United States Transuranium & Uranium Registries
2022 Scientific Advisory Committee Meeting
Teleconference, April 28–29, 2022

Research and Operation in FY2023

Sergey Y. Tolmachev, Research Professor & Director

United States Transuranium and Uranium Registries
College of Pharmacy and Pharmaceutical Sciences
1845 Terminal Drive, Suite 201, Richland, WA 99354
www.ustur.wsu.edu

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Mission

- Follow up occupationally-exposed individuals (volunteer Registrants) by studying the biokinetics (deposition, translocation, retention, and excretion) and tissue dosimetry of uranium and transuranium elements, such as plutonium, americium, curium, and neptunium
- Obtain, analyze, preserve, and make available for future research, materials from individuals who had documented intakes of uranium and transuranium elements
- Apply USTUR data to refine dose assessment methods in support of reliable epidemiological studies, radiation risk assessment, and regulatory standards for radiological protection of workers and public

Specific Aims

- Manage and operate the Registries
- Conduct scientific research
- Demonstrate and promote broader use and application of USTUR research, data, and materials
- Contribute to the education of a new generation of scientists

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5/10-y Research and Operation Plan

2022–2027:

- Tissue distribution and biokinetics of actinides, beryllium, and zirconium
- Uncertainties in dose assessment for radiation epidemiology
- Harmonization of USTUR database system
- Completion of Health Physics database population
- Elimination of tissue sample backlog for radiochemical analysis
- Reestablishing in-house KPA for uranium

2022–2032:

- Effect of chelation on actinide distribution in the body (PhD project)
- Analyses of cases with a single intake of primary radionuclide
- Pooled analysis of specific groups: *UPPU*, wound, refractory $^{239}PuO_2$, ^{238}Pu
- Analyses of cases with intakes of multiple radionuclides
- Tissue distribution and biokinetics of minor actinides: ^{237}Np and ^{244}Cm

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Fiscal year 2023 (FY2023)

April 1, 2022 – March 31, 2023

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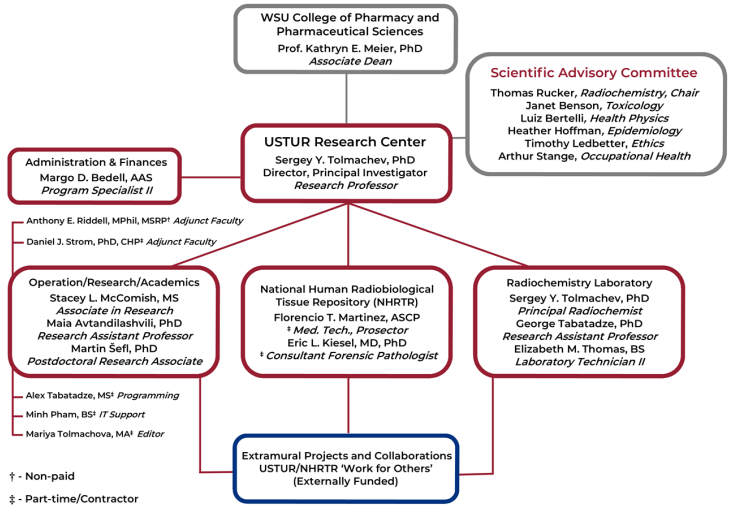
USTUR in FY2023

- 1st year of FY2023–FY2027 grant period: April 1, 2022 – March 31, 2027
- Managed by: DOE, Office of Domestic and International Health Studies
- Operated by: Washington State University, College of Pharmacy and Pharmaceutical Sciences (Award: DE-HS0000073)
- Operated under: Central DOE IRB #WASU-68-50181 (September 7, 2022)
- FY2023 budget: $1,200,000
- FY2023–FY2027 budget: $6,500,000
- Supported full-time equivalent (FTE)
  - ✓ Faculty and staff: 6.5
  - ✓ Temporary appointment: 1.2



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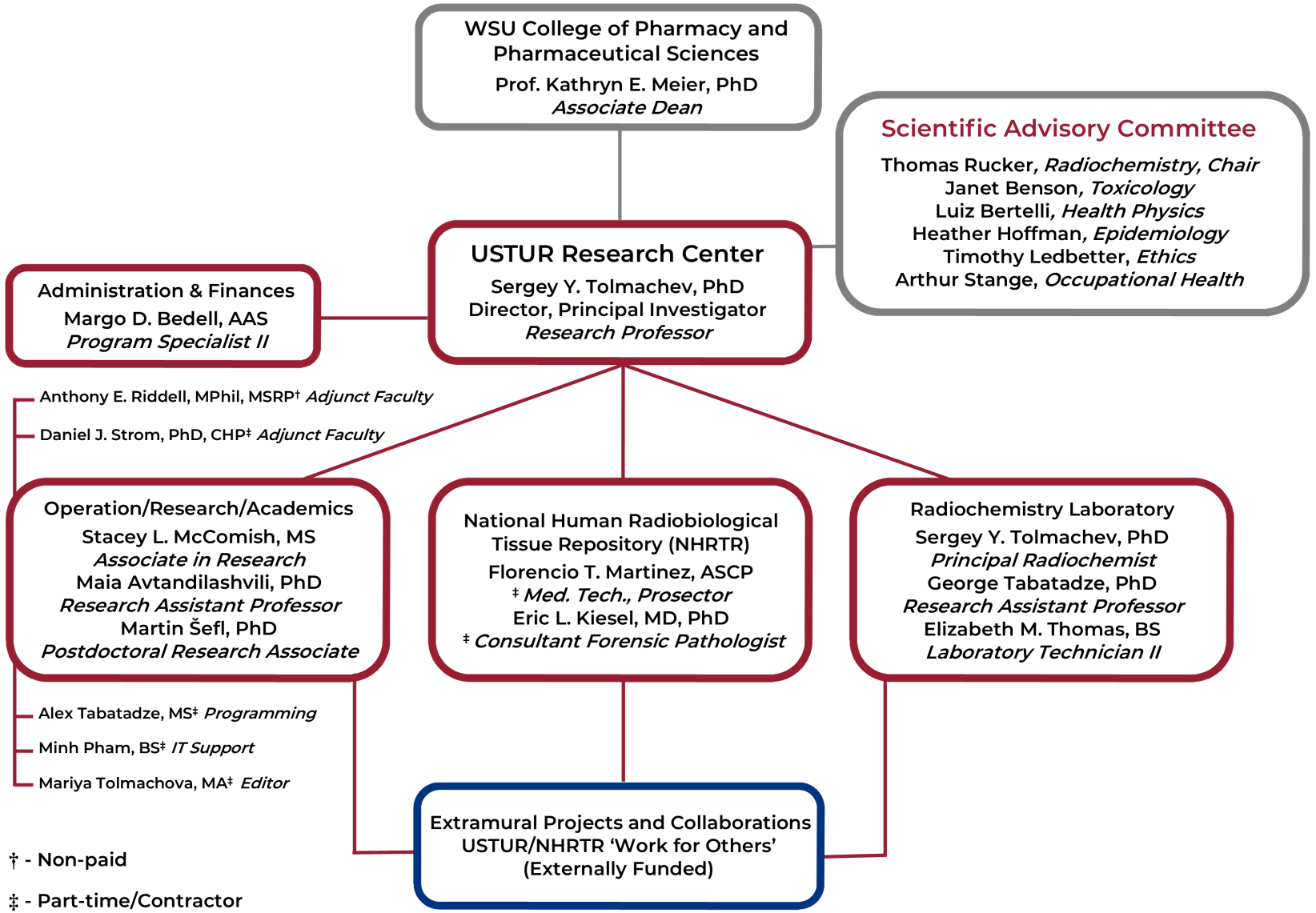
Organization Structure and Personnel



