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

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*"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:
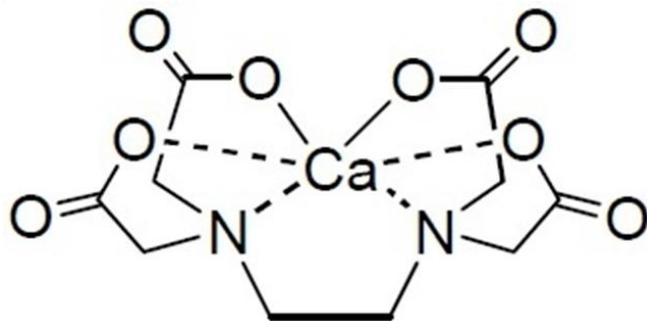
Ca-EDTA
ethylenediaminetetraacetic acid
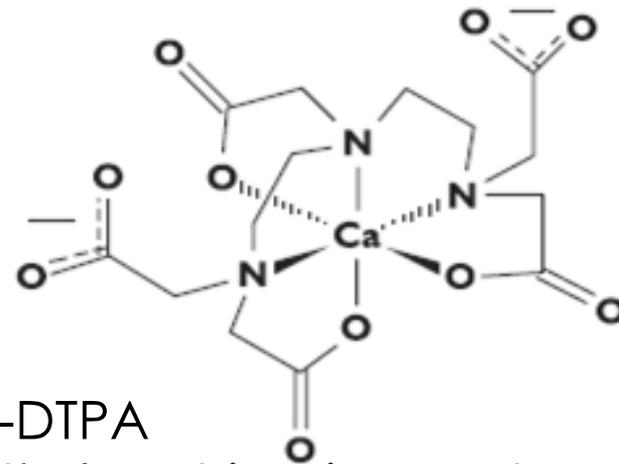
Ca-DTPA
diethylenetriaminepentaacetic acid

