EURADOS Annual Meeting
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USTUR Research: Land of Opportunity

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"Learning from Plutonium and Uranium Workers"

US Transuranium and Uranium Registries

- Follow up occupationally exposed workers, from exposure through full lifespan, by studying the biokinetics (uptake, translocation and retention), and tissue dosimetry of the actinides (Pu, Am, and U)
- Funded by the U.S. Department of Energy since 1968

USTUR Registrants

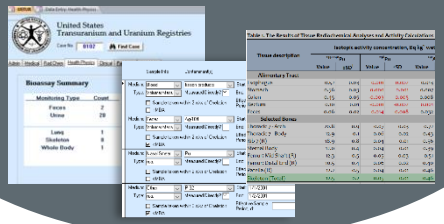
- Voluntary Tissue Donors (Posthumous)
  - Whole-body Donors (43)
  - Partial-body Donors (304)
- Former Nuclear Workers from DOE Sites
- Documented Radiation Exposure and Work History
- Exposure Criteria:
  - *Actinide internal deposition of ≥74 Bq (2 nCi)*
  - *External dose to the whole body ≥0.1 Sv (10 rem)*

Unique Data Resource

- Work History
- Exposure & Medical Records
- Bioassay

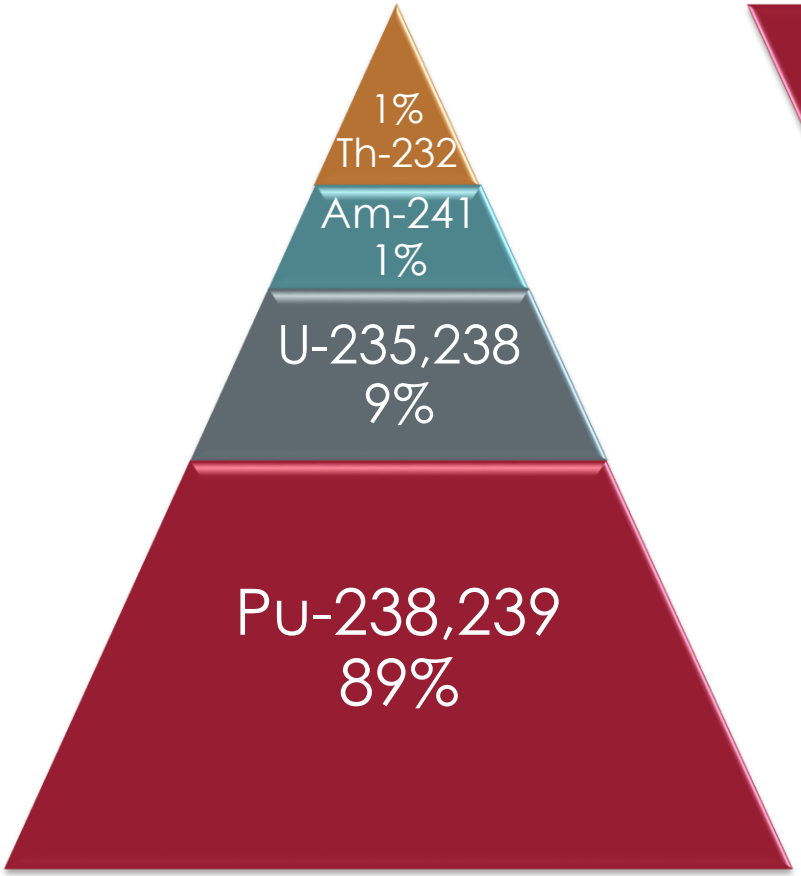
- Autopsy Tissue Radiochemical Analysis

USTUR Data

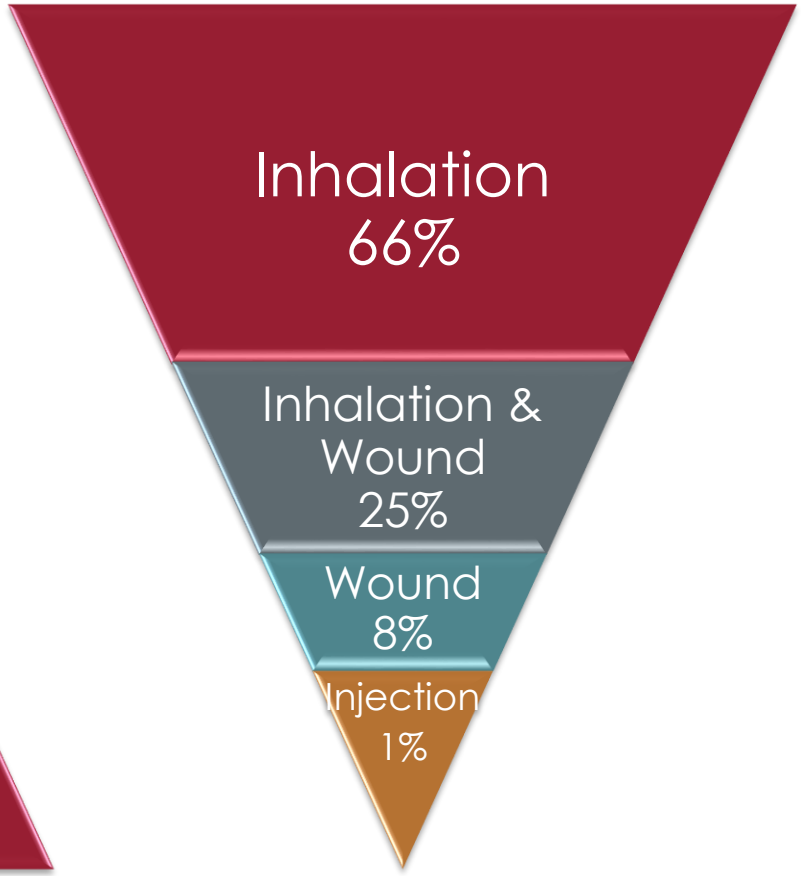


Primary Exposure

Radionuclide



Route of Intake



