2017 Scientific Advisory Committee Meeting
Red Lion Hanford House, Richland, WA
August 25-26, 2017

# Enhancement of Plutonium Excretion Following Late Ca-EDTA/DTPA Treatment

Sara Dumit, Maia Avtandilashvili, Sergei Y. Tolmachev

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

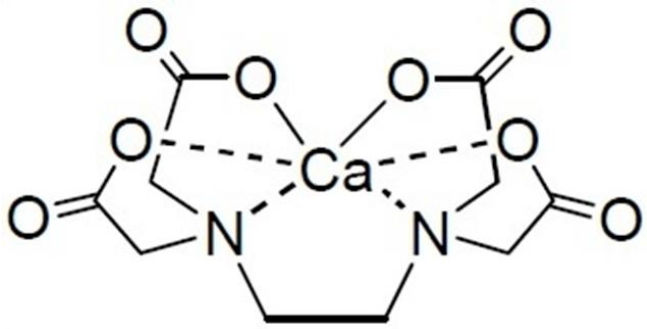
*"Learning from Plutonium and Uranium Workers"*

# Objectives

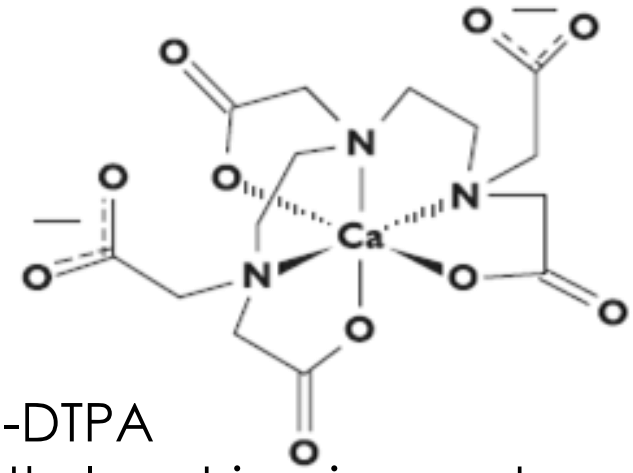
- Calculate plutonium excretion enhancement following delayed Ca-EDTA/DTPA treatment
- Compare effectiveness of chelating agents
- Evaluate Pu-EDTA complex removal half-time

# Chelation Treatment for Plutonium

- Chelating agents
- Remove radioactive elements from the body
- Enhance metal excretion by forming stable complex
- Chelating agents for Pu decorporation:




Ca-EDTA
ethylenediaminetetraacetic acid




Ca-DTPA
diethylenetriaminepentaacetic acid

# Chelation Treatment: Dosimetry Challenge

- Administration of chelating agents alters radionuclide biokinetics
- Urinary excretion of radionuclide is enhanced significantly
- Common practice for radiation dose estimation is to exclude data affected by treatment
- Affected data may be corrected using enhancement factor

# Enhancement Factor

- Enhancement factor (EF)

*measured radionuclide daily excretion rate at the day of chelation divided by expected excretion on the same day without chelation (LaBone 1994)*

- Empirical parameter determined on case-by-case basis. Varies significantly among individuals
- Recommended value for plutonium decorporation with Ca-DTPA is 50

