Chelation Treatment after Occupational Exposure to Plutonium

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Objectives
- Plutonium biokinetic modeling under chelation treatment
- Estimating plutonium intake and radiation dose
- Evaluating effectiveness of chelation treatment

USTUR Case 0785
- Primary exposure: Plutonium (Pu)
- Exposure scenario: Acute inhalation and wound
- Material type: M (assumed)
- Smoking status: 35 y (0.5 pack per day)
- Cause of death: Lung cancer
- Post-Intake: 51 y
- Age: 79 y

Accident
- Glove-box explosion; Working with plutonium nitrate solution
- Face, hair, neck, hands, and forearms contamination
- Facial wound deposition 8,032 Bq
- Plutonium systemic burden 7,400 Bq (worksite)
  Five times higher than permissible amount

Autopsy Tissue Analysis
- Total of 32 tissue samples
- \(^{239+240}\text{Pu}\) concentration measured
- Total tissue/organ activity estimated

Table: Tissue/Organ (Pu Concentration, Bq kg\(^{-1}\))
<table>
<thead>
<tr>
<th>Tissue/Organ</th>
<th>Pu Concentration, Bq kg(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lungs</td>
<td>18.2 (\pm) 0.3</td>
</tr>
<tr>
<td>LNTH</td>
<td>5.88 (\pm) 98</td>
</tr>
<tr>
<td>Liver</td>
<td>548 (\pm) 36</td>
</tr>
<tr>
<td>Skeleton</td>
<td>109 (\pm) 8</td>
</tr>
<tr>
<td>Total Systemic</td>
<td>2,728 (\pm) 74</td>
</tr>
</tbody>
</table>

LnTH: Lung concentration ratio = 3.23

Exposure to very insoluble material ("Super S")

IMBA Professional Plus\(^{\circledR}\)

- A suite of software modules for internal dosimetry
- Implements all current bioassay and dosimetric models
- Enables the user to:
  - Estimate an intake from bioassay measurement data
  - Predict bioassay quantities from a specific intake
  - Calculate resulting doses

Data Analysis

Biokinetic Models
- International Commission on Radiological Protection Human Respiratory Tract Model (ICRP 190)
- National Council on Radiation Protection and Measurements Wound Model (NCRP 196)
- Leggett Plutonium Systemic Model (Leggett et al., 2009)

Assumptions
- Particle size: 1 \(\mu\)m AMAD
- Lung absorption type: Slow (S)
- Wound retention category: Insoluble colloid

Estimating Residual Intake: Activity not Removed by Chelation Therapy

- Inhalation: 33,050 Bq (97%)
- Wound: 1,084 Bq (3%)

Total Intake and Dose Estimation

- Intake
  - Residual intake: 34,134 Bq
  - Pu removed by chelation:
    - Committed Effective Dose: 548 Bq
  - Projected CED: 1.11 Sv

Conclusions
- Exposure to highly insoluble plutonium
- Systemic deposition 51 years post-intake was 2,728 Bq
- Major internal contamination from inhalation (97%)
- Estimated intake was 34,817 Bq
- Estimated committed effective dose was 1.09 Sv
- Only 25 dose was saved by chelation treatment

Podium Presentation
The results were also presented at the 61st Annual Meeting of the Health Physics Society: July 17 - 21, 2016 Spokane, WA as a part of USTUR: Five Decade Follow-up of Plutonium and Uranium Workers special session

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References