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USTUR Case 0785: Modeling Pu Decorporation Following Complex Exposure

Sara Dumit, Maia Avtandilashvili, Bastian Breustedt, Sergei Y. Tolmachev

United States Transuranium and Uranium Registries
College of Pharmacy, Washington State University

"Learning from Plutonium and Uranium Workers"

Objectives

- Plutonium biokinetic modeling under decorporation treatment
- Estimating intake and dose

USTUR Case 0785

- Primary exposure: Plutonium (Pu)
- Exposure scenario: Acute inhalation and wound
- Material type: M (assumed)
- Smoking status: 38 y (0.5 pack per day)
- Cause of death: Lung disease
- Post-intake: 51 y
- Age: 79 y

Case 0785 Accident

- Working with plutonium nitrate solution
- Glove-box explosion
- Face, hair, neck, hands, and forearms contamination
- Facial wound deposition 8,032 Bq
- Plutonium systemic burden 7,400 Bq (worksite)

Five times higher than MPBB

Treatment

Decorporation Therapy

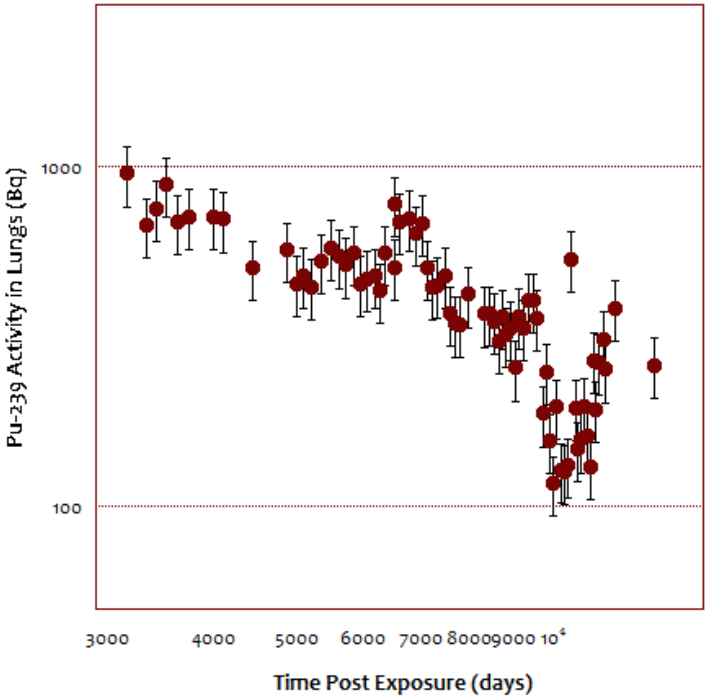
- Immediately: 1-2 g Ca-EDTA, 2 i.v. per day, 4 weeks
- 9 months post-accident: 2 g Ca-EDTA, 2 i.v. per day, 2 weeks
- 7 years post-accident: 1 g Zn-DTPA, 1 i.v. per week, 10 weeks