From Data Collectors to Data Users

Research Opportunities

- Biokinetics and tissue dosimetry
- Decorporation modeling
- Long-term distribution in human body
- More …

Plutonium Biokinetics

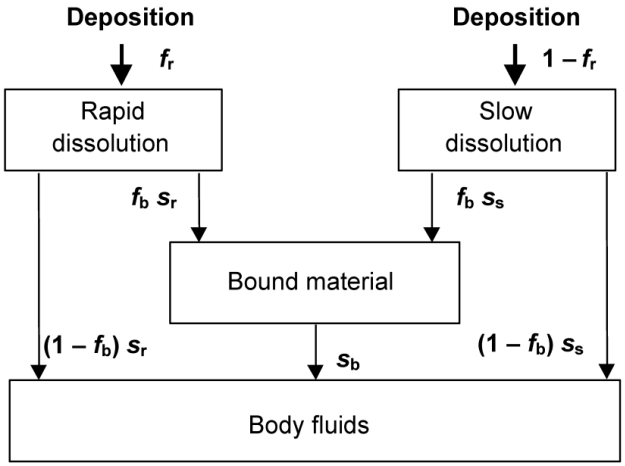
Pu-239 Soluble Material

- U(you)P(ee)PU Club: 26 workers exposed at Los Alamos during 1943 – 1945
- 16 of them are USTUR Registrants
  - ✓ 6 whole-body donations
  - ✓ 6 partial-body donations
  - ✓ 4 living Registrants
- Follow-up data: lung counts, urine
  - ✓ From 3 to 100+ positive urine measurements

http://permalink.lanl.gov

Long-term Retention in the Upper Airways

- Whole-body Cases 0631 and 0745
- USTUR/PNNL collaboration
- Plutonium bound fraction

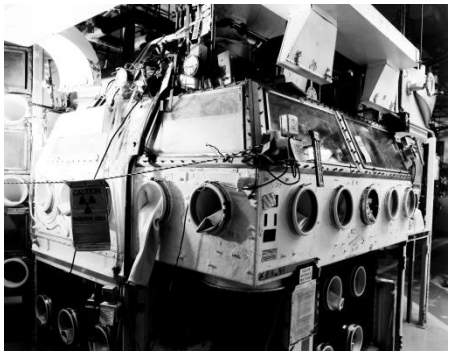


Lung Clearance: Absorption to Blood

Tolmachev SY. Technical Report USTUR-0379-15; Richland, WA, 2013

Pu-239 Refractory Particles

- 'High-fired' PuO_2 aerosols
  - ✓ Generated at 1800°C
  - ✓ Particle size: 1 μm AMAD
- 23 USTUR Registrants involved
  - ✓ 5 whole-body donations
  - ✓ 16 partial-body donations
  - ✓ 2 living Registrants
- Follow-up bioassay: lung counts, urine, feces
  - ✓ From 1 to 60+ positive urine measurements



