

Distribution of Terminal Lung and Liver Dose Rates in United States Transuranium and Uranium Registries Registrants

Stacey L. McCord, Anthony
C. James, Sergei Y.
Tolmachev

smccord@tricity.wsu.edu



*"Learning from Plutonium and Uranium
Workers"*

Objective

- **A status report on progress made toward determining the distribution of terminal dose rates in U.S. Transuranium and Uranium Registries (USTUR) registrants.**
 - **Liver**
 - **Lung**

United States Transuranium and Uranium Registries

- Initiated in 1968 to use human data to verify biokinetic and dosimetric models.
- Consists of former nuclear workers (volunteer Registrants) who had accidental intakes of uranium and transuranium elements.
- Tissues are obtained at autopsy, preserved, and made available for future research.
- Tissues are radiochemically analyzed to determine organ content and activity concentration at the time of death.

USTUR: Registrant Status

| | | |
|---|--|--------------------|
| <u>As of June 24th, 2011</u> | | |
| Total Active (Living) and Deceased Registrants: | | 413 |
| Living Registrants: | | 82 |
| Deceased Registrants: | | 334 331 |
| Partial-body Donations: | | 291 |
| Thorotrast (medical exposure) | | 3 |

Terminal Lung and Liver Dose Rates in USTUR Registrants

- 1. Starting Point: Average Activity Concentration, Bq/kg, in the Right Lung and half of the Liver.**
 - e.g. $\text{Conc}_{\text{Rt lung}} = \text{Activity}_{\text{Rt lung}} / \text{Mass}_{\text{Rt lung}}$
 - ^{241}Am , ^{238}Pu , $^{239/240}\text{Pu}$, ^{234}U , ^{235}U , ^{238}U
- 2. Calculated Terminal Dose Rates (TDR), mGy/y, from the Activity Concentrations.**
 - Alpha only
 - Absorbed Dose Rate
 - Average Dose Rate
- 3. Total TDR = sum of individual radionuclide TDRs**

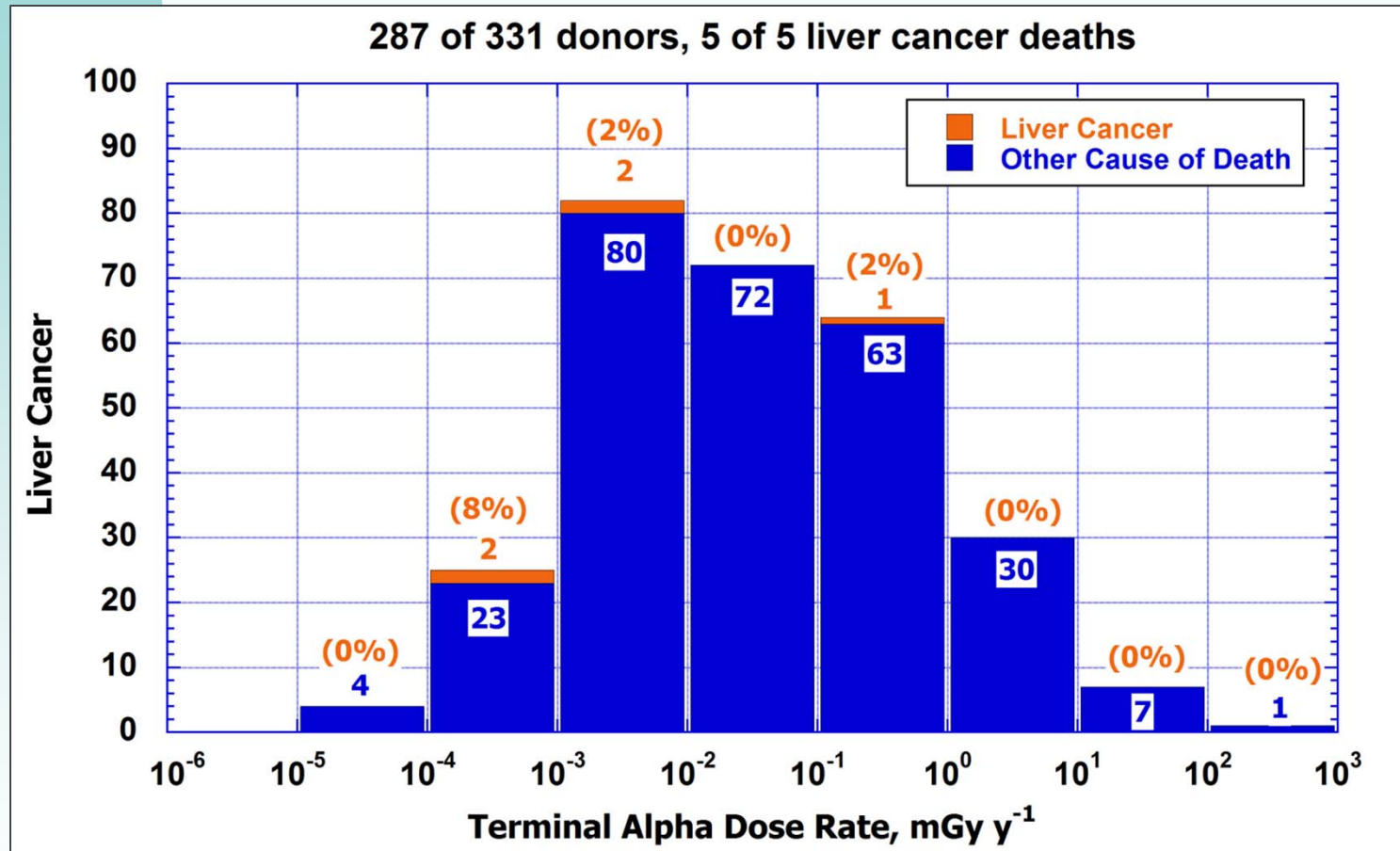
Why Terminal Dose Rates?

