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Cost-effectiveness of a machine learning risk prediction model (LungFlag™) in the selection of high-risk individuals for non-small cell lung cancer screening in Spain

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BACKGROUND AND OBJECTIVES

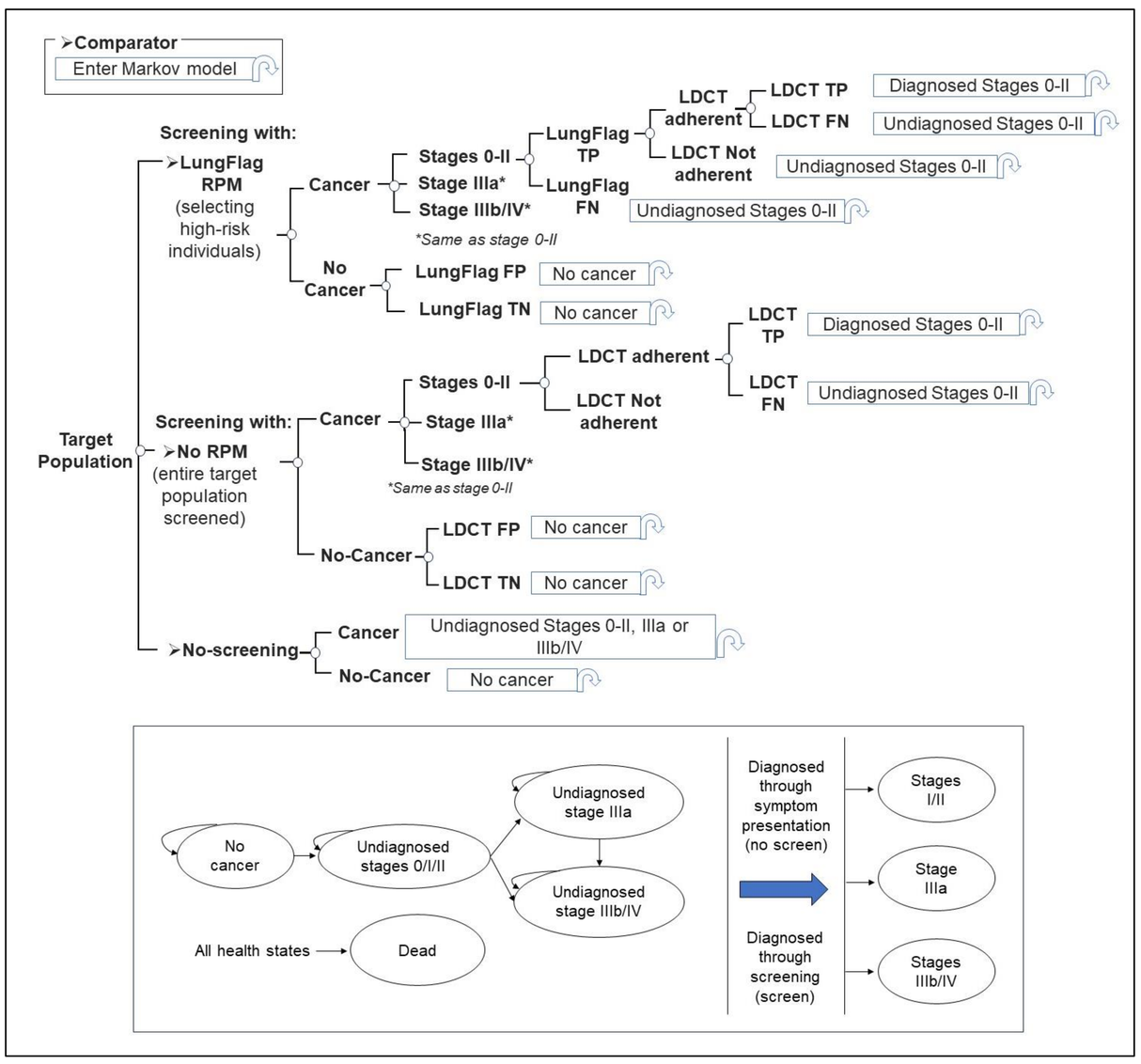
- Risk-prediction models (RPM) based on individual risk have proved to effectively identify individuals at high risk of lung cancer for screening in comparison to selection criteria based on age and pack-years alone[1].
- LungFlag™ is a machine learning-based risk prediction model designed to improve selection of individuals at-risk for enrollment in NSCLC screening programs with low dose computed tomography (LDCT), by evaluating routine clinical and laboratory data [2-3].
- The aim of this analysis is to assess the cost-effectiveness of implementing LungFlag™ in Spain.

METHODS

Model structure

- A joint model combining a decision-tree and Markov models (4 health states, monthly cycles), was adapted to the Spanish setting. Transition probabilities were obtained from the literature[4] .
- The analysis was conducted from the perspective of the Spanish National Health System and only direct medical costs were considered.
- Base case analysis used a 50-year lifetime horizon and a 3% discount rate was applied for both costs and future effects.
- The analysis compared the use of LungFlag™ versus the hypothetical scenario of screening the entire target population without using any RPM and versus the current situation in Spain of no-screening (Figure 1).

Figure 1. Diagram Model



RPM: risk prediction model; TP: True positive; FP: False positive; TN: True negative; FN: False negative; LDCT: low-dose computed tomography.

Target Population

- The target population included individuals meeting 2013 USPSTF screening criteria (adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years) in Spain, and it was estimated at 3.835.128 subjects based on the Spanish national health survey data[5-6].

