Health risk related to environmental and clinical radon sources: necessity to increase public awareness

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PRESENTATION OUTLINE

- Introduction – lung cancer
- What is radon
- Correlation of radon with cancer induction
- Radon-related health risk – acceptable limits
- Medical practices and radon
- Radon concentration measurement – mitigation
- Results

RAD 2020, Herceg Novi, Montenegro, June 15-19 2020
INTRODUCTION – LUNG CANCER (1/2)

- High levels of incidence and mortality both in men and women
- 5-year survival: ~25% (study-dependent)
- When diagnosed, in 79% of the cases it is not localized
  - ~22%: lymph nodes are affected
  - ~57%: metastases
INTRODUCTION – LUNG CANCER (2/2)

- ~80% deaths due to lung cancer: smokers
- Mortality due to lung cancer also exists in NON-smokers
- Most important environmental risk factor for lung cancer development for the whole population, also being no. 1 risk for non-smokers: RADON
What is Radon (1/2)

- Radioactive gas
- Exists in nature (uranium – radium – radon – polonium)
- Invisible – odorless – tasteless – not perceivable with human senses
WHAT IS RADON (2/2)

- Concentration inside buildings – basements/ground floors
- Ground permeability – cracks – pipes – well water
- 2nd most important cause of lung cancer
CORRELATION OF RADON WITH CANCER

- **1770: Carl Lebrecht Scheffler**
  - Studied health of mine workers
  - Radon is found out to be responsible for cancer induction

- **1988: IARC** (International Agency for Research on Cancer)
  - Radon is listed as a known carcinogenesis agent
HOW RADON EXPOSURE INDUCES CANCER

- Po-214, Po-218
  - Products of radon radioactive decay
  - $\alpha$- emitters of high LET

- Responsible for radiation burden of lungs during inhalation
- Single- and Double- strand breaks of DNA
**CORRELATION OF RADON EXPOSURE AND CARCINOGENESIS: PROOF (1/2)**

- **Laboratory studies**
  - DNA strand breaks due to Po-214, Po-218

- **Test animals**
  - Radon exposure induces lung cancer

- **Retrospective epidemiological studies – mine workers**
  - Last 50 years: 15 large-scale epidemiological studies (USA – Canada – Australia – China – Europe)
  - 68,000 workers
  - Latent period: 5 years
  - BEIR Committee: workers’ deaths: 39% (smokers) – 73% (non-smokers) are attributed to radon
CORRELATION OF RADON EXPOSURE AND CARCINOGENESIS: PROOF (2/2)

- Case-control epidemiological studies
  - 22 large-scale studies
  - $\uparrow$ radon concentration by $100 \text{ Bq/m}^3$
    excess relative risk of lung cancer development
      - $+11\%$ (USA-Canada studies)
      - $+16\%$ (European studies)
      - $+33\%$ (China studies)
RADON EXPOSURE ASSOCIATED RISK DATA (1/3)

- 8th highest cause of mortality in USA (EPA)
- No. 1 environmental risk factor for lung cancer development in USA

<table>
<thead>
<tr>
<th>CAUSE OF DEATH</th>
<th>ANNUAL MORTALITY ASSESSMENT IN USA (2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. Lung cancer</td>
<td>154000</td>
</tr>
<tr>
<td>4th. Breast cancer</td>
<td>41000</td>
</tr>
<tr>
<td>6th. Prostate cancer</td>
<td>29000</td>
</tr>
<tr>
<td>8th. Non-Hodgkin lymphoma</td>
<td>21000</td>
</tr>
<tr>
<td>RADON</td>
<td>21000</td>
</tr>
<tr>
<td>12th. Ovaries’ cancer</td>
<td>14000</td>
</tr>
</tbody>
</table>

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RADON EXPOSURE ASSOCIATED RISK DATA (2/3)

- ~21000 deaths due to radon exposure in USA annually

<table>
<thead>
<tr>
<th>CITY IN GREECE</th>
<th>POPULATION (inhabitants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sparta</td>
<td>19000</td>
</tr>
<tr>
<td>Preveza</td>
<td>19000</td>
</tr>
<tr>
<td>Livadia</td>
<td>21000</td>
</tr>
<tr>
<td>Arta</td>
<td>22000</td>
</tr>
</tbody>
</table>

- The population of a whole city of such size dies due to radon exposure in USA annually
# RADON EXPOSURE ASSOCIATED RISK DATA

## RISK OF LUNG CANCER INDUCTION DUE TO RADON EXPOSURE (RESIDENCES)

<table>
<thead>
<tr>
<th>Rn conc.(pCi/l)</th>
<th>Rn conc.(Bq/m³)</th>
<th>Health risk – non smokers (%)</th>
<th>Health risk – smokers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25</td>
<td>46</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>74</td>
<td>0.4</td>
<td>3.2</td>
</tr>
<tr>
<td>4</td>
<td>148</td>
<td>0.7</td>
<td>6.2</td>
</tr>
<tr>
<td>10</td>
<td>370</td>
<td>1.8</td>
<td>15.0</td>
</tr>
</tbody>
</table>

* non-smokers: max 100 cigarettes during lifetime

**Synergy of smoking – radon factors**

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Acceptable limits of radon concentration - residences: Are they safety limits?

- Acceptable limits: **NOT** safety limits
- They correspond to a level of risk that is considered to be acceptable

<table>
<thead>
<tr>
<th>BODY</th>
<th>ACCEPTABLE LIMIT (Bq/m³)</th>
<th>ACCEPTABLE LIMIT (pCi/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO</td>
<td>100</td>
<td>2.7</td>
</tr>
<tr>
<td>EPA</td>
<td>148</td>
<td>4</td>
</tr>
</tbody>
</table>
ARE THERE ANY MEDICAL PRACTICES CURRENTLY AVAILABLE THAT MAY RESULT IN INCREASED RADON CONCENTRATION LEVELS?

- Ra-223: bone metastases due to prostate cancer
- Slow administration – the patient exhales radon
- Radon concentration around the patient: \( \sim 2 \text{ MBq/m}^3 \)
  (~10000 times or 4 orders of magnitude above the acceptable limits of radon concentration in residences)
RADON CONCENTRATION MEASUREMENT

- **Who - how**
  - Special equipment/experts (bodies or companies)

- **When**
  - EPA: recommends measurement of radon concentration in residences *every 5 years* (with cooling-heating systems on and off) or after extended building renovation or cooling-heating systems changes

- **Acceptable limits**
  - EPA: 4 pCi/l (148 Bq/m³) - safe side 2 pCi/l (74 Bq/m³)
  - USA: inside residences 48 Bq/m³ – outside **15 Bq/m³**

- **Aim**
  - Radon concentration inside = Radon concentration outside (in all cases <2 pCi/l = 74 Bq/m³)
RADON MITIGATION MEASURES

- Provision during construction (reduced cost)
- In case of older buildings: intervention (Active Soil Depressurization System)
- USA: recommendation for screening in sensitive target groups with LDCT (e.g. annually for smokers 50 y.o., 1 package of cigarettes/day during the last 20 years, recorded living in a high radon concentration residence)
IN CONCLUSION…

- Radon issue should be studied in depth by health professionals – public awareness needs to be increased

- **PROVISION** in residences under construction (amendment of radon-related guidelines during upgrading of national building code legislation)

- **MEASUREMENT AND MITIGATION** in case of older establishments (residences – educational institutes – workplaces)

- **SCREENING**
BIBLIOGRAPHICAL REFERENCES


Thank you for your time…

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