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Management and Operation

- Communicate with Registrants and next-of-kin
- Accept Registrant donations
- Operate the National Human Radiobiological Tissue Repository (NHRTR)
- Conduct radiochemical analysis of tissues
- Develop and populate USTUR database system

Hiring and Promotion

- **Martin Šefl (FY2023)**

Postdoctoral Associate → Research Assistant Professor

- **Maia Avtandilashvili (FY2024)**

Research Assistant Professor → Research Associate Professor

- **George Tabatadze (FY2024)**

Research Assistant Professor → Research Associate Professor

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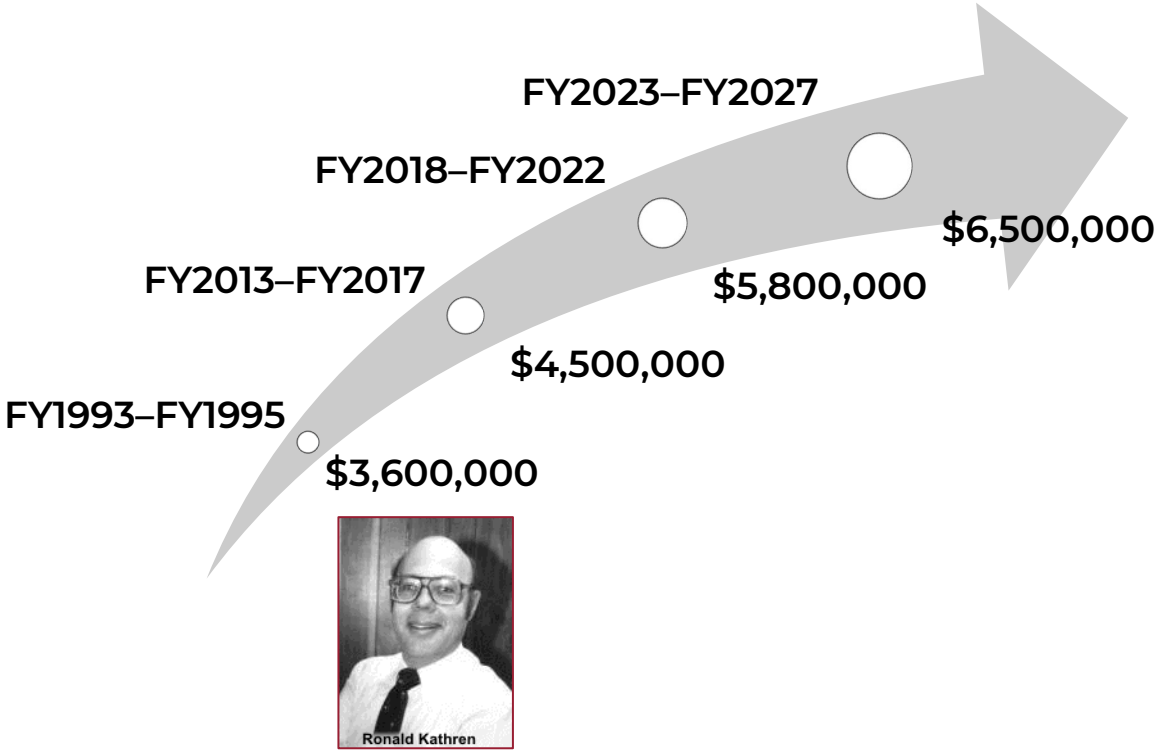
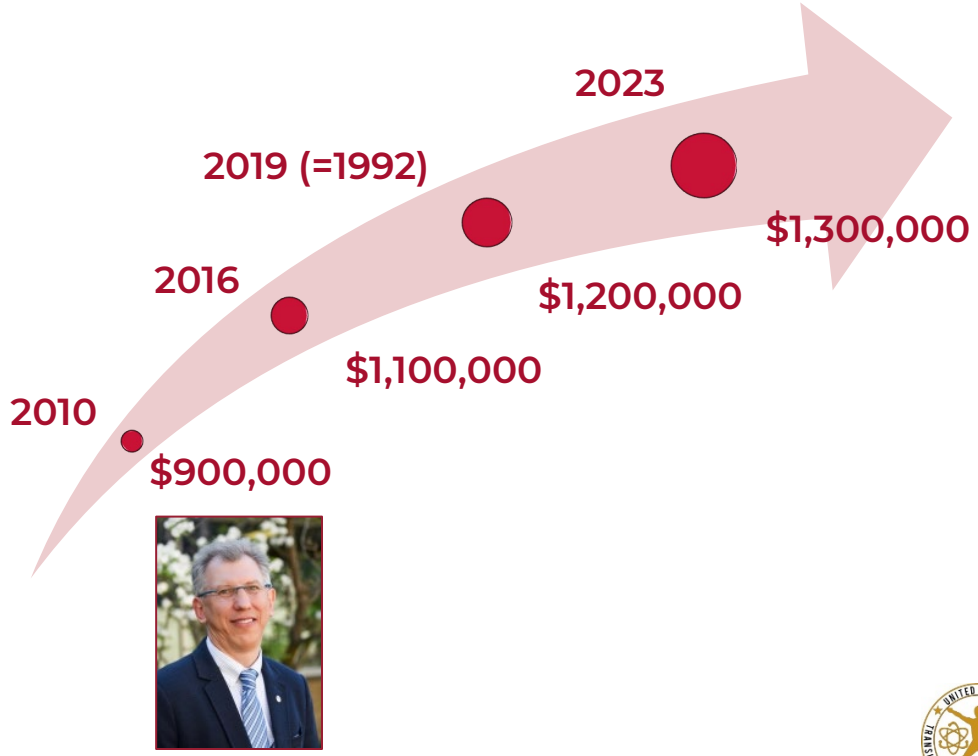
Request for Salary Increase