# 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
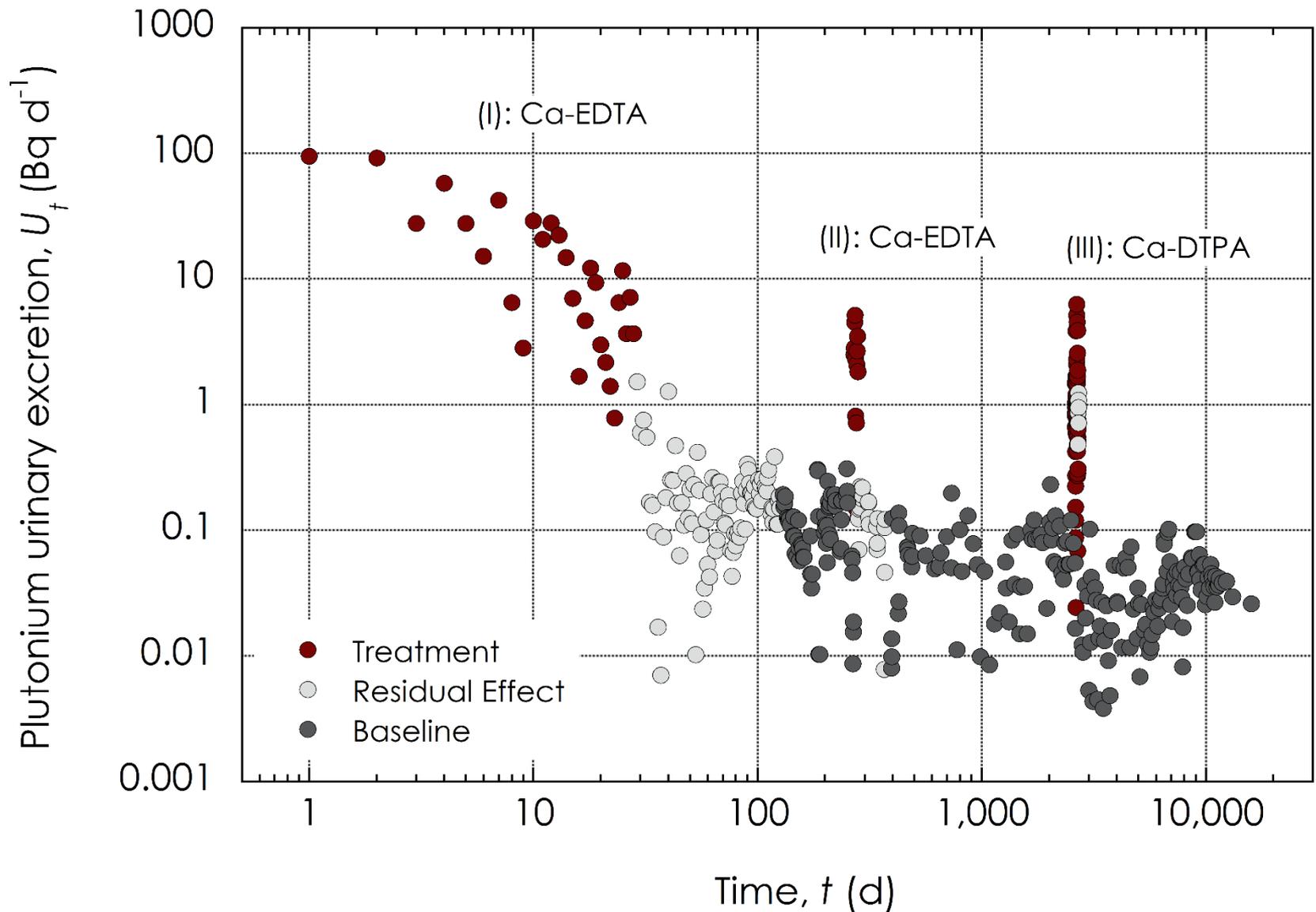
- Post-intake:  51 y

- 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)