https://www.lm.doe.gov

Pu-239 Contaminated Wound

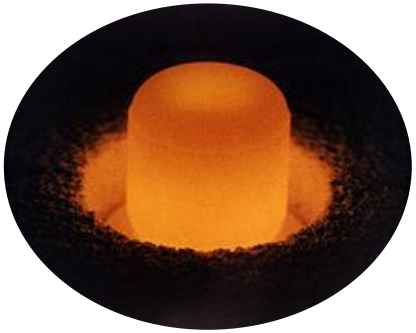
- 14 USTUR Registrants with wound as primary intake
  - ✓ 4 whole-body donations
  - ✓ 8 partial-body donations
  - ✓ 2 living Registrants
- No chelation treatment
- Follow-up bioassay: wound counts, urine
  - ✓ From 1 to 94 positive urine measurements

Fifty-two Year Follow-up Study

- USTUR Case 0820: *living*
- Puncture wound to the right hypothenar pad
  - ✓ Depth: ~1 cm
- Initial ^{239}Pu deposition: 11 kBq
  - ✓ 1.6 kBq measured after immediate tissue excision
- Nodule excised 51-y later
  - ✓ 632 Bq removed
- A total of 13 wound counts
  - ✓ Latest estimate: 1.9 ± 0.2 kBq

Falk RB, Daugherty NM, Aldrich JM et al. *Health Physics* 2006; 91(2): 128-143

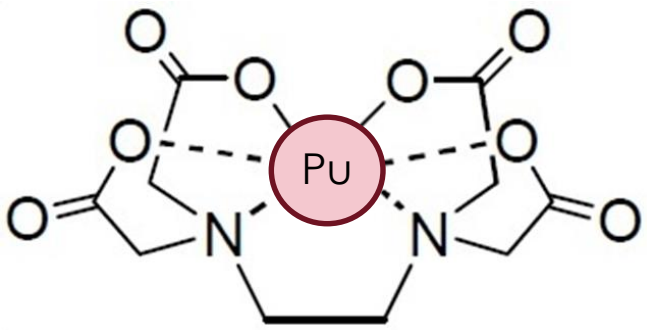
Pu-238 as Primary Radionuclide



https://en.wikipedia.org

- 10 USTUR Registrants
  - ✓ 2 whole-body donations
  - ✓ 4 partial-body donations
  - ✓ 4 living Registrants
- Follow-up bioassay: lung counts, urine
  - ✓ From 10 to 300+ positive urine measurements

Pu/Am Decorporation



Plutonium

- Treatment: Ca-EDTA, Ca/Zn-DTPA
- 15 USTUR Registrants
  - ✓ 6 whole-body donations
  - ✓ 6 partial-body donations
  - ✓ 3 living Registrants
- 'USTUR Chelation Model': Case 0269

James AC, Sasser LB, Stuit DB et al. *Radiat Prot Dosim* 2007; 127(1-4): 449-455

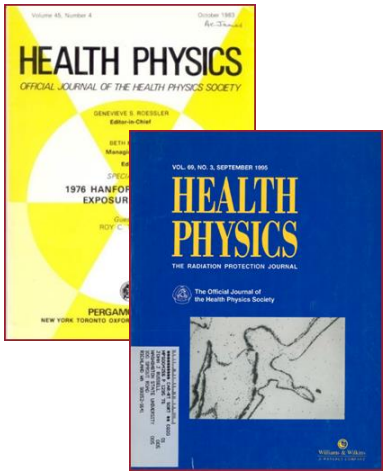
Task 7.3 Session, 13:30-15:30

Sara Dumit. *Plutonium Biokinetics in the Human Body under Decorporation Treatment*

Americium

- USTUR Case 0246: *'Atomic Man'*
  - ✓ Highest recorded ^{241}Am intake: > 40 MBq
  - ✓ 4 year DTPA therapy
  - ✓ Treatment efficacy factor: 80

