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A cost-effectiveness model of prostate cancer screening

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Jim Chilcott
Silvia Hummel
ScHARR
Contents

• Introduction to the project and topic
• Disease natural history model
• Data and model calibration
• Validation
• Results
• Conclusions
The project

• **Client:** UK National Screening Committee

• **Purpose:** Help determine IF a national prostate cancer screening programme should occur AND which screening strategy is best.

• **Objectives:**

  Estimate costs, benefits and resource implications of alternative screening options.
Introduction to prostate cancer

The prostate is a small gland in men behind the bladder.

The most common cancer in men in UK (excluding non-melanoma skin cancer)

In 2008:
Over 37,000 men diagnosed
Over 10,000 men died from prostate cancer
Aim of screening:
Reduce cancer mortality, morbidity and treatment costs through early diagnosis and intervention.

Current evidence:
In 2009 two large RCTs reported apparently inconsistent results in terms of the death rate ratio:

- ERSPC – significant reduction in PCa death rate
- PLCO – no statistically significant reduction
Challenges:

• Effectiveness of different screening programmes unknown.
• Scarce data around disease process due to its unobservable nature.
• Multiple unknown parameters in cancer screening model.
Solution:

- Develop loosely parameterised cancer screening simulation model.
- Calibrate unobservable model parameters to observed data.
- Estimate impact of prostate cancer screening using calibrated model.
About the model:

- Disease natural history model (Simul8)
- Calibration module (Excel, Visual Basic)
- Simulation model of prostate cancer screening (Simul8)
- Resource impact model (Excel)
## Screening strategies investigated

<table>
<thead>
<tr>
<th>No. Screens</th>
<th>Screening Age (years)</th>
<th>Screening Interval (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>50</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Repeat</td>
<td>50-70</td>
<td>2, 4</td>
</tr>
<tr>
<td></td>
<td>50-74</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td></td>
<td>55-70</td>
<td>2, 4</td>
</tr>
<tr>
<td></td>
<td>55-74</td>
<td>2, 4</td>
</tr>
</tbody>
</table>
Outputs:

- Age-specific incidence
- Age-specific mortality
- Prostate cancer stage distributions
- Over-detection rate
- Lead time
- Life years gained, QALYs gained
- Probability of developing prostate cancer
- Etc...
Definitions & terms used

**Over-detection:**

- PCa Onset
- Screen Detection
- Lead-time
- Clinical Diagnosis
- Other Cause Mortality
- PCa Mortality

**Relevant:**

- PCa Onset
- Lead-time
- PCa Mortality
- Screen Detection
- Clinical Diagnosis
- Other Cause Mortality
Disease natural history model
## Data

<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age specific cancer incidence</td>
<td>Office of National Statistics</td>
</tr>
<tr>
<td>Cancer stage distributions</td>
<td>ProtecT RCT</td>
</tr>
<tr>
<td></td>
<td>UK Cancer Registry (ERIC)</td>
</tr>
<tr>
<td>Gleason score distributions</td>
<td>ProtecT RCT</td>
</tr>
<tr>
<td></td>
<td>UK Cancer Registry (ERIC)</td>
</tr>
<tr>
<td>PSA/biopsy test characteristics</td>
<td>ERSPC RCT</td>
</tr>
<tr>
<td></td>
<td>(Rotterdam section)</td>
</tr>
<tr>
<td>Progression Free Survival</td>
<td>ERSPC RCT</td>
</tr>
<tr>
<td></td>
<td>(Rotterdam section)</td>
</tr>
<tr>
<td>Overall Survival</td>
<td>ERSPC RCT</td>
</tr>
<tr>
<td></td>
<td>(Rotterdam section)</td>
</tr>
</tbody>
</table>
Calibration process

1. Initial parameter set
2. Generate new set of parameters
3. Run simulation for 50,000 people
4. Compare model prediction to data (SSE)
5. Accept/Reject parameter set
6. Repeat process 4,000 times
Total SSE during calibration
Validation: Incidence

The graph shows the age-specific incidence (per 100,000) of a condition across different age groups. The blue line represents the ONS incidence, while the red line represents the modelled incidence. The graph indicates a peak incidence in the age group of 75-79 years for both ONS and modelled incidences.
Validation: PCa mortality
Validation: BAUS

Localised G<7

Localised G=7

Localised G>7

BAUS data

ScHARR model
Results: Incidence

The graph shows the incidence of prostate cancer (PCa) per 1000 years across different age bands and screening intervals. The age bands are 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, and 85+.

- **No screening**
- **Once at 50**
- **50-74 every 4 years**
- **50-74 every 2 years**
- **50-74 every year**

The incidence peaks in the 70-74 age band for the '50-74 every year' screening interval, with significant reductions observed for other screening intervals.
Results: Mortality

![Graph showing PCa mortality rates by age band and screening frequency.](image)
## Over-detection & Lead time:

<table>
<thead>
<tr>
<th></th>
<th>Once at 50</th>
<th>50-74 every 4 years</th>
<th>50-74 every 2 years</th>
<th>50-74 every year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-detection rate</td>
<td>18%</td>
<td>44%</td>
<td>45%</td>
<td>46%</td>
</tr>
<tr>
<td>Lead time (for over-detected cases)</td>
<td>15.2 yrs</td>
<td>11.6 yrs</td>
<td>12.5 yrs</td>
<td>13.0 yrs</td>
</tr>
</tbody>
</table>
Conclusions:

A minimal life gain is offset by the high levels of disease management and over-diagnosis:

- One off screening: life gain of 0.004 years (1.2 days) with 36 years of additional disease management
- Repeat screening: life gain of 0.03 years (10-11 days) with 67-84 years of additional disease management
Have you heard our findings?

BBC News 06/12/2010 http://www.bbc.co.uk/news/health-11930979

Experts scrap prostate screening proposal

UK experts have recommended against a screening programme for prostate cancer, saying its potential harms would outweigh any benefits.

The UK National Screening Committee says after weighing all the evidence, screening for this male cancer using a blood test called PSA is not advisable.

PSA screening has been contentious because of concerns about over-diagnosis.

Blood can be checked for PSA levels
Acknowledgements:

• Dr Anne Mackie and Prof Julietta Patnick at the UK National Screening Committee
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• The British Association of Urological Surgeons
• The ProtecT team