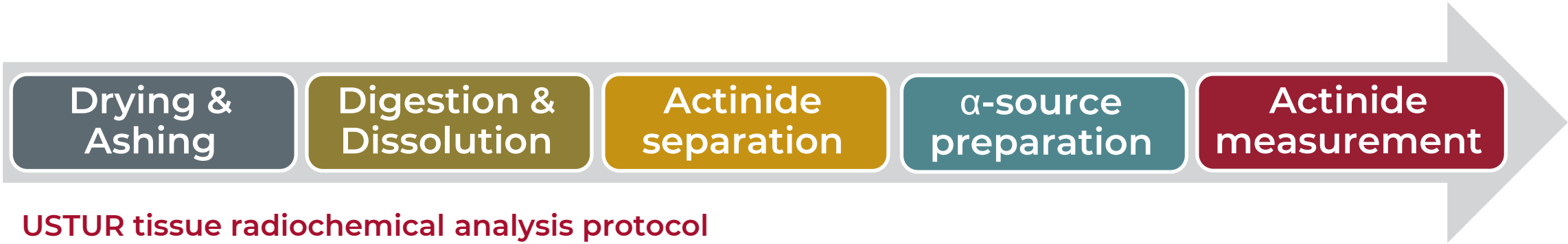
- WSU salary freeze: 2009–2013; 2017; 2019; 2021
- Overall faculty salary ‘increase’ in 2007–2022: 12.8%
- USTUR salary increase: promotion or visa status adjustment
- Request: out-of-cycle salary increase





Radiochemistry Group Tasks

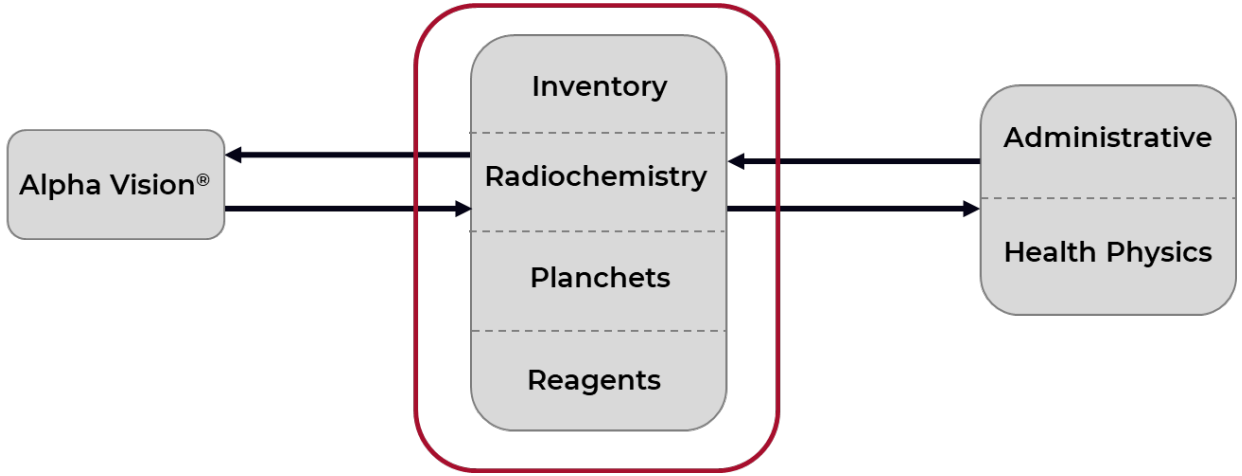
- Complete installation of new fume hoods
- Reinstate tissue analysis throughput to 350–400 samples
- Populate radiochemistry database



USTUR tissue radiochemical analysis protocol

Database and Material Inventory Tasks

- Health physics database: Hanford
- Database harmonization: single laboratory information management system
- National Human Radiobiology Tissue Repository Inventory
  - Los Alamos National Laboratory acid solutions
  - Radium dial painter frozen tissues



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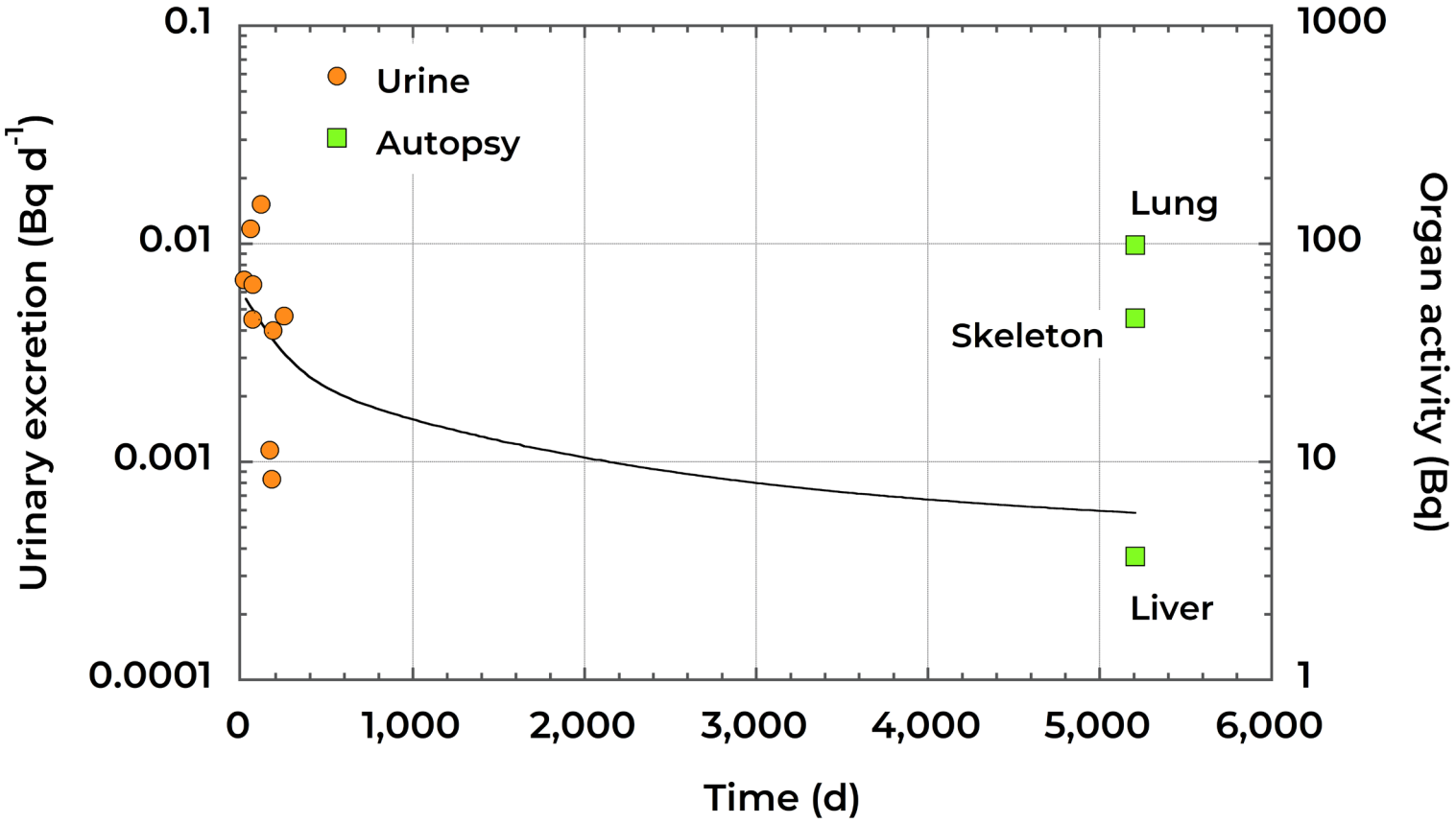
Internal Research Projects