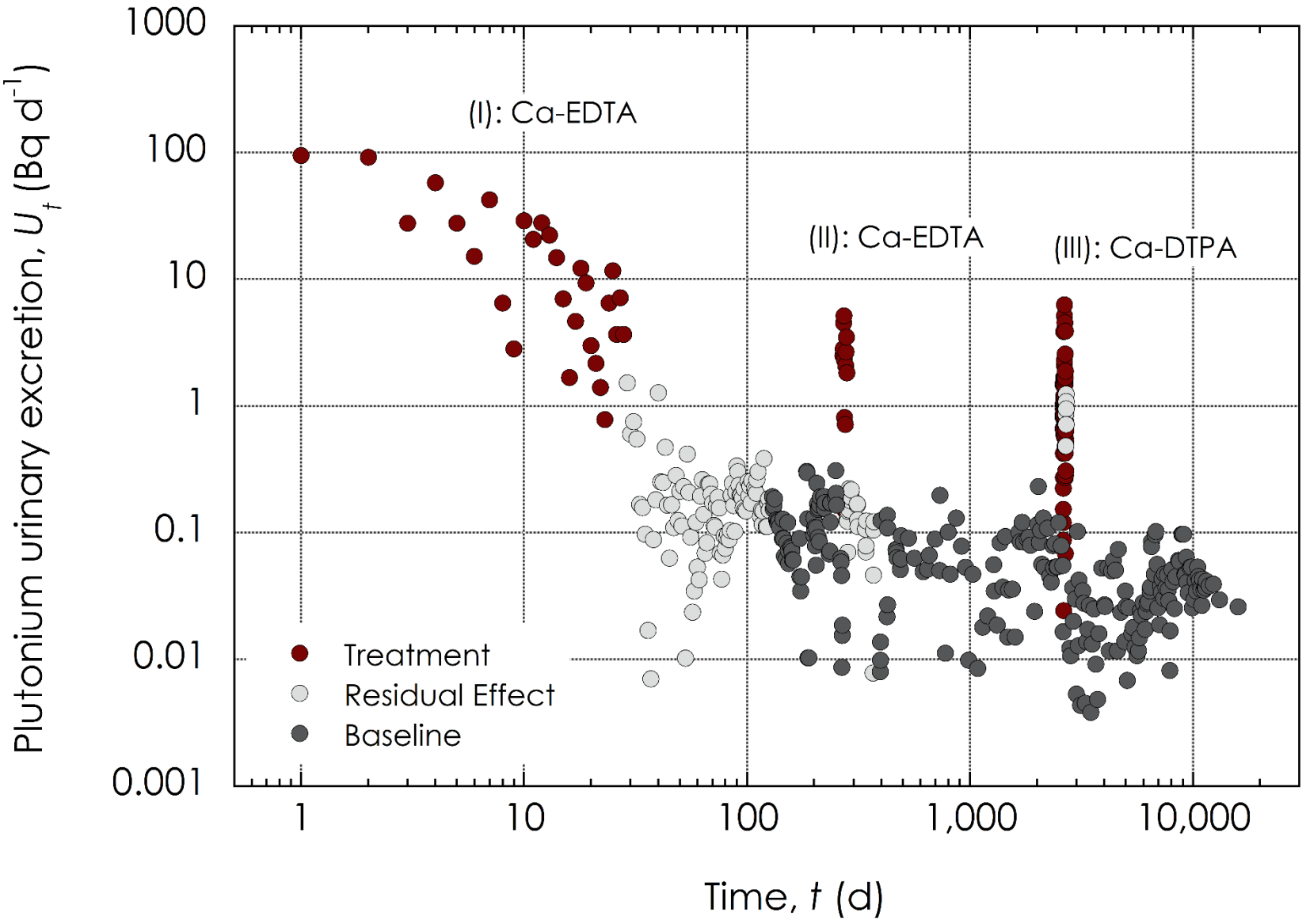
# USTUR Case 0785 Summary

- Primary exposure: Plutonium (Pu)
- Exposure scenario: Acute inhalation and wound
- Material type: Mixture (M and S)
- Treatment: Wound excision
  Ca-EDTA/DTPA chelation
- Smoking status: Yes (cigars)
- Cause of death: Mesothelioma
- Post-intake: 51 y
- Age: 79 y

# Ca-EDTA/DTPA Treatment Regimen

| | |
|---|---|
| (I) Initial: | Ca-EDTA, 67g (daily) |
| • Week 1: | 1g × 2 × 7d |
| • Week 2: | 1g × 2 × 3d; 2g+1g; 2g × 2 ×1d |
| • Weeks 3 – 4: | 2g × 2 × 10d |
| (II) Delayed: | Ca-EDTA, 40g (daily) |
| • Week 39 – 40: | 2g × 2 × 10d |
| (III) Delayed: | Ca-DTPA, 12g (weekly) |
| • Weeks 374 – 385: | 1g × 1 × 12wk |

