Simulaciones en medicina preventiva en el contexto de Estados Unidos y su contribución en la toma de decisiones

Simposio “Los retos de la medicina preventiva y su contribución en el logro de la Atención Primaria de la Salud en México”

Rafael Meza
Universidad de Michigan
rmeza@umich.edu
Cáncer de Pulmón
Toma de decisiones a nivel poblacional
Lung Cancer Deaths Drop by 20% with CT Scan

"My opinion is that one can conclude from the NLST data that three annual low-dose helical CTs in individuals ages 55 to 74 with 30-pack-year smoking history can lower lung-cancer-specific mortality by 20 percent," NCI's Berg said in an interview. "Claims beyond that we are not addressing. We are saying that our data speak to what we did in the population in which we did it."

"The CISNET modelers may be able to look at different frequencies of screening, different ages at starting, different risk levels, such as 20 pack-year smokers or a 40 pack-year smokers."
SPECIAL ISSUE: The Science behind Cancer Screening

Using an Ocean of Data, Researchers Model Real-Life Benefits of Cancer Screening

Randomized clinical trials are widely acknowledged as the best way to determine whether a cancer screening test saves lives. But even when trial results indicate that a particular screening method has a clear benefit, the findings may not be easily translated into recommendations for the public. The results of a screening trial may apply only to certain people, and the findings can change as the study period lengthens—all of which means that the results may not apply to the general population.

For example, the National Lung Screening Trial (NLST) showed that screening of current or former heavy smokers with three annual low-dose CT scans can reduce their risk of dying from lung cancer. But NLST enrolled only people aged 55 to 74 who had smoked for 30 pack years and had quit less than 15 years previously.

"Would a similar screening regimen also benefit younger or older smokers? Would lighter smokers benefit equally? And when should they start and stop screening?" asked Dr. Eric "Rocky" Feuer, scientific coordinator of NCI’s Cancer Intervention and Surveillance Modeling Network (CISNET). Patients and doctors alike will almost certainly ask these questions.

CISNET’s five research teams use modeling to try to answer these types of questions for several different cancer types. Using the results of screening trials, the teams are trying to estimate the true benefit of screening in the general population and to identify the
Males: all scenarios

![Graph showing the relationship between screens per 100,000 and the percentage of possible lung cancer deaths averted.]

- E deaths prevented
- F deaths prevented
- MGH deaths prevented
- Mich deaths prevented
- S deaths prevented

McMahon et al, Plos 2014
Screening for Lung Cancer: Recommendations from the USPSTF

- [USPSTF Recommendations](#)
- [Background modeling study](#)
- [Editorial by Peter Bach](#)
- [Editorial by Michael Unger & Frank Detterbeck](#)
Screening for Lung Cancer: U.S. Preventive Services Task Force Recommendation Statement

Virginia A. Moyer, MD, MPH, on behalf of the U.S. Preventive Services Task Force*

Description: Update of the 2004 U.S. Preventive Services Task Force (USPSTF) recommendation on screening for lung cancer.

Methods: The USPSTF reviewed the evidence on the efficacy of low-dose computed tomography, chest radiography, and sputum cytologic evaluation for lung cancer screening in asymptomatic persons who are at average or high risk for lung cancer (current or former smokers) and the benefits and harms of these screening tests and of surgical resection of early-stage non–small cell lung cancer. The USPSTF also commissioned modeling studies to provide information about the optimum age at which to begin and end screening, the optimum screening interval, and the relative benefits and harms of different screening strategies.

Population: This recommendation applies to asymptomatic 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.

Recommendation: The USPSTF recommends annual screening for lung cancer with low-dose computed tomography in 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. Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery. (B recommendation)

Arnt Intern Med.
For author affiliation, see end of text.
* For a list of the members of the USPSTF, see the Appendix (available at www.annals.org).
This article was published online first at www.annals.org on 31 December 2013.
Table. Screening Scenarios From CISNET Models*