- Actinides and beryllium retention, distribution, and biokinetics
- Evaluating bias and uncertainty in radiation dose assessment
- Misclassification of cause of death on death certificates
- ‘Missing’ uranium exposure
- Implementation of latent bone modeling (LBM) approach
- Radium distribution in tissues (NCRP SC 6-13)
- Plutonium distribution in heart (MPS, NCRP SC 6-14?)

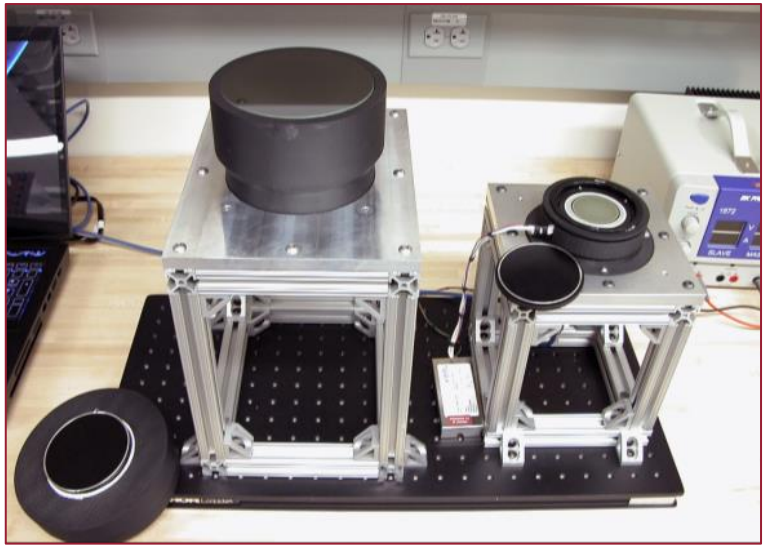
Filling the Gap: Follow-up Urine Collection



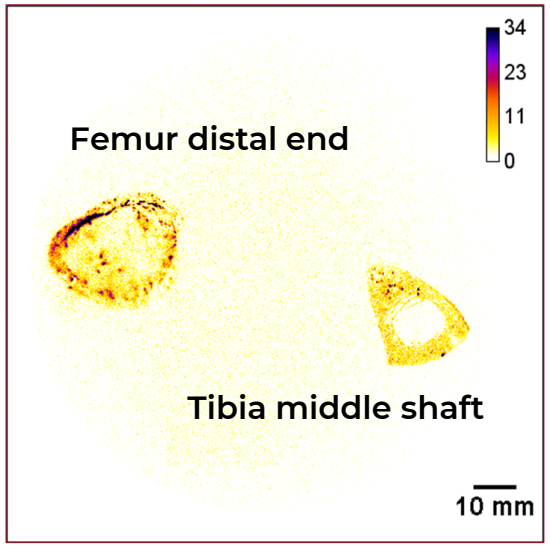
- Effect of late-in-life bioassay results on dose estimation

Mapping Radium Distribution

Ionizing-radiation quantum imaging detector (iQID)



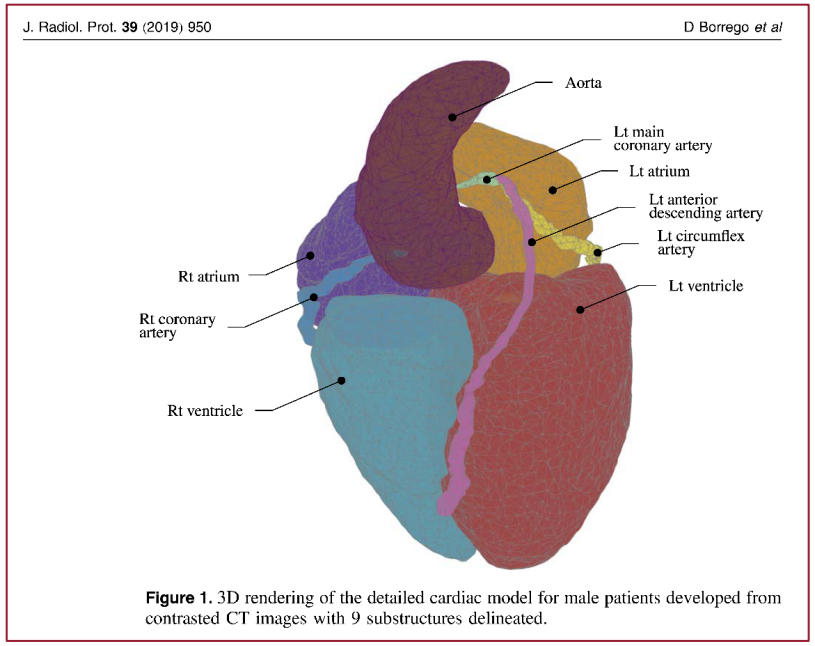
Case 03-210: 250.2 µCi



NCRP SC 6-13: Radium Dosimetry

- Distribution is skeleton: ‘healthy’ vs necrotic bones
- Distribution in soft tissues: heart and beyond