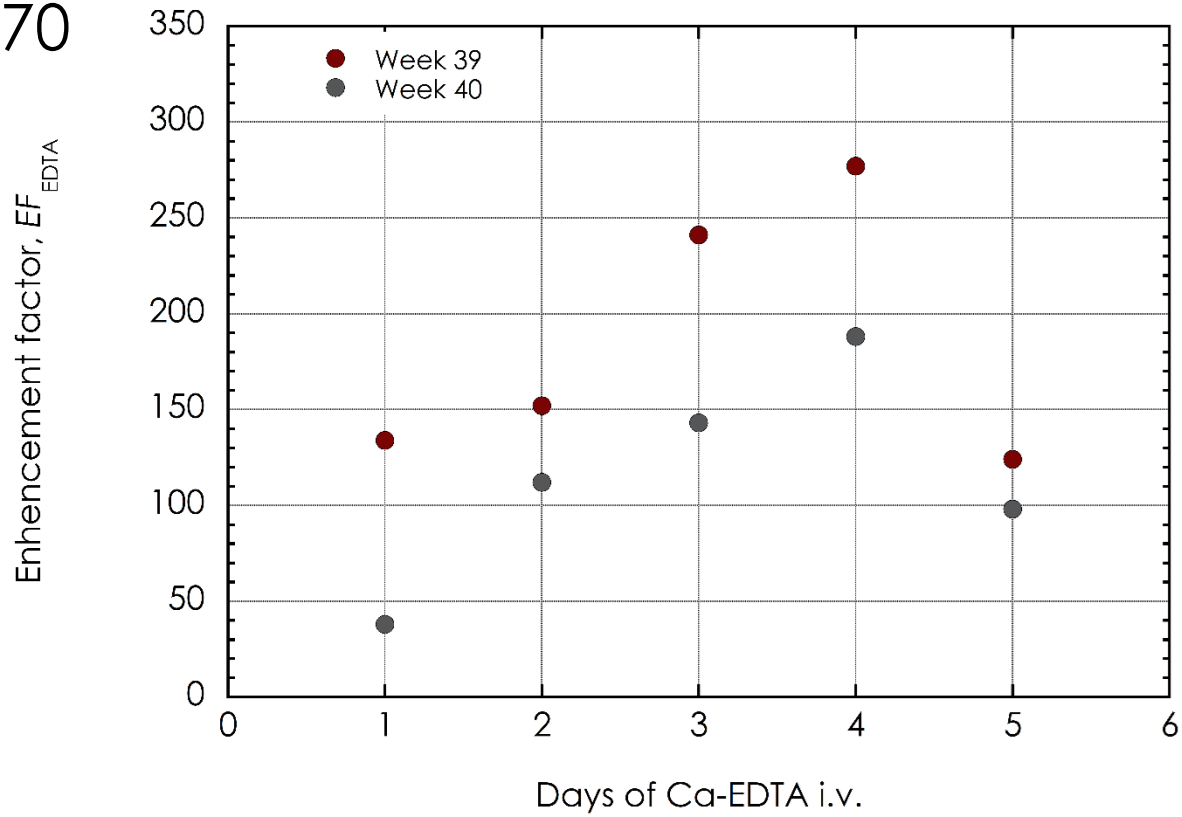
# Plutonium Urinary Excretion



# Ca-EDTA Enhancement Factor

Regimen II: weeks 39 - 40

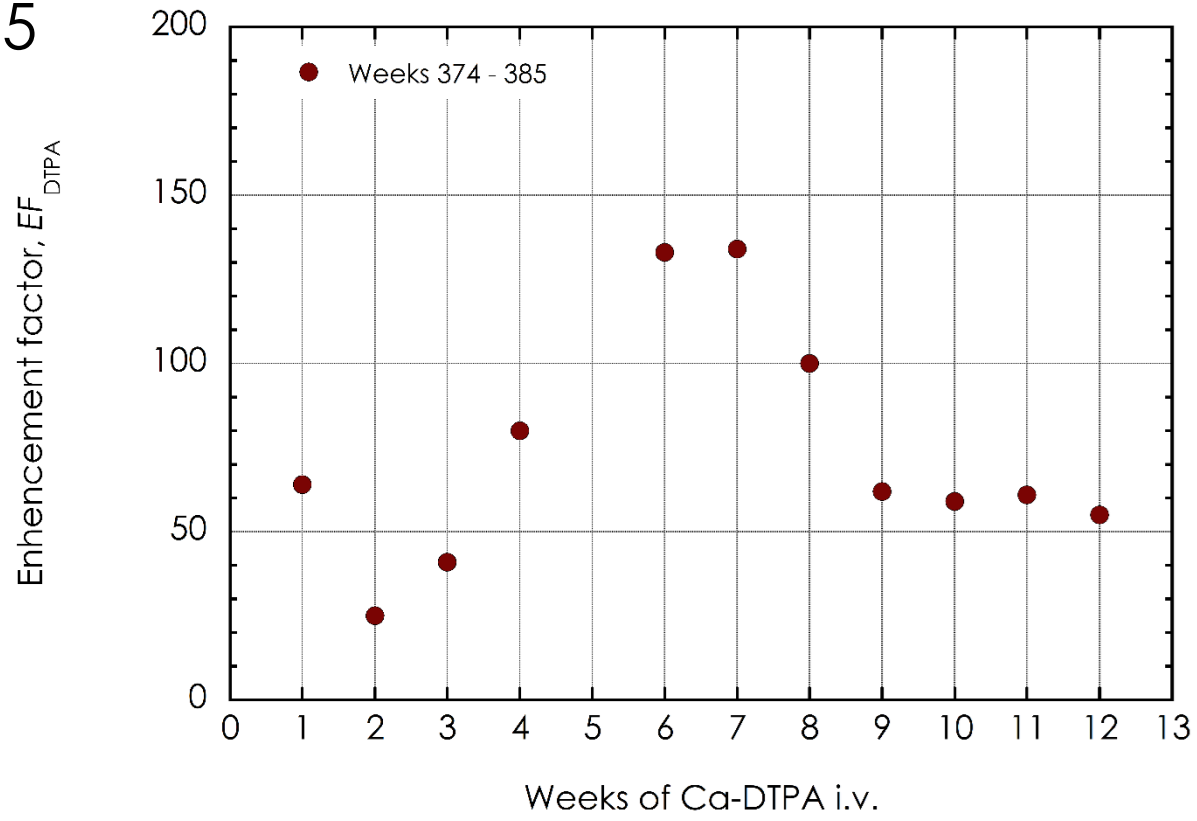
- N =10
- Range: 38 - 277
- Mean: 150 ± 70



