Population Collective Effective Dose from Nuclear Medicine procedures in Greece

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Introduction – legislation

- **2001** - first Ministerial Order - *annual* collection of frequencies

- **2003** – GAEC’s Board of Directors decision - *annual* data collection of nuclear medicine therapies (i.e. radiopharmaceutical, administered activity, hospitalization dates etc)

- **2007** – Ministerial Order – establishment of national DRLs for nuclear medicine procedures (adults)

- **2010** - Ministerial Order - GAEC to estimate population collective effective doses from medical applications, *every 3 years*

- **2012** – collection of data for the establishment of national pediatric DRLs for nuclear medicine procedures
Introduction – the survey

- **2010** - the most recent national survey of NM practice in Greece - GAEC’s Department of Licensing and Inspections (DLI)

The objectives of this survey were:
- a) the assessment of different NM procedures frequencies,
- b) the estimation of relevant uncertainties
- c) the determination of annual collective effective dose to the Greek population from NM and
- d) the determination of relative contribution of different NM procedures.
Materials & Methods

• Collection of frequencies:
  – nuclear medicine departments submit annually to GAEC the frequency data questionnaire
  – record keeping by GAEC (database)
  – the data used correspond to the year 2009 → the 2009 survey

• Collection of administered activities:
  – during on site inspections carried out by GAEC, nuclear medicine specialists fill in a questionnaire
  – pragmatic values (MBq) for standard sized adult patients
  – the data used in the 2009 survey correspond to period 2006-2009
## Materials & Methods

### Diagnostic part of NM frequency questionnaire

<table>
<thead>
<tr>
<th>Examination type</th>
<th>Number of exams</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroid scan I-131</td>
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<tr>
<td>Thyroid scan Tc-99m</td>
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<td>Renal static scan</td>
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<tr>
<td>Renal dynamic scan (only DTPA)</td>
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<tr>
<td>Bone scan</td>
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<tr>
<td>Lung scan (only perfusion)</td>
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<tr>
<td>Myocardium scan TI-201</td>
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<td></td>
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<tr>
<td>Myocardium scan Tc-99m</td>
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<tr>
<td>MUGA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole body scan TI-201</td>
<td></td>
<td></td>
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<tr>
<td>Whole body scan Ga-67</td>
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<td></td>
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<tr>
<td>Whole body scan In-111</td>
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<tr>
<td>Whole body scan I-131</td>
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<tr>
<td>Liver-spleen scan (gastro)</td>
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<td>PET</td>
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<tr>
<td>Other scans</td>
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<tr>
<td><strong>Total number of scans</strong></td>
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</tr>
</tbody>
</table>

**Pediatric NM exams not collected**

No. of exams: mandatory,  No. of patients: optional
Materials & Methods

- The collected activity data correspond to 100% of NM dep/s.

- The collected frequency data correspond to 86% - 100% of NM dep/s.

- Scaling up to 100%  
  46 working weeks per year  

Definition of 4 workload categories for each procedure

The "n/a" nuclear medicine departments were categorized by estimating their workload based on:
- previous years workloads
- annually supplied radiopharmaceutical activities
- regional population density
- on-site inspection outcomes
• Scaling up to 100% (cont’d):

Example: bone scan

**Cat. 4** 0 ≤ No. of exams ≤ 100 (approx. 2 patients/week) 50 300

**Cat. 3** 100 < No. of exams ≤ 500 (approx. 11 patients/week) 750 2000

**Cat. 2** 500 < No. of exams ≤ 1000 (approx. 22 patients/week)

**Cat. 1** 1000 < No. of exams ≤ 3000 (more than 22 patients/week)

The average value of frequency was assigned to the “n/a” nuclear medicine departments for each workload category.
Materials & Methods

• Scaling up to 100% - **uncertainty estimation**: 

\[ \delta x = \frac{\max - \min}{2} \]

Workload Category (cat): \( \min < \text{No. of exams} \leq \max \)

\[ u_{\text{cat}} = \frac{\delta x}{\sqrt{3}} \]

• Type B, rectangular distribution

• in each category, all “n/a” NM dep/s have the same \( u_{\text{cat}} \)

Frequency uncertainty \( u_{\text{freq}} = \sqrt{\sum_{\text{cat}} (N_{\text{n/aNMdeps,cat}} \cdot u_{\text{cat}}^2)} \)

Relative frequency uncertainty per procedure

\[ u_{\text{relfreq}} = \frac{u_{\text{freq}}}{\text{frequency}} \times 100\% \]
Materials & Methods

Average admin. activity (MBq) × ICRP factor (mSv/MBq) = Effective dose (mSv) per procedure

\[ \sum \text{Population effective dose per procedure (manSv)} \]

Population effective dose (manSv) from NM procedures

Population effective dose (manSv) / country’s population = Effective dose per caput (mSv)
Results

• Total number of procedures: 257212

• Population collective effective dose: 1.79manSv

• Annual per caput effective dose: 0.16mSv
Results

National NM “Top 5”

- $^{201}$TI myocardium scan
- $^{99m}$Tc MIBI myocardium scan (stress and rest)
- $^{99m}$Tc bone scan
- $^{131}$I thyroid scan (after ablation, 0% uptake)
- $^{99m}$Tc thyroid scan

Relative standard uncertainty (k=1) for the “Top 5 exams” frequency extrapolation ranges from 0.8% - 3.4%.
Results

The national "Top 5 NM exams" contribute

- 83% to the total NM frequency in Greece
- 91% to the total collective effective dose from NM procedures in Greece
Conclusions

- The NM practice in Greece seems to follow the global practice (UNSCEAR 2008) dominated by cardiovascular studies, bone scans and thyroid studies.

- Average Administered Activities (AAAs) calculated in this survey (2006-2009 data) do not exhibit remarkable changes, compared to the ones calculated in the past (2002-2005 data*).

- Conclusions relevant to NM frequency trends cannot be drawn - the scale-up method used in the 2009 survey was different than the one used in the past.

- The annual per caput effective dose of 0.16mSv from NM procedures in Greece is higher than the mean per caput (0.12mSv), corresponding to Level I countries (UNSCEAR 2008).

Thank you for your attention