<table>
<thead>
<tr>
<th>Minimum Pack-Years at Screening, n</th>
<th>Minimum Age at Which to Begin Screening, y</th>
<th>Time Since Last Cigarette, y</th>
<th>Population Ever Screened, %</th>
<th>Lung Cancer Deaths Averted, %</th>
<th>Lung Cancer Deaths Averted, n</th>
<th>Total CT Screens, n</th>
<th>Radiation-Induced Lung Cancer Deaths, n</th>
<th>Overdiagnosis, %§</th>
<th>CT Screens per Lung Cancer Death Averted, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>60</td>
<td>25</td>
<td>13.0</td>
<td>11.0</td>
<td>410</td>
<td>171 924</td>
<td>17</td>
<td>11.2</td>
<td>437</td>
</tr>
<tr>
<td>40</td>
<td>55</td>
<td>25</td>
<td>13.9</td>
<td>12.3</td>
<td>458</td>
<td>221 606</td>
<td>20</td>
<td>11.1</td>
<td>506</td>
</tr>
<tr>
<td>30</td>
<td>60</td>
<td>25</td>
<td>18.8</td>
<td>13.3</td>
<td>495</td>
<td>253 095</td>
<td>21</td>
<td>11.9</td>
<td>534</td>
</tr>
<tr>
<td>30</td>
<td>55</td>
<td>15</td>
<td>19.3</td>
<td>14.0</td>
<td>521</td>
<td>286 813</td>
<td>24</td>
<td>9.9</td>
<td>577</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>25</td>
<td>24.8</td>
<td>15.4</td>
<td>573</td>
<td>327 024</td>
<td>25</td>
<td>9.8</td>
<td>597</td>
</tr>
<tr>
<td>30</td>
<td>55</td>
<td>25</td>
<td>20.4</td>
<td>15.8</td>
<td>588</td>
<td>342 880</td>
<td>25</td>
<td>10.0</td>
<td>609</td>
</tr>
<tr>
<td>20</td>
<td>55</td>
<td>25</td>
<td>27.4</td>
<td>17.9</td>
<td>664</td>
<td>455 381</td>
<td>31</td>
<td>10.4</td>
<td>719</td>
</tr>
<tr>
<td>10</td>
<td>55</td>
<td>25</td>
<td>36.0</td>
<td>19.4</td>
<td>721</td>
<td>561 744</td>
<td>35</td>
<td>9.5</td>
<td>819</td>
</tr>
</tbody>
</table>

CISNET = Cancer Intervention and Surveillance Modeling Network; CT = computed tomography.
* All scenarios model the results of following a cohort of 100 000 persons from age 45 to 90 y or until death from any cause, with a varying number of smokers and former smokers screened on the basis of smoking history, age, and years since stopping smoking. Bold text indicates the screening scenario with a reasonable balance of benefits and harms and that is recommended by the U.S. Preventive Services Task Force.
† In all scenarios, screening is continued through age 80 y.
‡ Number of CT screenings is a measure of harm because it relates to the number of patients who will have risk for overdiagnosis and potential consequences from false-positive results.
§ Percentage of screen-detected cancer that is overdiagnosis; that is, cancer that would not have been diagnosed in the patient's lifetime without screening.

Figure Legend:
Screening Scenarios From CISNET Models*
Benefits and Harms of Computed Tomography Lung Cancer Screening Strategies: A Comparative Modeling Study for the U.S. Preventive Services Task Force

Harry J. de Koning, MD; Rafael Meza, PhD; Sylvia K. Plevritis, PhD; Kevin ten Haaf, MSc; Vidit N. Munshi, MS; Jihyoun Jeon, PhD; Saadet Ayca Erdogan, PhD; Chung Yin Kong, PhD; Summer S. Han, PhD; Joost van Rosmalen, PhD; Sung Fun Choi, SM; Paul F. Pinsky, PhD; Amy Berrington de Gonzalez, PhD; Christine D. Berg, MD; William C. Black, MD; Marlin C. Tammemägi, PhD; William D. Hazellon, PhD; Eric J. Feuer, PhD*; and Pamela M. McMahon, PhD*

Background: The optimal screening policy for lung cancer is unknown.

Objective: To identify efficient computed tomography (CT) screening scenarios in which relatively more lung cancer deaths are averted for fewer CT screening examinations.

Design: Comparative modeling study using 5 independent models.

Data Sources: The National Lung Screening Trial; the Prostate, Lung, Colorectal, and Ovarian trial; the Surveillance, Epidemiology, and End Results program; and the U.S. Smoking History Generator.

50% (model ranges, 45% to 54%) of cases of cancer being detected at an early stage (stage I/II), 575 screenings examinations per lung cancer death averted, a 14% (range, 8.2% to 23.5%) reduction in lung cancer mortality, 497 lung cancer deaths averted, and 5250 life-years gained per the 100,000-member cohort. Harms would include 67,550 false-positive test results, 910 biopsies or surgeries for benign lesions, and 190 overdiagnosed cases of cancer (3.7% of all cases of lung cancer [model ranges, 1.4% to 8.3%]).

Results of Sensitivity Analysis: The number of cancer deaths averted for the scenario varied across models between 177 and
Cáncer de Colon
Toma de decisiones a nivel poblacional
Screening for Colorectal Cancer

US Preventive Services Task Force Recommendation Statement

US Preventive Services Task Force

polyps, advanced adenomas based on size, or both, as well as colorectal cancer. The USPSTF also commissioned a comparative modeling study to provide information on optimal starting and stopping ages and screening intervals across the different available screening methods.

**Findings**  The USPSTF concludes with high certainty that screening for colorectal cancer in average-risk, asymptomatic adults aged 50 to 75 years is of substantial net benefit. Multiple screening strategies are available to choose from, with different levels of evidence to support their effectiveness, as well as unique advantages and limitations, although there are no empirical data to demonstrate that any of the reviewed strategies provide a greater net benefit. Screening for colorectal cancer is a substantially underused preventive health strategy in the United States.