# Ca-DTPA Enhancement Factor

Regimen III: weeks 374 - 385

- N =11
- Range: 25 - 134
- Mean: 74 ± 35



# Effectiveness of Chelating Agent

- The measure of effectiveness, $E_{DRUG}$

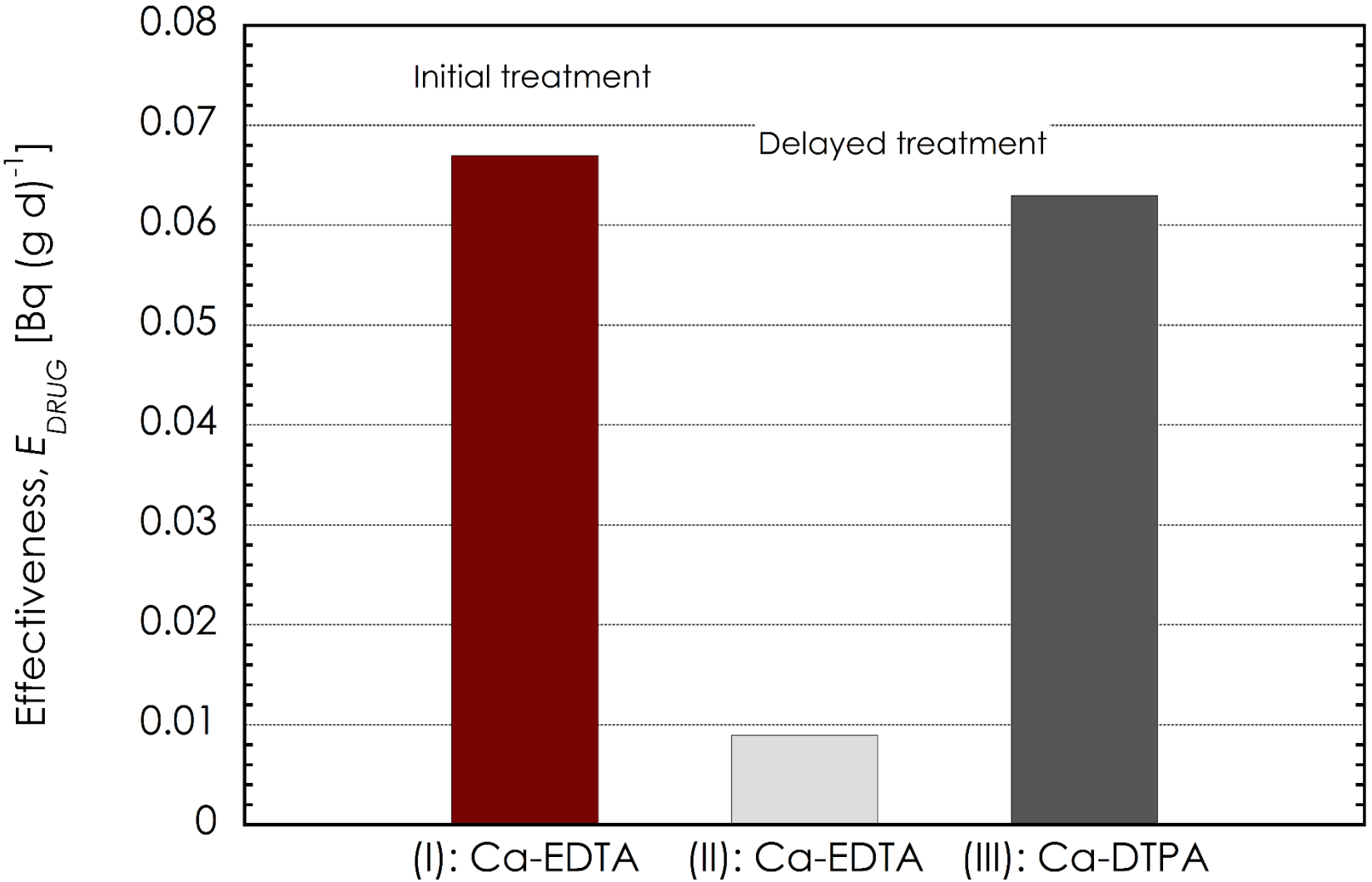
$$E_{\mathrm{DRUG}} = \frac{A}{D \times t}$$

