SCR.
RESULTS

Smoking cessation alone by frequency and age

- Brief intervention
- Intensive treatment

Cost per person (€)

QALYs per person

- Once (@35 or 55)
- Twice (@35&40 or @35&55 & 55&60)
- Thrice (@35,40&45 or @55,56&57 @55,60&65)

IT @35&40&45
2,363 €/QALY

CS

Bl @35&40&45

No intervention

Cost per person (€)
Smoking cessation alone by frequency and age

RESULTS

Strategies lying on the efficiency curve dominate those lying to the right of the curve because they are more effective, and either cost less or have more attractive cost-effectiveness ratio than the next best strategy.
RESULTS

Smoking cessation alone and screening alone by frequency and age

- Brief intervention
- Intensive treatment

- Once (@35 or 55)
- Twice (@35&40 or @35&55 & 55&60)
- Thrice (@35,40&45 or @55,56&57 @55,60&65)

Cost per person (€)

QALYs per person

2,363 €/QALY

No intervention

CS

BI @35&40&45

IT @35&40&45

Once (@35 or 55) Twice (@35&40 or @35&55 & 55&60) Thrice (@35,40&45 or @55,56&57 @55,60&65)
RESULTS

Once smoking cessation + screening by frequency and age

- Brief intervention
- Intensive treatment

+ Screening

- Once (@35 or 55)
- Twice (@35&40 or @35&55 & 55&60)
- Thrice (@35,40&45 or @55,56&57 or @55,60&65)
- 4y (@55-65)
- 3y (@55-65)
- 2y (@55-65)
- 1y (@55-65)
RESULTS

Once smoking cessation + screening by frequency and age

- Brief intervention
- Intensive treatment

+ Screening

- BI @35
- IT @35
- BI @55
- IT @55

Cost per person (€)

QALYs per person
RESULTS

Once smoking cessation + screening by frequency and age

- Brief intervention
- Intensive treatment + Screening

- BI @35 + 3xSCR-HR @55&56&57 CS
- IT @35 + 4y-xSCR-HR @55-65 1,360 €/QALY
- IT @35 + 1y-xSCR-HR @55-65 4,927 €/QALY
RESULTS

Twice smoking cessation + screening by frequency and age

- Brief intervention
- Intensive treatment

+ Screening

- Once (@35 or 55)
- Twice (@35&40 or @35&55 & 55&60)
- Thrice (@35,40&45 or @55,56&57 or @55,60&65)
- 4y (@55-65)
- 3y (@55-65)
- 2y (@55-65)
- 1y (@55-65)
RESULTS

Twice smoking cessation + screening by frequency and age

- Brief intervention
- Intensive treatment

Graph showing QALYs per person vs. Cost per person (€) for different interventions:
- **BI @35&40 + 1y-xSCR-HR @55-65 (414 €/QALY)**
- **BI @35&40 + 2y-xSCR-HR @55-65 (236 €/QALY)**
- **BI @35&40 + 2xSCR-HR @55&60 (58 €/QALY)**
- **BI @35&40 + 1xSCR-HR @55 (CS)**
- **IT @35&40 + 1y-xSCR-HR @55-65 (2,729 €/QALY)**
RESULTS

Thrice smoking cessation + screening by frequency and age

- Brief intervention
- Intensive treatment

+ Screening

- Once (@35 or 55)
- Twice (@35&40 or @35&55 & 55&60)
- Thrice (@35,40&45 or @55,56&57 or @55,60&65)
- 4y (@55-65)
- 3y (@55-65)
- 2y (@55-65)
- 1y (@55-65)
RESULTS

**Thrice smoking cessation + screening by frequency and age**

- Brief intervention: BI @35&40&45 + 1xSCR-HR @55 (CS)
- Intensive treatment: IT @35&40&45 + 3xSCR-HR @55&60&65 (3.547 €/QALY)

**Graph**

- BI @35&40&45 + 1y-xSCR-HR @55-65 (77 €/QALY)
Lung cancer is a high burden in terms of health and economic cost, and there exist preventive measures to reduce its incidence and mortality.

Unique LC model in Europe to assess the cost-effectiveness of LC preventive strategies, combining both smoking cessation and LC screening.
Smoking cessation interventions alone are mainly more effective and cost-effective than screening interventions alone.

Early smoking cessation intervention at age 35 is more favourable than at age 55.

Increasing frequency of smoking cessation interventions reduces the frequency of screening interventions.
The most cost-effective smoking cessation strategy is the intensive treatment thrice at 5-year intervals starting at age 35, which would reduce lung cancer incidence by 11.6%.

A smoking cessation strategy consisting of 3 brief interventions at 5-year intervals starting at age 35 is cost-saving respect to the no-intervention scenario, reducing incidence by 7%.
The most cost-effective combined strategy is composed of 3 intensive treatment at 5-year intervals starting at age 35 and 3 screening interventions on high risk population at ages 55, 60, and 65.

Such strategy would reduce lung cancer incidence by 12.1%.

Screening interventions contribute with a marginal reduction, but it is still more cost-effective than performing a smoking cessation intervention alone.
Still pending to perform other sensitivity analyses on other assumed parameters, such as coverage or screening sensitivity.
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