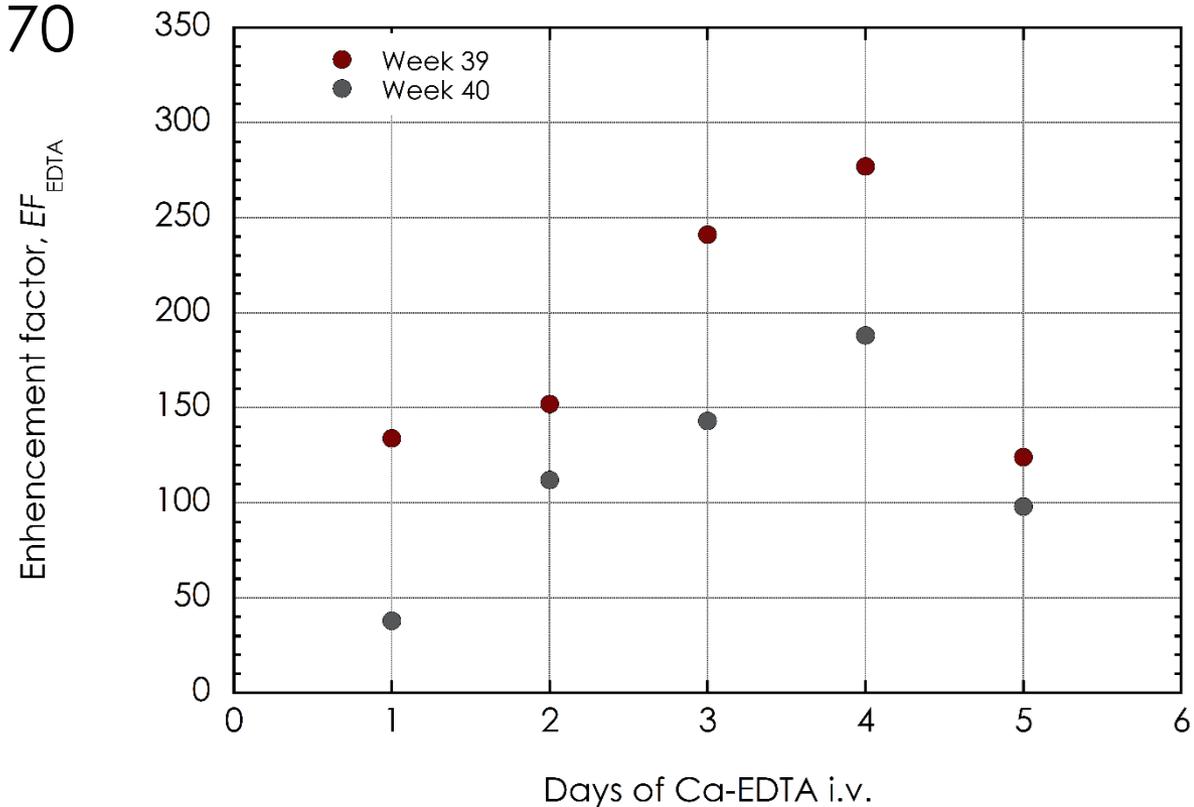- Weeks 374 – 385:    1g × 1 × 12wk

# Plutonium Urinary Excretion

# Ca-EDTA Enhancement Factor

Regimen II: weeks 39 - 40