*A* (Bq) - activity excreted during time *t*

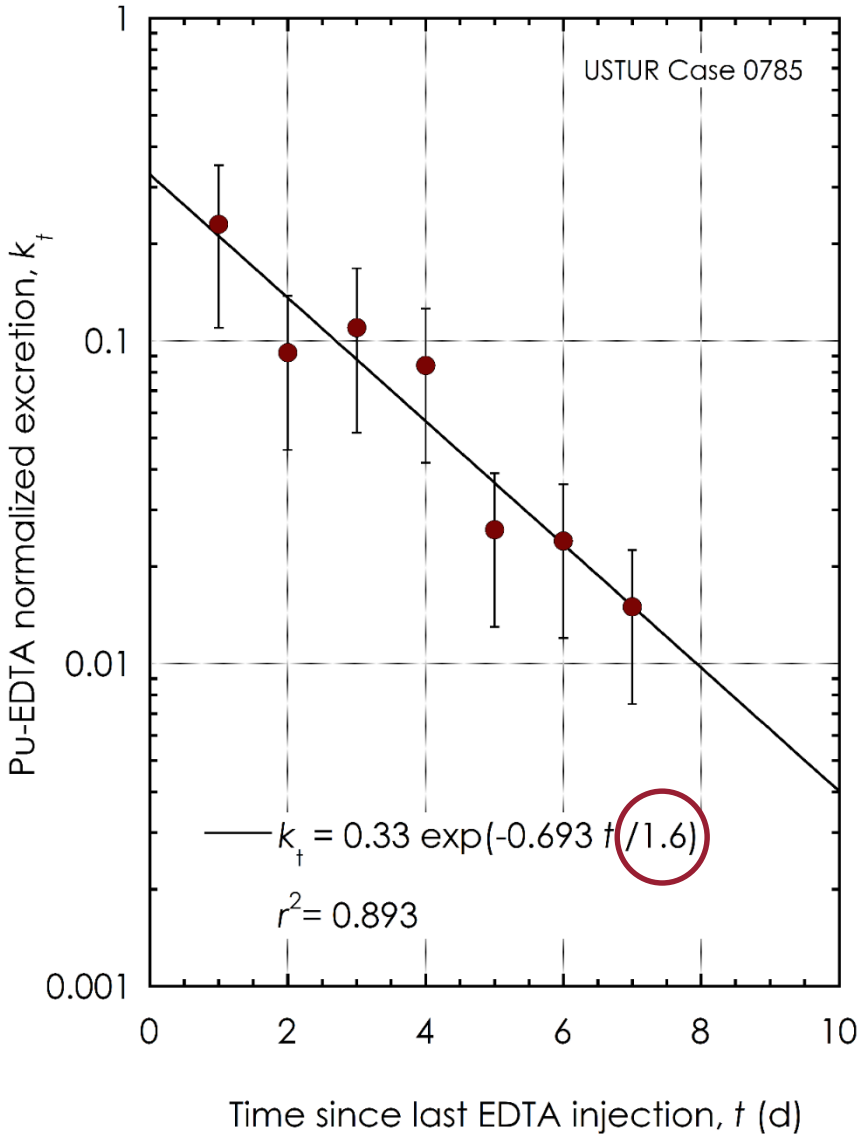
*D* (g) - dosage of an administrated drug

