Lung Cancer Risks from Radon in Ontario: Burden of Illness, Estimates and their Policy Implications

Ray Copes, MD
Emily Peterson, MPH
PUBLIC HEALTH ONTARIO

• Arm’s length agency funded by Province of Ontario
• Became operational in 2008
• Provide science and technical advice and support to the health care system (e.g. public health units) and the Government of Ontario
• Also run the Public Health Labs
• Do not have regulatory or statutory powers; do not make policy
• Research and teaching through links to, and appointments at, Ontario universities
Radon in Context as source of Ionizing Radiation Exposure
Average Amounts of Ionizing Radiation Received Annually by Resident of the United States or Canada (mSv)

- **Radon (1.9)** 31%
- **Cosmic (0.27)** 4%
- **Terrestrial (0.28)** 4%
- **Internal (0.39)** 6%
- **Nuclear Medicine (0.8)** 13%
- **x-Ray diagnosis (2.4)** 39%
- **Other Artificial (0.05)** 1%
- **Consumer Products (0.1)** 2%

# Lifetime Lung Cancer Risk

(Adapted from the US EPA)

<table>
<thead>
<tr>
<th>Radon Level (Lifetime Exposures)</th>
<th>People who never smoked</th>
<th>People who smoked</th>
</tr>
</thead>
<tbody>
<tr>
<td>740 Bq/m³</td>
<td>36/1,000</td>
<td>260/1,000</td>
</tr>
<tr>
<td>370 Bq/m³</td>
<td>18/1,000</td>
<td>150/1,000</td>
</tr>
<tr>
<td>296 Bq/m³</td>
<td>15/1,000</td>
<td>120/1,000</td>
</tr>
<tr>
<td>148 Bq/m³</td>
<td>7/1,000</td>
<td>62/1,000</td>
</tr>
<tr>
<td>74 Bq/m³</td>
<td>4/1,000</td>
<td>32/1,000</td>
</tr>
<tr>
<td>48 Bq/m³</td>
<td>2/1,000</td>
<td>20/1,000</td>
</tr>
<tr>
<td>15 Bq/m³ (average outdoor level)</td>
<td></td>
<td>3/1,000</td>
</tr>
</tbody>
</table>

Why do Burden of Illness Estimates?
How understandable is?

- IARC Group 1 carcinogen
- Second largest contributor to ionizing radiation exposure
- 200 Bq/m$^3$ or any other measure of radon
- % of homes above a given level
Twelve Principal Outrage Components  

**“SAFE”**  
- Voluntary  
- Natural  
- Familiar  
- Not Memorable  
- Not Dreaded  
- Chronic  
- Knowable  
- Individually controlled  
- Fair  
- Morally irrelevant  
- Trustworthy source  
- Responsive process

**“RISKY”**  
- Coerced  
- Industrial  
- Exotic  
- Memorable  
- Dreaded  
- Catastrophic  
- Unknowable  
- Controlled by others  
- Unfair  
- Morally relevant  
- Untrustworthy sources  
- Unresponsive process
How best to communicate to public and public health professionals?

• Context is important

• How do you relate to other worries, priorities?

• “How important is this?” is asked by many people, groups, organizations

• Frames of reference vary

• How many will get sick and/or die?

• Where does this fit? We can’t do everything!

• WHO Environmental Burden of Disease

• Other national, local efforts directed at all or some hazards
Public Health System in Ontario

- Highly decentralized service delivery – 36 health units
- Ontario Public Health Standards common to all
- Some flexibility to tailor to local needs priorities
- Health Hazard Prevention and Management Standard
- Permissive not prescriptive
- Level of awareness and interest in radon varied across health units
Ontario Radon Burden of Illness Calculations : Purpose

• Calculate the lung cancer burden of illness attributable to Radon in Ontario

• Estimated number of lung cancer deaths that can be prevented if all homes above 50, 100, 150 and 200 Bq/m$^3$ were remediated to background levels

• Perform calculations separately for each of the 36 health units in Ontario
Data Sources

- Cross-Canada Survey of Radon in Homes (Health Canada)
- Proportion of pop. living in apartment buildings by health unit (Statistics Canada)
- Proportion of pop. ever-smokers by health unit (CCHS)
- All cause and lung cancer mortality by health unit (CCHS)
- RR for lung cancer mortality and all-cause mortality due to smoking (American Cancer Society)
Results: Ontario Burden Estimates

• 13.6% (95% CI 11.0,16.7) of lung cancer deaths in Ontario attributable to radon

= 847 (95% CI: 686, 1039) radon-related lung cancer deaths in 2007

• 85% of these in ever-smokers
### Results: Individual Health Unit Burden Estimates

<table>
<thead>
<tr>
<th>Geographic Region</th>
<th>Population Attributable Risk Percent (PAR%)</th>
<th>Lung Cancer Deaths Attributable to Radon</th>
<th>Number (percentage) of radon-attributable lung cancer deaths that can be prevented</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (95% Confidence Interval)</td>
<td></td>
<td>100 (Bq/m³)</td>
</tr>
<tr>
<td>Ontario</td>
<td>13.6 (11.0-16.7)</td>
<td>847</td>
<td>233 (28%)</td>
</tr>
<tr>
<td>Health Unit 1</td>
<td>25.3 (21.7-29.6)</td>
<td>21</td>
<td>9 (42%)</td>
</tr>
<tr>
<td>Health Unit 2</td>
<td>9.1 (6.9-11.6)</td>
<td>24</td>
<td>1 (4%)</td>
</tr>
</tbody>
</table>
Results: Ontario Preventable Cancer Estimates

<table>
<thead>
<tr>
<th>Remediation Level</th>
<th>50 Bq/m³</th>
<th>100 Bq/m³</th>
<th>150 Bq/m³</th>
<th>200 Bq/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lung cancer deaths prevented</td>
<td>389</td>
<td>233</td>
<td>149</td>
<td>91</td>
</tr>
<tr>
<td>Percent of lung cancer deaths prevented</td>
<td>46%</td>
<td>28%</td>
<td>18%</td>
<td>11%</td>
</tr>
</tbody>
</table>
IMPLICATIONS FOR POLICY
Is test and remediate the best option?

• Good evidence that remediation is effective

• Literature mixed on effectiveness of education to promote testing and remediation in homes
  • Many barriers, few people remediate
  • Financial incentives may help

• Large portion of burden from exposures below the current Canadian guideline

• Only option for older homes

• What about public buildings?
Building Codes

• Could reduce levels to well below the current guideline (address larger portion of burden)
• More consistent with ALARA?
• But, takes many years for housing turnover
• More research needed on effectiveness of building codes
• Impact of insurance companies?
  • Tarion now covers new builds with levels above Health Canada Guideline (>200Bq/m³)
Possible Public Health Responses

• Health Unit education/awareness campaigns?
  • Health Canada education materials available for free upon request

• Incentives for homeowners to test and remediate?
  • e.g. Rebate if provide testing results to HU

• Testing and remediation in public buildings (schools) and group facilities?

• Building codes?
  • National model construction codes


Why so little success to date?

• ‘Natural’, no organoleptic impact
• For private homes- alignment of those bearing risk and those responsible for testing/remediation
• Little ‘Outrage’
• Is government sending a mixed message?
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