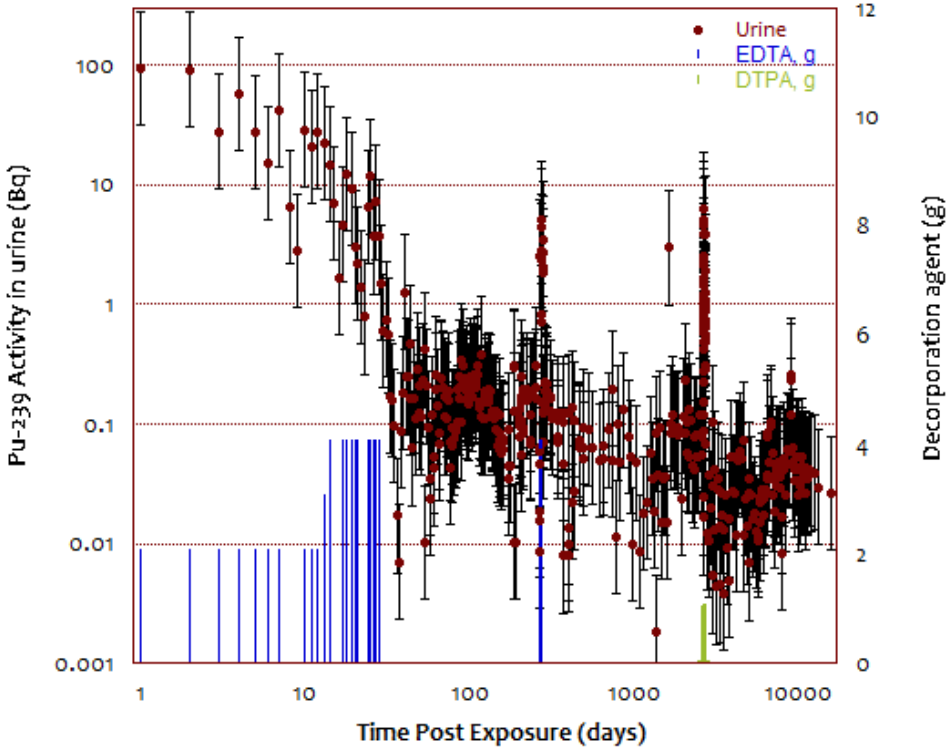
Wound Excision

- 3 weeks post-accident: 7,344 Bq of plutonium was removed

Bioassay Measurements

- In-vivo: 74 lung counts
- In-vitro: 478 urinanalyses





Autopsy Tissue Analysis

- Total of 32 tissue samples
- $^{238,239+240}$Pu concentration measured
- Total tissue/organ activity estimated

Tissue/Organ	$^{239+239}$Pu Concentration, Bq kg^{-1}	$^{239+240}$Pu Activity, Bq
Lungs	18.2 ± 0.3	24.6 ± 0.4
LNTH	5,884 ± 98	108.7 ± 1.8
Liver	548 ± 36	602.0 ± 40
Skeleton	209 ± 8	1,936 ± 74
Total Systemic	-------	2,728 ± 84

- LNTH:Lung concentration ratio = 323
- Exposure to very insoluble material (Super S)

Data Analysis

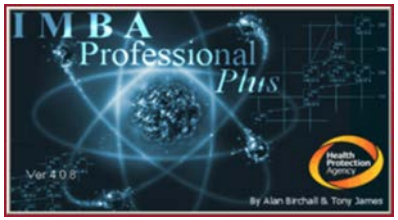
Biokinetic Models

- ICRP Human Respiratory Tract Model (ICRP 130)
- NCRP Wound Model (NCRP 156)
- Leggett Plutonium Systemic Model (Leggett et al, 2005)

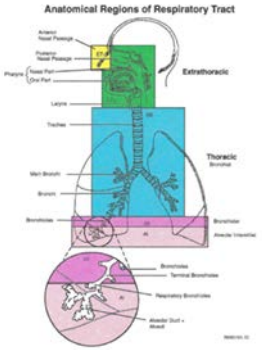
Assumptions

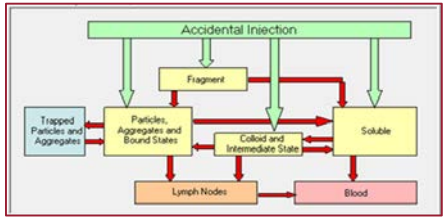
- Particle size: 1 μm AMAD
- Lung absorption type: S
- Wound retention category: insoluble colloid