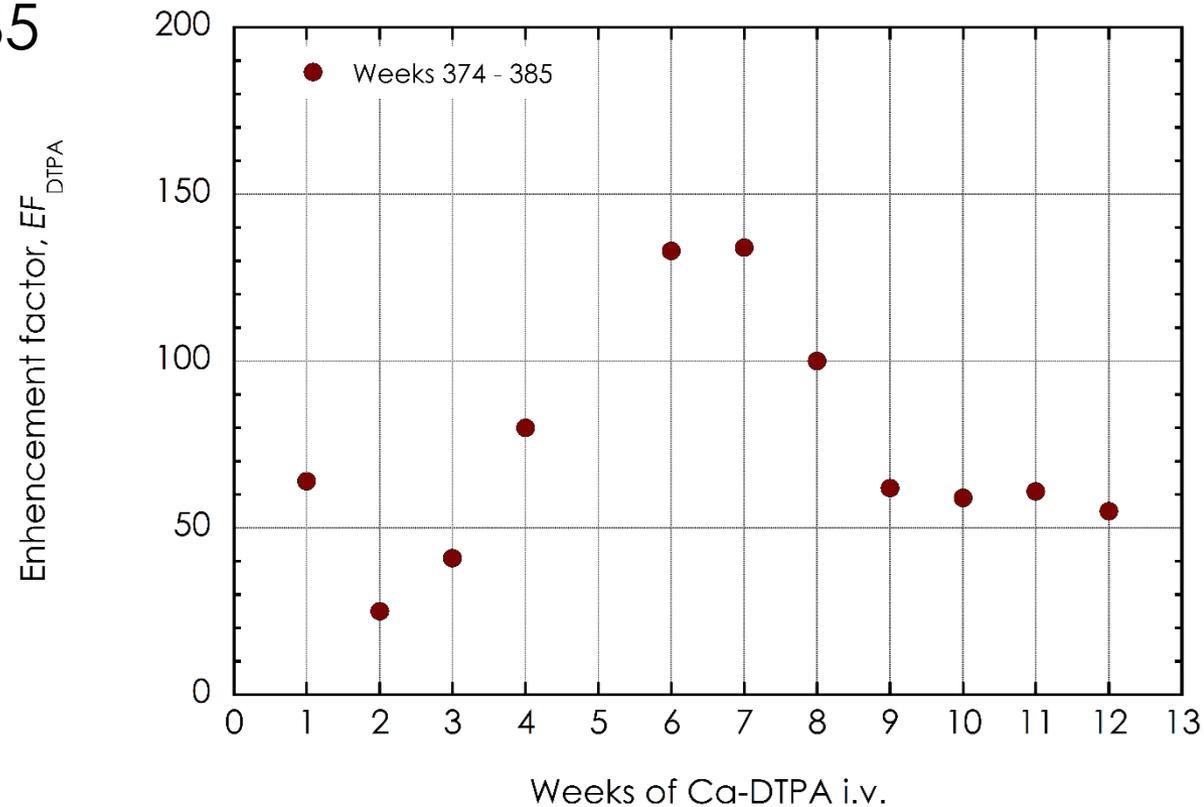
- N =10

- 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

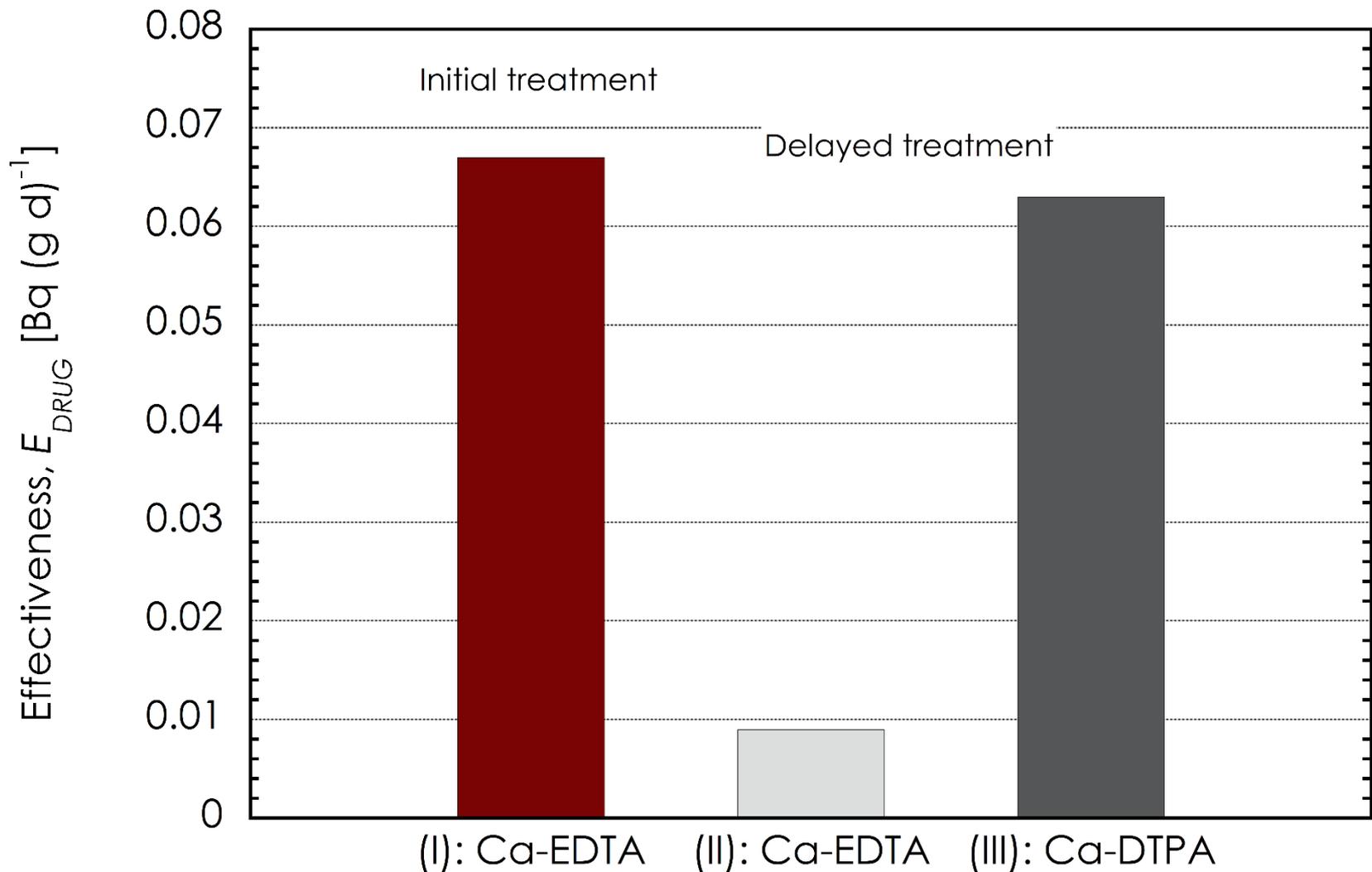- The measure of effectiveness, $E_{\text{DRUG}}$