Plutonium in Heart: *Dissection*

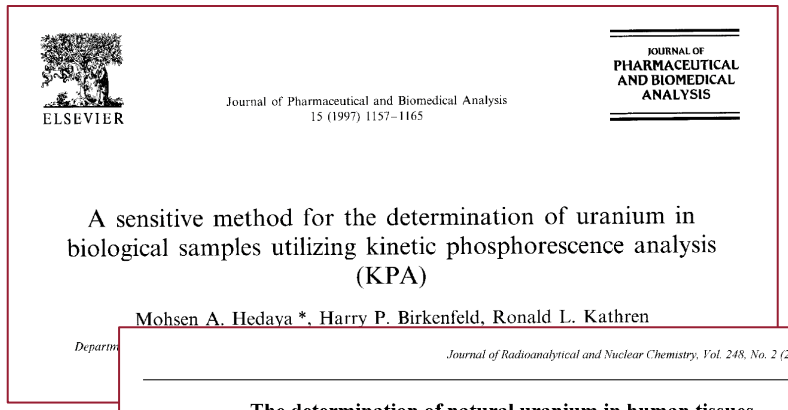


Five cases completed

- Systemic deposition: <2–33 nCi
- Total samples: 59

In-house Uranium Analysis

- Alpha-spectrometry – isotopic analysis: ^{234}U and ^{238}U, maybe ^{235}U
- Kinetic phosphorescence analysis (KPA) – elemental analysis: total U



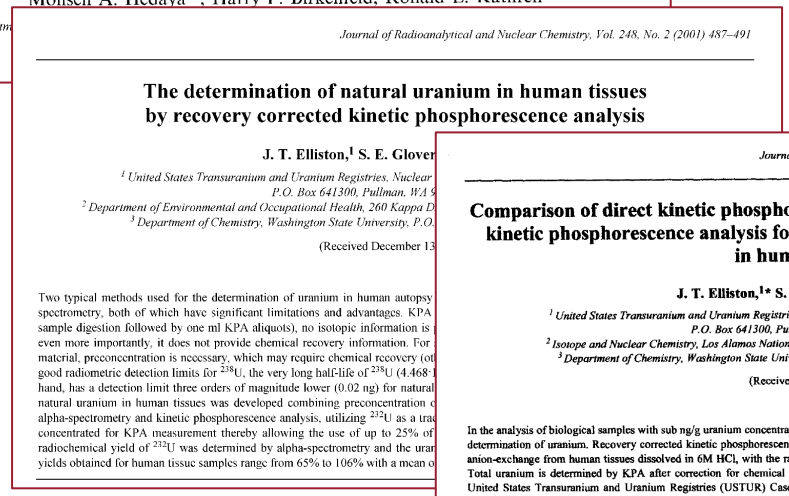
ELSEVIER

Journal of Pharmaceutical and Biomedical Analysis
15 (1997) 1157–1165

JOURNAL OF PHARMACEUTICAL AND BIOMEDICAL ANALYSIS

A sensitive method for the determination of uranium in biological samples utilizing kinetic phosphorescence analysis (KPA)

Mohsen A. Hedaya *, Harry P. Birkenfeld, Ronald L. Kathren



Journal of Radioanalytical and Nuclear Chemistry, Vol. 248, No. 2 (2001) 487–491

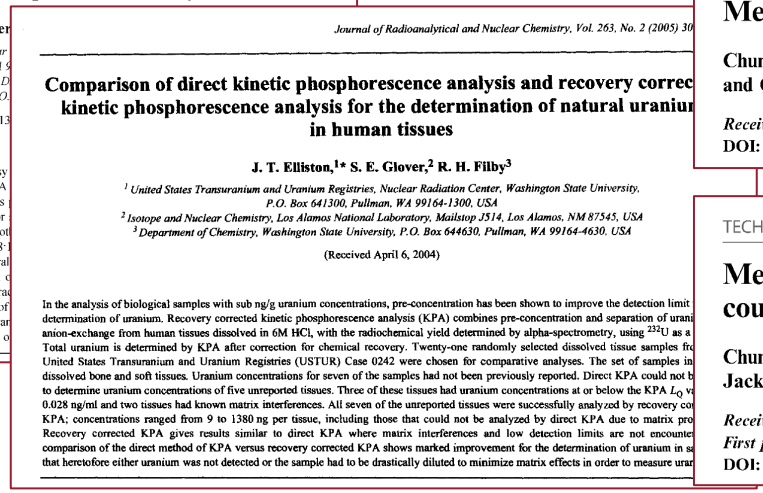
The determination of natural uranium in human tissues by recovery corrected kinetic phosphorescence analysis

J. T. Elliston,[1] S. E. Glover

[1] United States Transuranium and Uranium Registries, Nuclear
P.O. Box 641300, Pullman, WA 9
[2] Department of Environmental and Occupational Health, 260 Kappa D
[3] Department of Chemistry, Washington State University, P.O.

(Received December 13

Two typical methods used for the determination of uranium in human autopsy spectrometry, both of which have significant limitations and advantages. KPA sample digestion followed by one ml KPA aliquots), no isotopic information is even more importantly, it does not provide chemical recovery information. For material, preconcentration is necessary, which may require chemical recovery (ot good radiometric detection limits for ^{238}U, the very long half-life of ^{238}U (4.468 hand, has a detection limit three orders of magnitude lower (0.02 ng) for natural natural uranium in human tissues was developed combining preconcentration alpha-spectrometry and kinetic phosphorescence analysis, utilizing ^{232}U as a trac concentrated for KPA measurement thereby allowing the use of up to 25% of radiochemical yield of ^{232}U was determined by alpha-spectrometry and the uran yields obtained for human tissue samples range from 65% to 106% with a mean o



Journal of Radioanalytical and Nuclear Chemistry, Vol. 263, No. 2 (2005) 30

Comparison of direct kinetic phosphorescence analysis and recovery correc kinetic phosphorescence analysis for the determination of natural uraniu in human tissues

J. T. Elliston,[1]* S. E. Glover,[2] R. H. Filby[3]

[1] United States Transuranium and Uranium Registries, Nuclear Radiation Center, Washington State University, P.O. Box 641300, Pullman, WA 99164-1300, USA
[2] Isotope and Nuclear Chemistry, Los Alamos National Laboratory, Mailstop J514, Los Alamos, NM 87545, USA
[3] Department of Chemistry, Washington State University, P.O. Box 644630, Pullman, WA 99164-4630, USA

(Received April 6, 2004)