  Carbaugh E. *Health Physics* 2017; In preparation



- USTUR Case 0846
  - ✓ Initial systemic deposition: 66.7 kBq
  - ✓ 7 year DTPA therapy
  - ✓ Post-mortem activity in skeleton: 26 kBq

  Breustedt B et al. *Health Physics* 2017; In preparation

Uranium Distribution and Biokinetics

Occupational Exposure

- 33 USTUR Registrants
  - ✓ U-natural: 17
  - ✓ U-enriched: 5
  - ✓ U-depleted: 3
  - ✓ Unknown: 8

https://en.wikipedia.org

- Follow-up bioassay: urine, lung counts
  - ✓ From none to 300 positive urine measurements

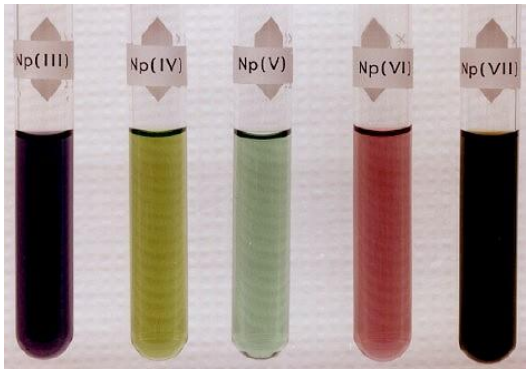
Uranium Distribution in Human Body

- Uranium in man
  - ✓ No occupational exposure to U
  - ✓ Five plutonium workers
- Uranium in woman
  - ✓ Medical exposure to Thorotrast (^{232}Th)
  - ✓ No radiation workers
  - ✓ Two whole-body donors

Minor Actinides: Np-237 and Cm-244

Neptunium-237

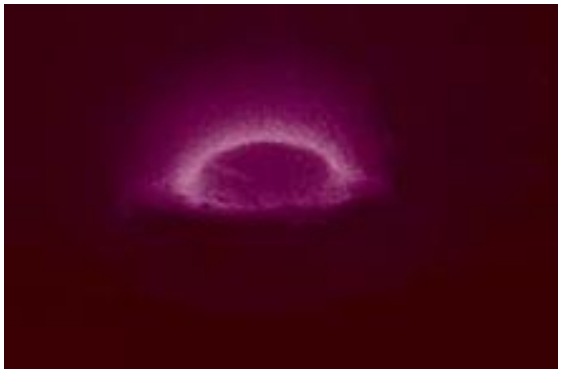
- Partial-body Case 0605: *living*
- Single acute inhalation
- Estimated ^{237}Np intake: 15 Bq
- Three positive urine measurements
- Major exposure to $^{238}PuO_2$



https://en.wikipedia.org

Curium-244

- Partial-body Case 0587: *living*
- Single acute inhalation
- Estimated ^{244}Cm systemic deposition: 1.3 kBq
- Potential exposure to enriched uranium



https://en.wikipedia.org

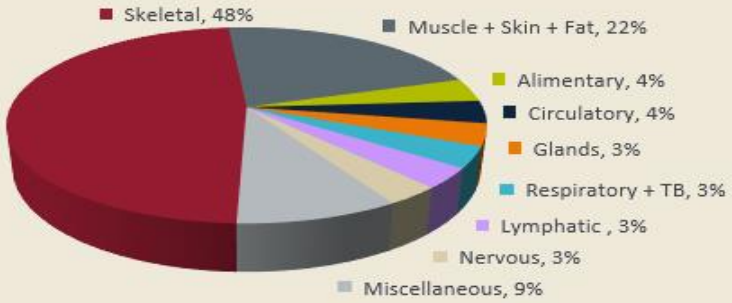
Other than Actinides

Non-Radioactive Materials

- Beryllium
  - ✓ 6 whole-body donations
  - ✓ Self-reported exposure to Be over 6 – 27 years
- Zirconium
  - ✓ Whole-body Case 0303
  - ✓ Documented chronical exposure to Zr
- *Other stable metals : 20+ whole body donors*

U.S. TRANSURANIUM AND URANIUM REGISTRIES
Learning from Plutonium and Uranium Workers

What materials are available?



So many opportunities –

– So little time!

Questions?

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