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

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

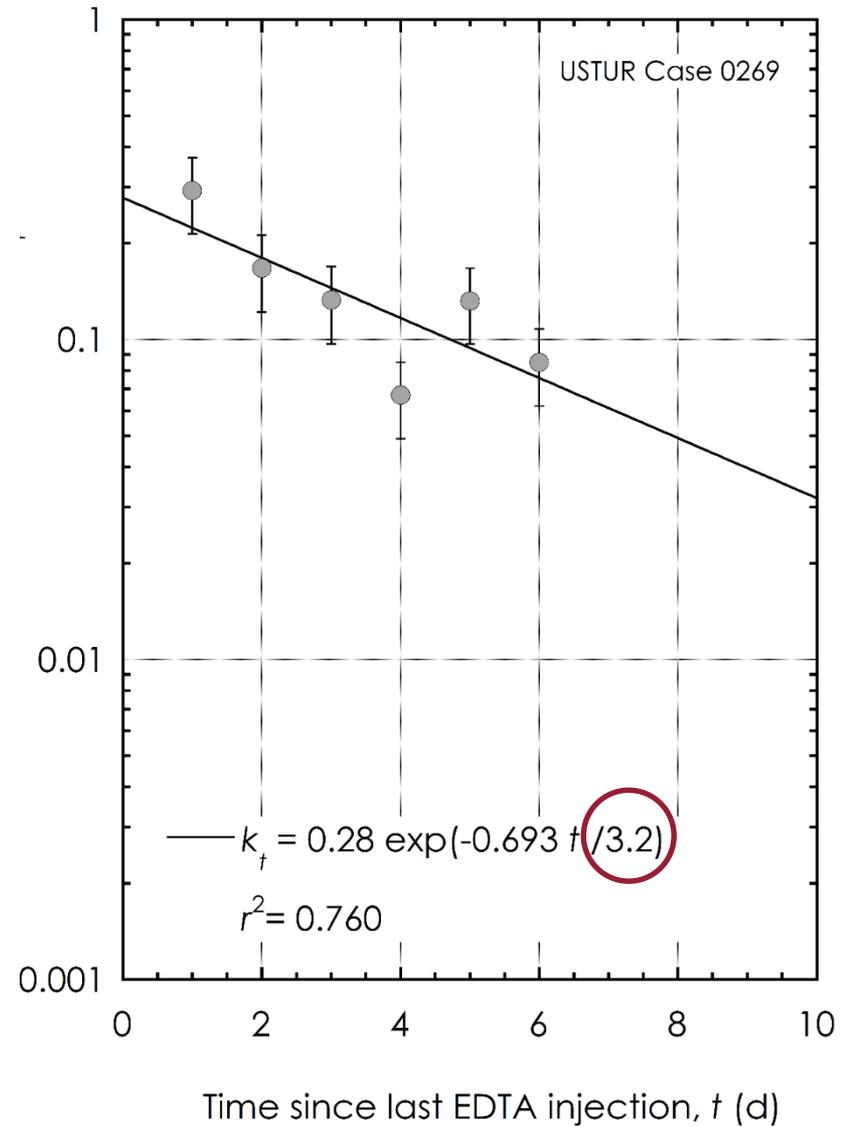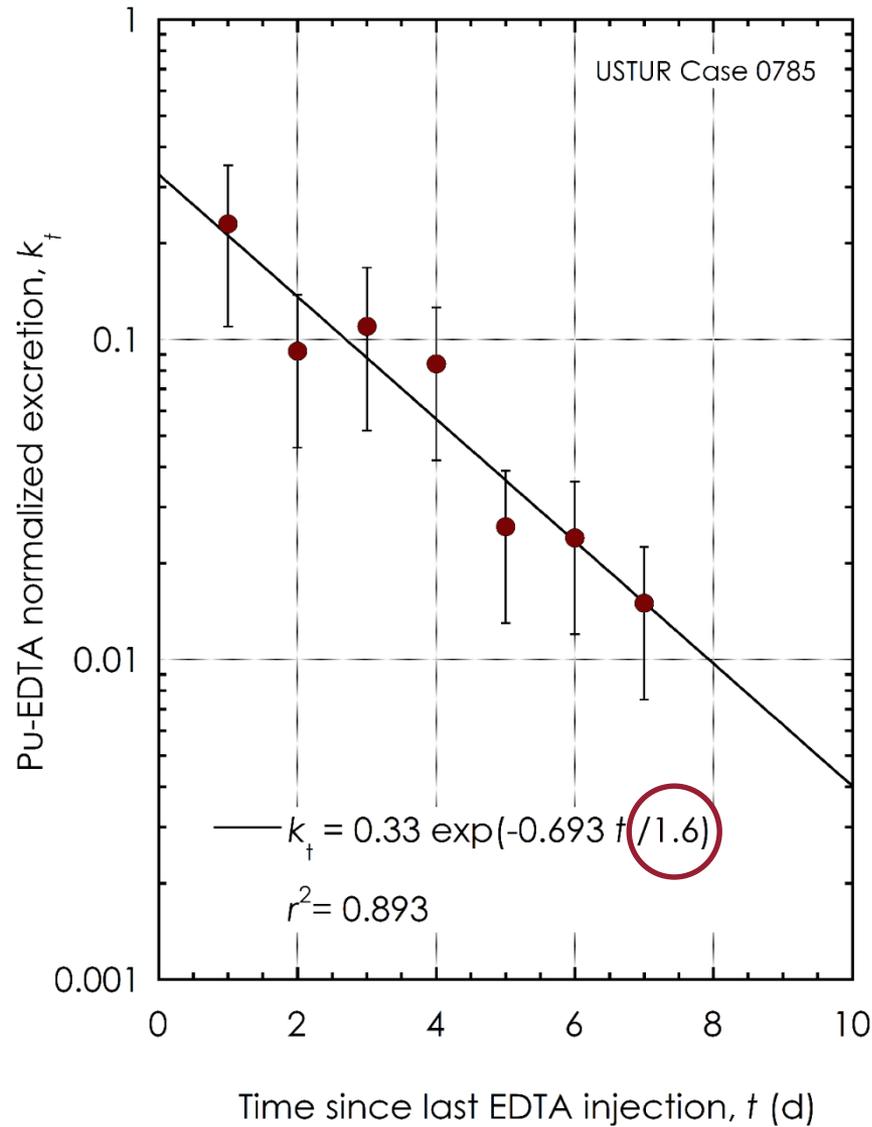$D$ (g) - dosage of an administrated drug

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

# Effectiveness: Ca-EDTA vs Ca-DTPA

# Pu-EDTA Complex Removal



USTUR Case 0785

$k_t = 0.33 \exp(-0.693 \, t/1.6)$

$r^2 = 0.893$

USTUR Case 0269

$k_t = 0.28 \exp(-0.693 \, t/3.2)$

$r^2 = 0.760$

Pu-EDTA normalized excretion, $k_t$

Time since last EDTA injection, $t$ (d)

Time since last EDTA injection, $t$ (d)

# 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?