In the analysis of biological samples with sub ng/g uranium concentrations, pre-concentration has been shown to improve the detection limit determination of uranium. Recovery corrected kinetic phosphorescence analysis (KPA) combines pre-concentration and separation of urani anion-exchange from human tissues dissolved in 6M HCl, with the radiochemical yield determined by alpha-spectrometry, using ^{232}U as a Total uranium is determined by KPA after correction for chemical recovery. Twenty-one randomly selected dissolved tissue samples fr United States Transuranium and Uranium Registries (USTUR) Case 0242 were chosen for comparative analyses. The set of samples in dissolved bone and soft tissues. Uranium concentrations for seven of the samples had not been previously reported. Direct KPA could not b to determine uranium concentrations of five unreported tissues. Three of these tissues had uranium concentrations at or below the KPA L_Q v 0.028 ng/ml and two tissues had known matrix interferences. All seven of the unreported tissues were successfully analyzed by recovery co KPA; concentrations ranged from 9 to 1380 ng per tissue, including those that could not be analyzed by direct KPA due to matrix pro Recovery corrected KPA gives results similar to direct KPA where matrix interferences and low detection limits are not encounte comparison of the direct method of KPA versus recovery corrected KPA shows marked improvement for the determination of uranium in s that heretofore either uranium was not detected or the sample had to be drastically diluted to minimize matrix effects in order to measure urar

Cite this: *J. Anal. At. Spectrom.*, 2011, **26**, 2524

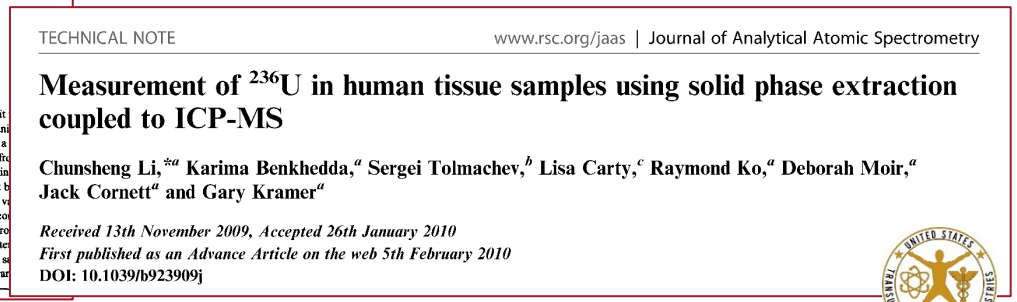
www.rsc.org/jaas

TECHNICAL NOTE

Measurement of uranium isotopes in human tissue samples by TIMS

Chunsheng Li,*[a] Nancy Elliot,[b] Sergei Tolmachev,[c] Stacey McCord,[c] Tom Shultz,[b] Youqing Shi[b] and Gary H. Kramer[a]

Received 5th August 2011, Accepted 27th September 2011
DOI: 10.1039/c1ja10231a



TECHNICAL NOTE www.rsc.org/jaas | Journal of Analytical Atomic Spectrometry

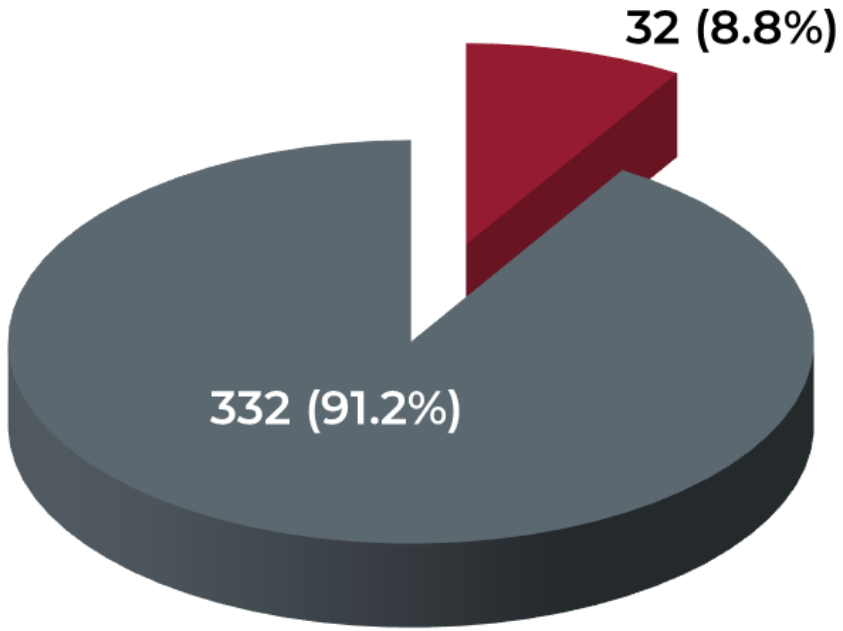
Measurement of ^{236}U in human tissue samples using solid phase extraction coupled to ICP-MS

Chunsheng Li,*[a] Karima Benkhedda,[a] Sergei Tolmachev,[b] Lisa Carty,[c] Raymond Ko,[a] Deborah Moir,[a] Jack Cornett[a] and Gary Kramer[a]

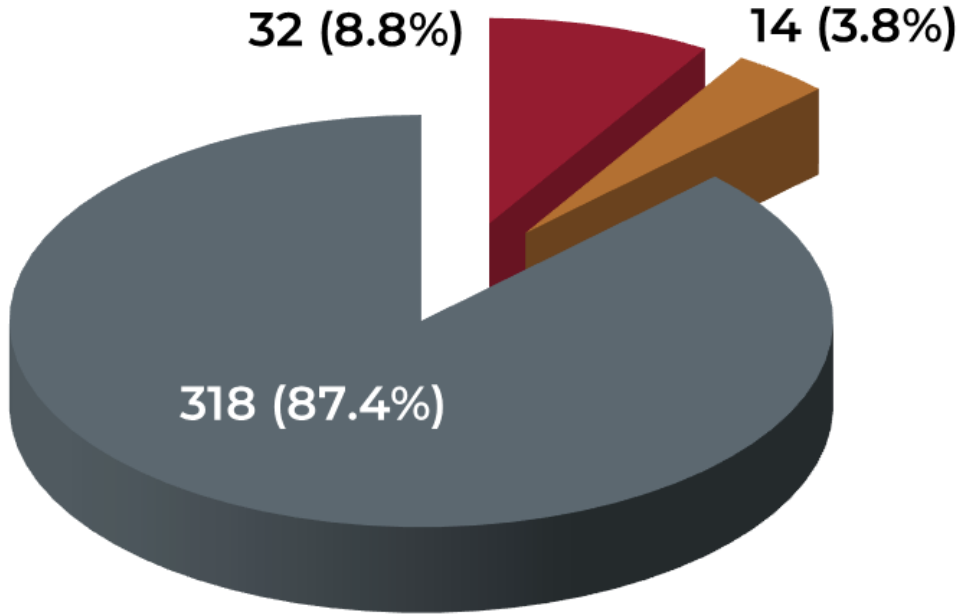
Received 13th November 2009, Accepted 26th January 2010
First published as an Advance Article on the web 5th February 2010
DOI: 10.1039/b923909j