- **Calculated directly from the radiochemistry results (high degree of confidence in the data points).**
- **No modeling is involved.**
- **Uncertainties arise when applying models to calculate the total dose to an individual:**
 - **Intake date, especially for multiple intakes.**
 - **Solubility of the material (Nitrate? Oxide?)**
 - **Limitations of the models themselves (e.g. “Super S” material).**

Underlying Cause of Death

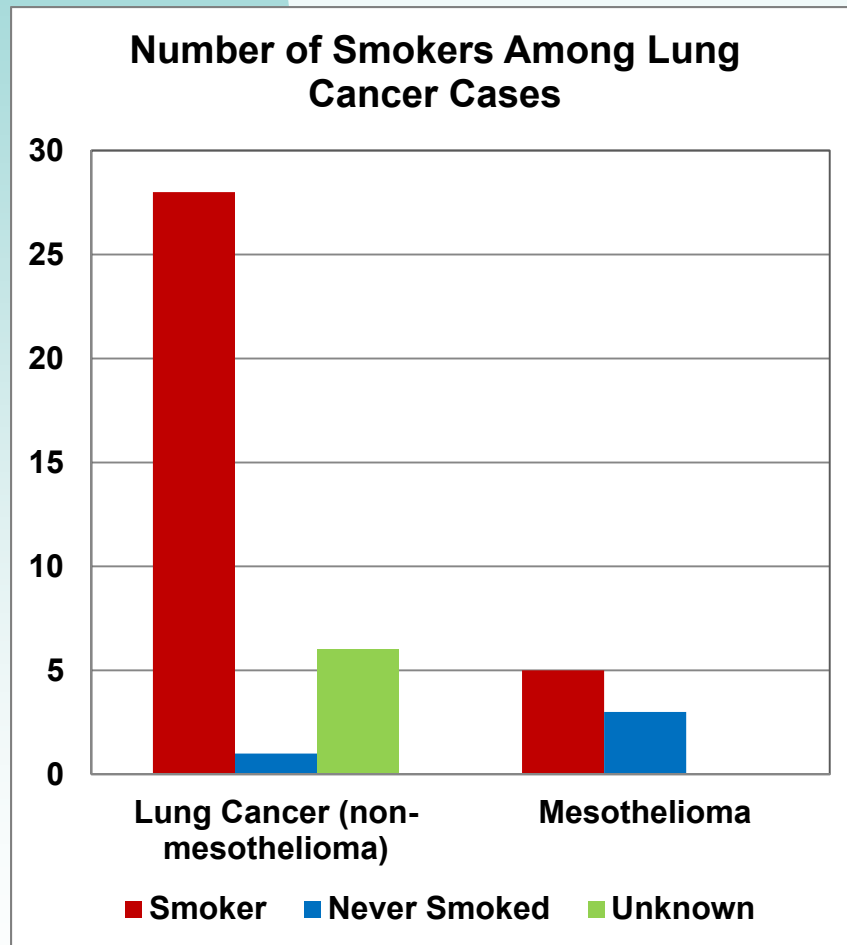
- The Centers for Disease Control (CDC)* defines **Underlying Cause of Death as the disease or injury which initiated the train of morbid events leading directly or indirectly to death** or the circumstances of the accident or violence which produced the fatal injury.
- 3 Underlying Causes of Death will be discussed:
 - Liver Cancer
 - Lung Cancers (non-mesothelioma)
 - Mesothelioma – Associated with Asbestos exposure not plutonium.