Parameters

- 5-year prevalence of lung cancer in the general Spanish population was used to estimate probability of having cancer (0.1393%)[7] as well as the increased relative risk to be an active smoker or having a smoking history (24.11)[8] and the proportion of NSCLC among all lung cancers.
- Based on experts' opinion, individuals on both screening arms were distributed across the cancer stages as follows: stages 0-II (75%), stage IIIa (7.5%) and stages IIIb-IV (17.5%)[9-10]. In the no-screening arm, individuals who had cancer entered in the ‘undiagnosed NSCLC’ health states according to the distribution observed in real-life studies (without screening): stages 0-II (19.1%), stage IIIa (15.8%) and stages IIIb/IV (65.1%)[11].
- The model considered an LDCT adherence of 56% in both screening arms[10].
- Healthcare resources and unit costs were obtained from the literature and Spanish databases and were validated by a panel of experts[12-14].

- LungFlag™ sensitivity was 44.1%, 42.6% and 32.8% for stages 0-II, stage IIIa and stages IIIb-IV respectively, for a 90% specificity, obtained from retrospective case-control study of Gould et al[2].

Sensitivity analyses

- One-way sensitivity analysis (OWSA) and probabilistic sensitivity analyses (PSA) were carried out to evaluate the uncertainty associated with the model.

RESULTS

- In the target population defined, using LungFlag™ would limit the number of LDCTs needed to 232,120 scans as compared with 2,147,672 LDCT scans if the entire population was screened.
- Table 1 shows the base case results of the cost-effectiveness analysis.

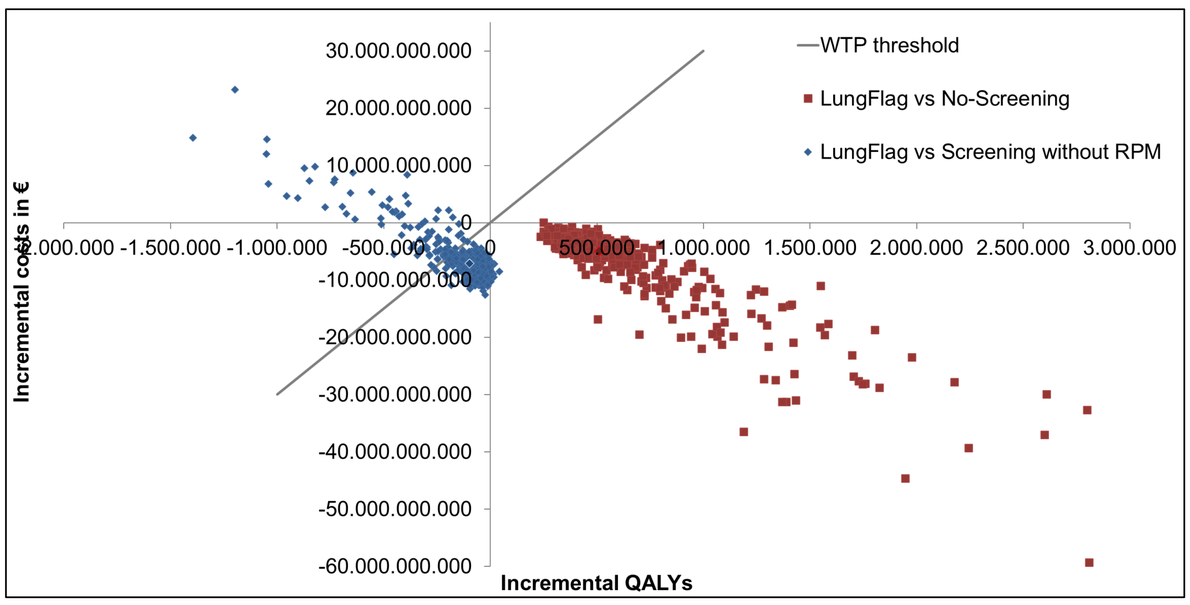
Table 1. Base case results

	Screening with LungFlag™	Screening without RPM	No-Screening	LungFlag™ versus:	
				Screening without RPM	No-Screening
Total costs (€)	10,053.47	17,106.16	15,028.95	-7,052.69	-4,975.48
LYs	72.88	73.10	72.00	-0.22	+0.88
QALYs	61.66	61.76	61.15	-0.10	+0.51
ICER (in € per LY gained)				Less QALYs, savings	Dominant
ICUR (in € per QALY gained)				Less QALYs, savings	Dominant

LY: life year; QALY: quality-adjusted life year; ICER: incremental cost-effectiveness ratio; ICER: incremental cost-utility ratio.

- LungFlag™ would be dominant versus no-screening. Compared to the hypothetical scenario where the whole target population was screened, significantly savings were provided but with a decrement in LYs and QALYs. The cost-effectiveness ratio (ICER) obtained showed that the savings generated by LungFlag™ offset this loss of QALYs and LYs, making it a cost-effective strategy.
- According to the results of the one-way sensitivity analysis, those variables affecting more the (ICER) were lifetime QALYs of stages 0-II, discount rate for cost and effects, the adherence to screening and the sensitivity of LungFlag™ for stages 0-II.
- The PSA results were represented by an incremental cost-effectiveness plane (Figure 2). All simulations versus no-screening showed that LungFlag™ is dominant, while 91.4% of the simulations versus screening the entire target population showed that LungFlag™ is as cost-effective strategy considering a threshold of €25,000 - €30,000/QALY[15].

Figure 2. Incremental cost-effectiveness plane.



RPM: risk prediction model; WTP: wiliness-to-pay; QALY: quality-adjusted life-year.

CONCLUSION

Using LungFlag™ for the selection of high-risk individuals for NSCLC screening in Spain, would be cost-effective compared to a hypothetical scenario screening all individuals meeting USPSTF criteria. This strategy would be dominant versus the current situation of no-screening.

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