Uranium Exposure Cases

- Based on case number (1000-series)



- Based on exposure records

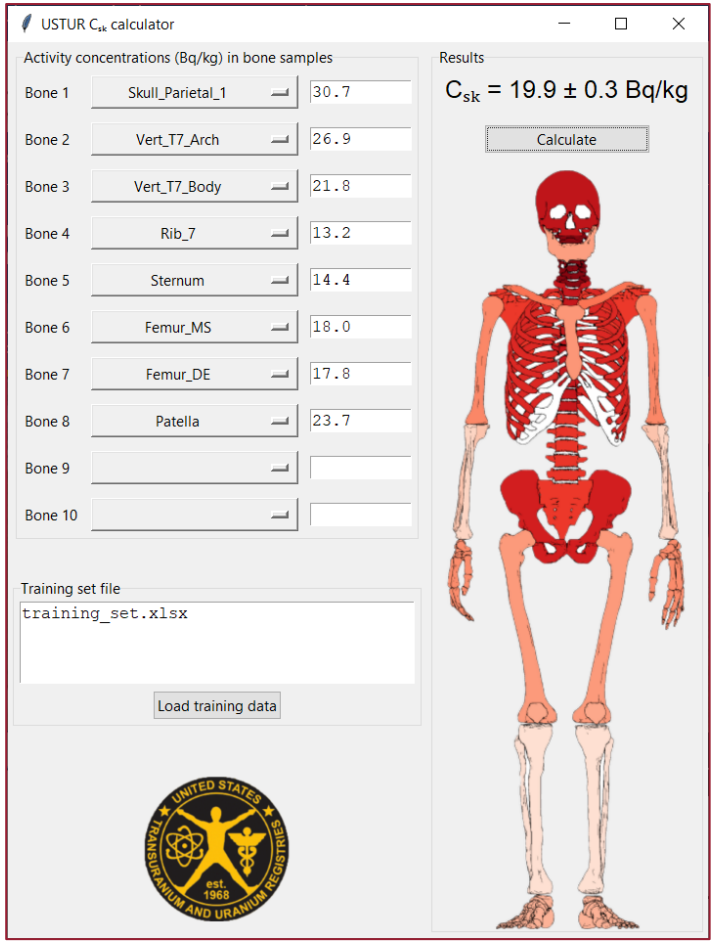


Uranium U/Pu Pu/Am

In-house KPA capability needed!

Implementation of LBM at the USTUR

- Development of C_{skel} calculator



Quick calculation of C_{skel} using measured C_{bone}

Radiation Protection Dosimetry (year), Vol. 0, No. 0, pp. 0–0
DOI: 10.1093/rpd/nc0000

SECTION TIT

LATENT BONE MODELLING FOR ESTIMATION OF PLUTONIUM CONCENTRATION IN SKELETON OF FORMER NUCLEAR WORKERS

Martin Šefl[1], Joey Y. Zhou[2], Maia Avtandilashvili[1], Sergei Y. Tolmachev[1*]
[1]United States Transuranium and Uranium Registries, Washington State University, Richland, Washington, USA
[2]Office of Domestic and International Health Studies, United States Department of Energy, Washington, District of Columbia, USA

Received month date year, amended month date year, accepted month date year

The skeleton is a major plutonium retention site in the human body. The estimation of the total plutonium activity in the skeleton is a challenging problem. For most tissue donors at the United States Transuranium and Uranium Registries, a limited number of bone samples is available. The skeleton activity is calculated using plutonium activity concentration (C_{skel}) and skeleton weight. If limited number of bone samples was analysed, C_{skel} must be estimated. Data of 13 non-osteoporotic whole-body donors were used for principal component regression (PCR) and the results were used to estimate C_{skel} for seven cases with four to eight analysed bone samples. PCR was compared to arithmetic mean estimate. This analysis suggests that PCR offers significant reduction of uncertainty of C_{skel} estimate for the studied cases.

New Project with Russian Health Studies

- Application of LBM approach to Mayak data

Radiation Protection Dosimetry (2017), Vol. 176, No. 1-2, pp. 117–131
Advance Access publication 19 August 2016
doi:10.1093/rpd/ncw239

THE MAYAK WORKER DOSIMETRY SYSTEM (MWDS-2013): ESTIMATION OF PLUTONIUM SKELETAL BURDEN FROM LIMITED AUTOPSY BONE SAMPLES FROM MAYAK PA WORKERS

K. G. Suslova[1,*], A. B. Sokolova[1], S. Yu. Tolmachev[2] and S. C. Miller[3]
[1]Southern Urals Biophysics Institute (SUBI), Ozyorsk, Chelyabinsk Region, Russia
[2]United States Transuranium and Uranium Registries (USTUR), College of Pharmacy, Washington State University, Richland, WA, USA
[3]Division of Radiobiology, Department of Radiology, School of Medicine, University of Utah, Salt Lake City, UT, USA

*Corresponding author: suslova@subi.su

Table 3. Bone samples from 88 MPA workers that comprised the skeletal compartments. The cortical and cancellous bone fractions were taken from Reference Man[19], where the ribs were combined with the clavicle, sternum and scapula.

Skeletal compartment	Bone sample	MPA Ash fraction (Mean ± SD)	Bone composition (%)[19]	
			Cortical bone	Cancellous bone
Cranium	Occipital bone and temporal bone	0.492 ± 0.049	95	5
	No. 1	0.480 ± 0.057		
Vertebral column	Thoracic vertebra No. 7	0.145 ± 0.036	25	75
	and lumbar vertebra No. 3	0.139 ± 0.028	34	66
Ribs	Rib No. 7	0.239 ± 0.055	94	6
Ends of long bone	Epiphysis and metaphysis of femur	0.204 ± 0.033	67	33
		0.189 ± 0.053		
Shafts of long bone	Diaphysis of femur	0.324 ± 0.081	67	33
Pelvic bone	Ilium	0.231 ± 0.044	90	10

Mayak Worker algorithm for C_{skel}:

- Based on 88 cases with 9 bone samples
- Tested on 176 Mayak cases with 2–6 bones and 10 USTUR whole-body cases

Updates needed:

- Effect of osteoporosis
- More cases available at the USTUR

Table 5. Characteristics of the USTUR whole-body cases. The routes of administration included penetrating wound W and/or inhalation INH. The absorption types included medium M and/or slow S. One case received one injection of Ca-EDTA, CH-1, another multiple chelation treatments CH, and several had wound excision WE. In one case (0769) the body mass was measured while alive.