Liver Cancer and Other Causes of Death by TDR



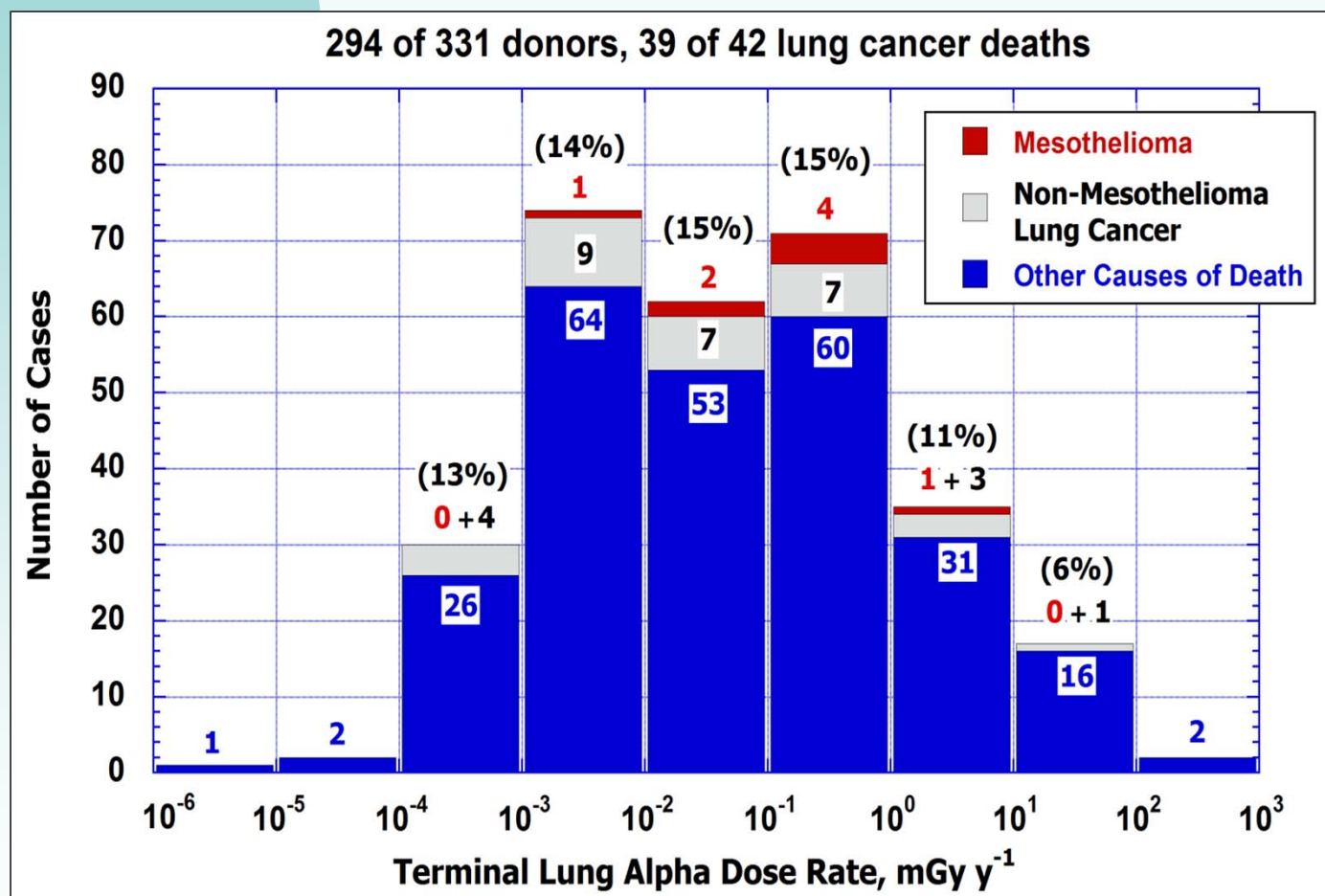
Liver cancers occurred only in LOW α -dose cases – note log scale on abscissa

Smoking Rates in Lung Cancer Cases



- Completed smoking histories indicate:
 - Mesothelioma: **63% smokers**
 - Non-mesothelioma lung cancer: **97% smokers**

Mesothelioma and Other Lung Cancers by TDR



“Self-selection”
 16 of 42 donors
 who died from
 lung cancer
 registered with
 the USTUR
 less than 1 year
 prior to death.

2 were in
 mesothelioma
 cases.

Conclusions

- **Terminal Dose Rate was selected as the basis for comparing the results from the 331 donors because it had the fewest uncertainties of the alternatives.**
- **Although not representative, alpha dose does not appear to cause excess lung cancer or liver cancer in USTUR registrants.**
- **Exposure to tobacco smoke and asbestos appear to be important lung cancer factors in the USTUR population.**

Future Directions

- **Calculate Terminal Dose Rates for other tissues such as the skeleton and lymph nodes.**
- **Ideally, apply biokinetic modeling techniques to calculate the cumulative alpha dose to the lung from urinalysis results, *in-vivo* measurements, and post-mortem radiochemistry results.**
- **Compare these results to the distribution of lung and liver cancers in the Pacific Northwest National Laboratory (PNNL) and Inhalation Toxicology Research Institute (ITRI) lifespan beagle dog studies.**
- **Carry out a statistical analysis of the presented data to confirm the finding that alpha dose does not cause excess lung cancer or liver cancer in USTUR registrants.**

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Thank you for your attention!

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