



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

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*“Learning from Plutonium and Uranium
Workers”*

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.**

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**

History of Study

- **In ~2007, a high frequency of mesothelioma among USTUR registrants was observed.**
- **Data collection started in 2009.**

USTUR: Registrant Status

<u>As of June 24th, 2011</u>	
Total Active (Living) and Deceased Registrants:	413
Living Registrants:	82
Deceased Registrants:	324 331
Partial-body Donations:	291
Thorotrast (medical exposure)	3

Types of Data Collected

- **Demographic (birthday, death date, race, sex)**
- **Time from Registration to Death**
- **Work History (hire date, termination date, years at a nuclear facility)**
- **Asbestos risk (qualitative categories: possibly/probably exposed, likely not exposed, not enough information to classify)**
- **Terminal Alpha Dose Rates (Liver, Lung)**
- **External Dose (lifetime, yearly)**
- **Tobacco Habits (ever smoked?)**
- **Causes of Death (Underlying + Up to Seven Contributing Causes)**

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

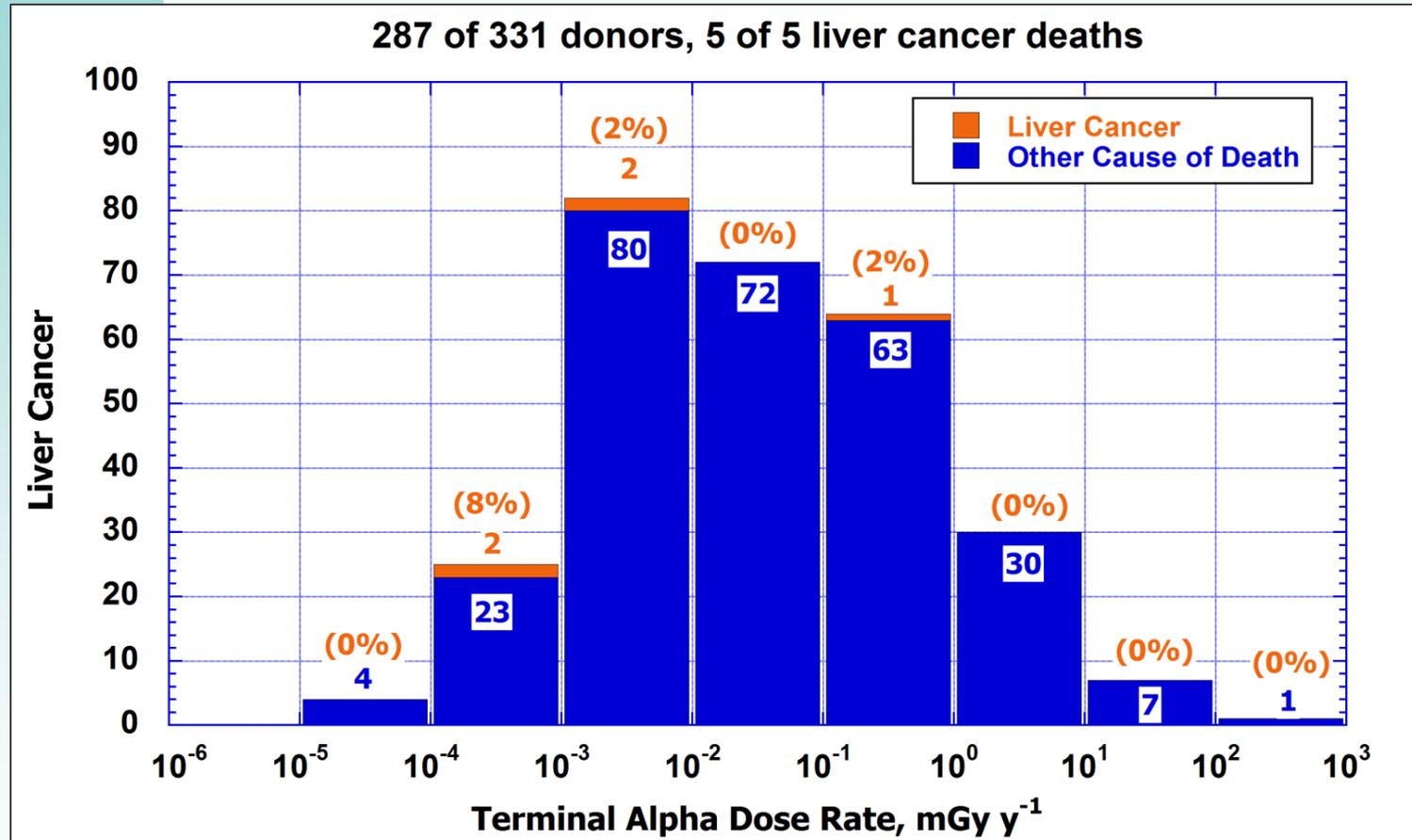
Why Terminal Dose Rates?