USTUR Case #	0102	0193	0208	0212	0213	0242	0259	0262	0269	0720	0744	0769
Exposure												
Route of intake	W/INH	INH	INH	W	INH	INH/W	INH	W/INH	INH	INH	W/INH	W/INH
Material type	M	S	S	M	S/M	S/M	S	S	M	M/S	M/S	M/S
Primary radionuclide	^{241}Am	^{239,240}Pu	^{239,240}Pu	^{239,240}Pu	^{239,240}Pu	^{239,240}Pu	^{238}Pu	^{239,240}Pu	^{239,240}Pu	^{239,240}Pu	^{239,240}Pu	^{239,240}Pu
Treatment	CH-1	No	No	CH/WE	No	No	No	No	CH	No	WE	WE
Work history												
Employment time, yr.	29	30	31	30	32	35	32	31	32	28	34	1
Post-employment, yr.	0	0	6	3	5	14	0	8	14	21	8	44
Anthropometry												
Body mass, kg	65.3	74.8	59.0	88.9	72.6	83.9	73.5	106.6	78.0	70.3	88.9	76.2
Body height, m	1.82	1.73	1.71	1.82	1.70	1.80	1.78	1.83	1.78	1.75	1.70	1.83
Skeleton												
Wet weight, kg	8.7	8.3	8.2	10.3	8.9	9.7	9.6	10.7	9.7	11.9	10.2	11.0
Ash weight, kg	2.5	2.7	2.4	3.2	2.9	3.1	3.2	3.2	2.3	2.9	3.1	3.2
Ash fraction, %	28.3	32.1	29.4	31.1	32.9	31.9	33.7	29.9	23.6	24.4	30.8	29.4
Primary nuclide is Pu												
Skeleton burden, Bq	—	50.4 ± 0.4	91.6 ± 0.4	113.7 ± 0.6	173.7 ± 0.8	405.5 ± 2.0	108.2 ± 2.5	29.6 ± 0.2	1183.1 ± 3.8	107.0 ± 0.8	87.6 ± 0.3	159.8 ± 1.7
Bone conc., Bq kg^{-1} ash (range)	—	6–151	12–172	7–163	19–234	62–421	3–148	3–25	106–1015	18–171	9–62	2–210

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SURF Program

CPPS Summer Undergraduate Research Fellowships program

- Students interested in entering into a doctoral program
- Ten weeks of full-time research (June-August)
- Stipend of $3,400

WASHINGTON STATE UNIVERSITY
COLLEGE OF PHARMACY AND PHARMACEUTICAL SCIENCES
SURF/SRF PROJECTS 2022

FACULTY MENTOR:
Sergey Y. Tolmachev, Ph.D., Professor, *NCRP Council Member*

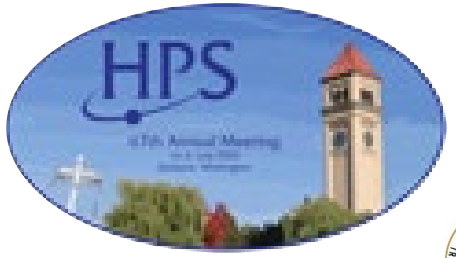
RESEARCH PROJECT:
Effects of death certificate misclassification on epidemiological studies

DESCRIPTION OF PROJECT:
Epidemiologic studies of risk from occupational radiation exposure rely heavily on the use of death certificates for classification of underlying causes of death, which are known to suffer bias from misclassification. With unique access to both death certificates and autopsy reports, the United States Transuranium and Uranium Registries (USTUR) performed a study of 240 former nuclear industry workers. The overall misclassification

Upcoming Conferences

- 2022 International Conference on Individual Monitoring of Ionising Radiation; Kraków, Poland, April 25–29, 2022
- 6th European Congress on Radiation Protection; Budapest, Hungary, May 30 – June 3, 2022
- 2022 EPR BioDose Workshop; Paris, France, June 7–10, 2022
- 67th Annual Meeting of the Health Physics Society; Spokane, Washington, July 17–21, 2022
- 68th Annual Meeting of the Radiation Research Society; Waikoloa Village, Hawaii, October 16–19, 2022

IM 2022
NEUDOS 14



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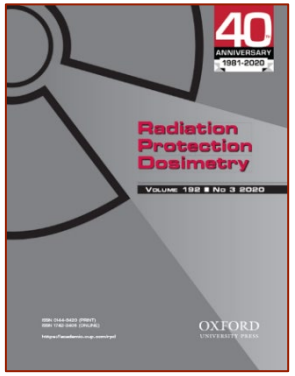
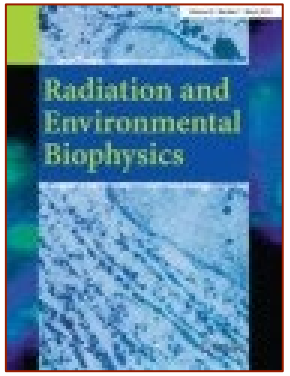
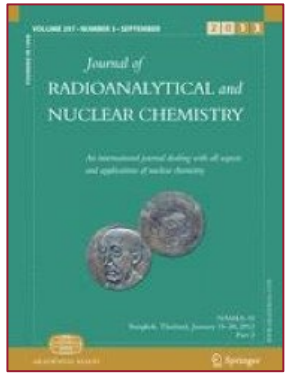
Publications in Progress

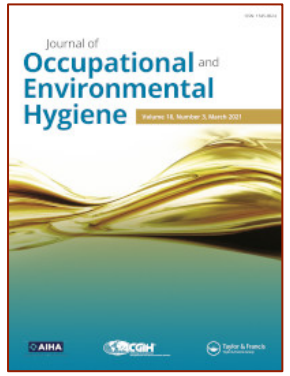
Twelve (12) manuscripts in:

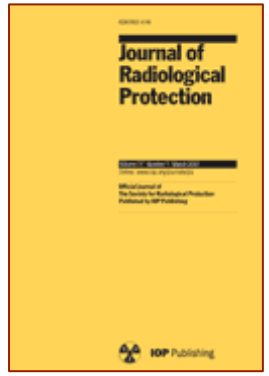
- Journal of Occupational and Environmental Hygiene (2.155†): 1
- Journal of Analytical Atomic Spectrometry (4.023): 1
- Journal of Radiological Protection (1.394): 1
- Journal of Radioanalytical Nuclear Chemistry (1.373): 3
- Health Physics Journal (1.316): 1
- Radiation Protection Dosimetry (0.972): 3
- Radiation and Environmental Biophysics (1.925): 2











†- impact factor

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Thank you!

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