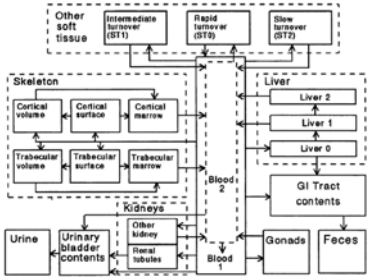
IMBA Professional Plus®



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

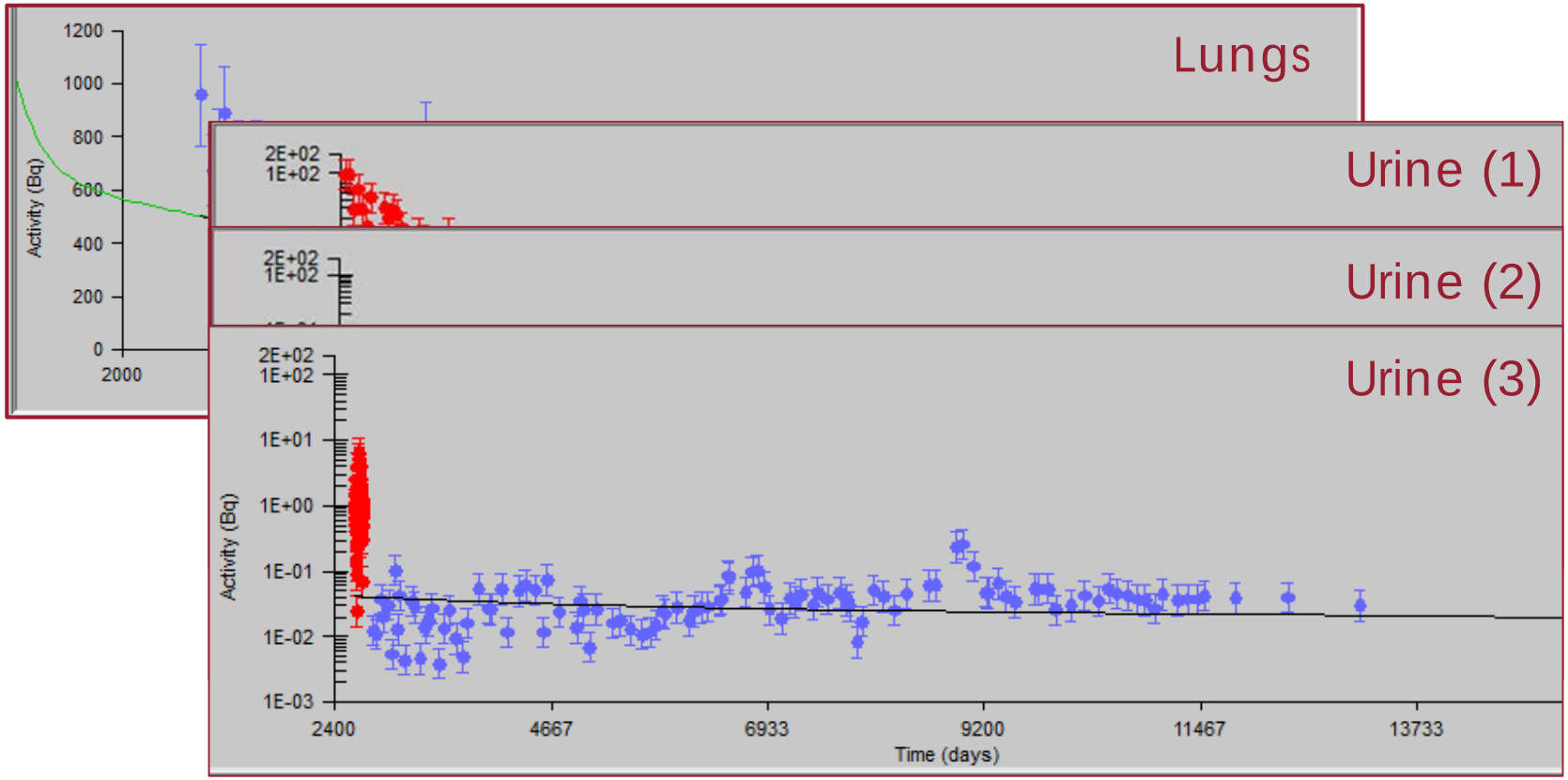






Residual Intake Estimation

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: + 683 Bq } 34,817 Bq
- Committed Effective Dose
  - ✓ Residual CED: 1.09 Sv
  - ✓ Projected CED: 1.11 Sv

Conclusions

- Exposure to highly insoluble Pu material
- Systemic deposition 51 years post-intake was 2,728 Bq with skeleton-to-liver activity ratio of 3:1
- Major internal contamination (97%) from inhalation
- Estimated intake was 34,817 Bq
- Estimated committed effective dose: 1.09 Sv
- Only 2% dose was saved by decorporation treatment

Thank you! Questions?