- **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.

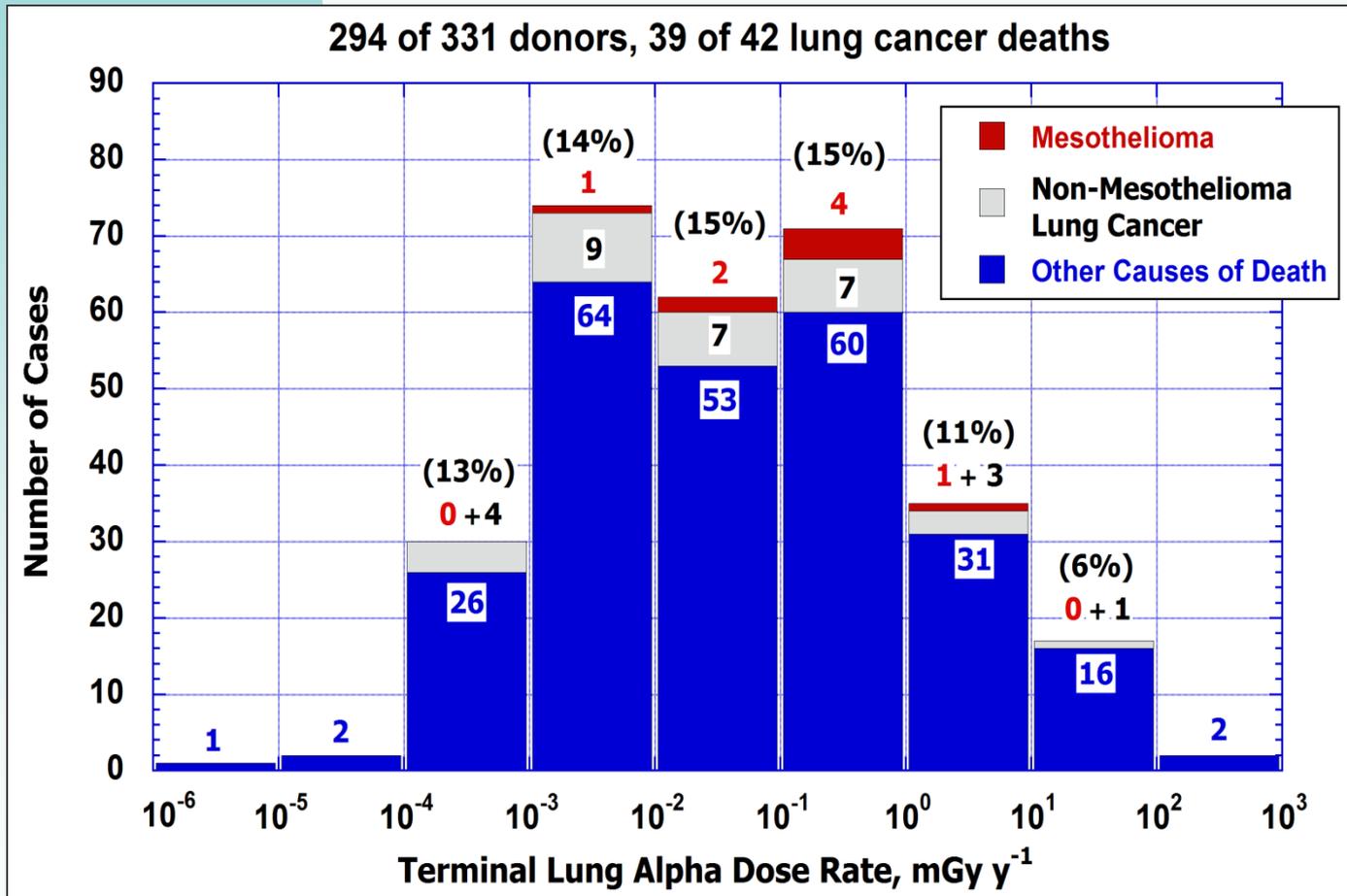
Liver Cancer and Other Causes of Death by TDR



Liver cancers occurred only in LOW α -dose cases (note log scale on abscissa). However...