**Conclusions and Recommendations**  The USPSTF recommends screening for colorectal cancer starting at age 50 years and continuing until age 75 years (A recommendation). The decision to screen for colorectal cancer in adults aged 76 to 85 years should be an individual one, taking into account the patient’s overall health and prior screening history (C recommendation).
MODELING STUDY

Estimation of Benefits, Burden, and Harms of Colorectal Cancer Screening Strategies
Modeling Study for the US Preventive Services Task Force

Amy B. Knudsen, PhD\textsuperscript{1}; Ann G. Zauber, PhD\textsuperscript{2}; Carolyn M. Rutter, PhD\textsuperscript{3}; Steffie K. Naber, MSc\textsuperscript{4}; V. Paul Doria-Rose, DVM, PhD\textsuperscript{5}; Chester Pabiniak, MS\textsuperscript{6}; Colden Johanson, BA\textsuperscript{1,8}; Sara E. Fischer, MPH\textsuperscript{2}; Iris Lansdorp-Vogelaar, PhD\textsuperscript{4}; Karen M. Kuntz, ScD\textsuperscript{7}

[+] Author Affiliations

A SimCRC: Colonoscopy strategies
Screening modality (color) | Age to begin-age to end screening (symbol) | Efficient frontier
--- | --- | ---
FIT | ○ 50-75 y ｖ 50-80 y 〇 50-85 y | With age to begin screening of 50 or 50 y
FIT-DNA | ♦ 55-75 y ♣ 55-80 y ◆ 55-85 y |
polyps, advanced adenomas based on size, or both, as well as colorectal cancer. The USPSTF also commissioned a comparative modeling study to provide information on optimal starting and stopping ages and screening intervals across the different available screening methods.

**Findings** The USPSTF concludes with high certainty that screening for colorectal cancer in average-risk, asymptomatic adults aged 50 to 75 years is of substantial net benefit. Multiple screening strategies are available to choose from, with different levels of evidence to support their effectiveness, as well as unique advantages and limitations, although there are no empirical data to demonstrate that any of the reviewed strategies provide a greater net benefit. Screening for colorectal cancer is a substantially underused preventive health strategy in the United States.

**Conclusions and Recommendations** The USPSTF recommends screening for colorectal cancer starting at age 50 years and continuing until age 75 years (A recommendation). The decision to screen for colorectal cancer in adults aged 76 to 85 years should be an individual one, taking into account the patient’s overall health and prior screening history (C recommendation).
Cáncer de Pulmón
Toma de decisiones a nivel individual
Should I get screened?
Lung Cancer Screening

SHOULD I DO IT?

Given your age and smoking history, you are **eligible** for screening according to the US Preventive Services Task Force criteria.

The chance of you developing lung cancer in the next 6 years is 2.9%. Talk to your doctor about the option to screen or not to screen as s/he will understand your situation best.
Compared to other people like you, there will be 6 fewer deaths out of 1000 in the next 6 years if you get screened.
**BENEFITS**

6 in 1000
Fewer people like you will die from lung cancer among those who were screened compared to those who were not screened.

**HARMS**

- 365 in 1000 people who were screened found a lung nodule that was not cancer.
- 18 in 1000 had an invasive procedure, such as biopsy or surgery, due to a lung nodule that was not cancer.
- 3 in 1000 had a major complication from invasive procedures.

Of the lung cancers found by screening, about 1 in 10 would have never harmed you (overdiagnosis). This may lead to unnecessary treatment and complications.
<table>
<thead>
<tr>
<th></th>
<th>Antes (SD)</th>
<th>Despues (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge score</td>
<td>7.52 (1.89)</td>
<td>10.93 (2.19)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Decisional conflict score</td>
<td>46.33 (29.69)</td>
<td>15.05 (25.78)</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

Lau et al, AJPM 2015
¿Porqué simulación matemática en salud?

• Manera efectiva de sintetizar información

• Datos de estudios clínicos, cohortes, registros, genómica, proteómica

• Escenarios contrafactuales—”Qué tal si?” – Experimentación en sílico

• Manera para hacer proyecciones (‘educated guesses’)

• Modelación permite crear un laboratorio virtual para sintetizar información disponible y estudiar el posible impacto de múltiples intervenciones

• Modelación también es útil para identificar vacíos de información
Aplicaciones de Simulación en Medicina Preventiva

- Prioritización de vacunas
- Planificación de respuesta en caso de enfermedades emergentes
- Análisis de costo-efectividad de intervenciones de salud
- Diseño y evaluación de estrategias de tamizaje
  - Poblacional
  - Individual – ayuda a la toma de decisiones
- Control de tabaco
  - Planeación y proyecciones
  - Evaluación de programas
- Planificación de sistemas de salud