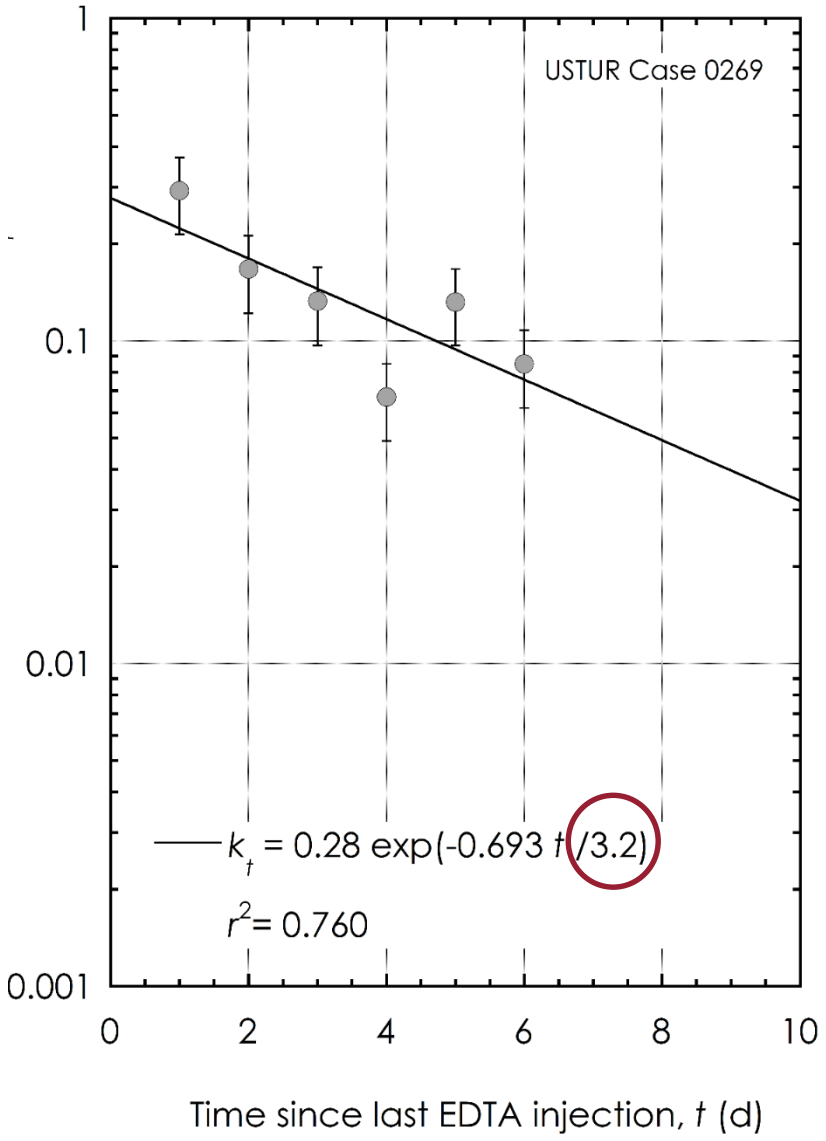
*t* (d) - duration of the treatment plus100 days

# Effectiveness: Ca-EDTA vs Ca-DTPA



# Pu-EDTA Complex Removal



# Summary

- Plutonium excretion enhancement factors were calculated following delayed Ca-EDTA/DTPA treatment. For Ca-EDTA, values ranged from 38 - 277 with a mean of 150 ± 70; for Ca-DTPA, values ranged from 25 - 134 with a mean of 74 ± 35
- Ca-EDTA enhancement factors for 5 daily injections showed monotonic increase from day 1 to 4, followed by decrease on day 5
- Attempt was made to compare effectiveness of chelating agents. Delayed administration of Ca-EDTA was significantly less effective than initial; delayed administration of Ca-DTPA was as effective as initial Ca-EDTA
- The half-time of Pu-EDTA complex removal in urine was evaluated to be 1.6 d which was comparable with 3.2 d estimated for USTUR Case 0269

# Thank you!

# Questions?