Data are NOT age-adjusted

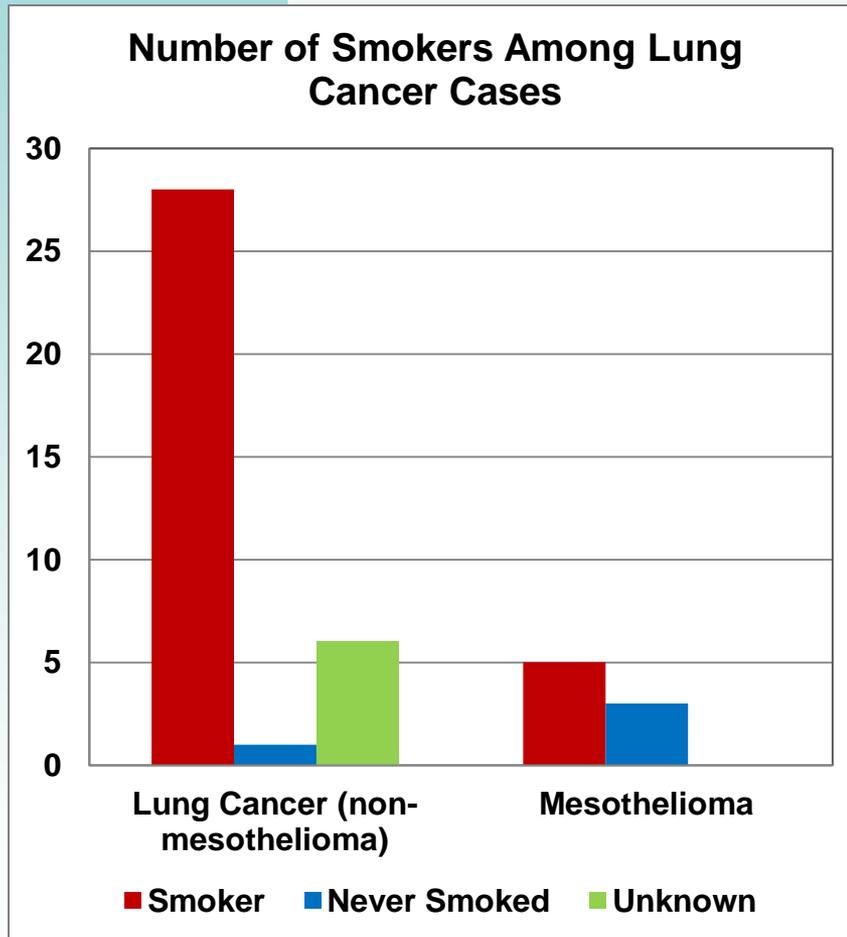
Mesothelioma and Other Lung Cancers by TDR



“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.

Smoking Rates in Lung Cancer Cases



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

Possible Confounding Factors

- **Asbestos exposure data is qualitative and sometimes subjective. Thus we may not be able to account for the contribution of asbestos to mesothelioma in USTUR Registrants.**
- **Self-selection**
 - **25% of USTUR registrants were registered <1 year prior to death.**

Possible Confounding Factors (cont.)

- **The National Death Index (NDI) is a central computerized index of death record information on file in the State vital statistics offices.***
- **The NDI tends to underreport deaths due to mesothelioma. (They are often recorded as lung cancer.)**
- **If the USTUR's data were compared a database (such as the NDI) that under represents mesothelioma, the results could be misleading.**

Possible Confounding Factors (cont.)

Case #	NDI Cause of Death
0013	Malignant Neoplasm, unspecified site
0084	No match
0256	Malignant Neoplasm, pleura
0648	Malignant Neoplasm, bronchus & lung unspecified site
0677	Malignant Neoplasm, unspecified site
0785	No match
1040	Malignant Neoplasm, pleura

Mesothelioma Cases = 7

NDI* matches = 5

Mesothelioma Cases according to NDI = 2

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.**

Thank you for your attention!

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