

Biokinetic modeling of DTPA decorporation therapy: The CONRAD approach

Bastian Breustedt (FZK), Eric Blanchardon (IRSN) for the members of the DTPA task-group

- **CONRAD project (2005-2008)**

- COordinated Network for Radiation Dosimetry
- supported by the European Commission (6th Framework Programme)
- coordination and harmonization of radiation protection practices all over Europe, and the maintenance and consolidation of competences in the field of radiation dosimetry
- 7 Working Packages on different topics
 - WP5: Internal Dosimetry (Coordinator M.A. Lopez)
 - 41 scientists coming from 19 institutions of 14 European countries

- **EURADOS group (1981 -)**

- European Radiation DOSimetry group
- 54 institutions from 25 European countries as "voting members"
- Nearly 200 scientists are registered as "associate members,"
- 11 Working Groups on different topics
 - WG7: Internal Dosimetry (Coordinator M.A. Lopez)
 - WG7 network: 70 scientists coming from 23 institutions of 16 countries (EU, USA, Canada)

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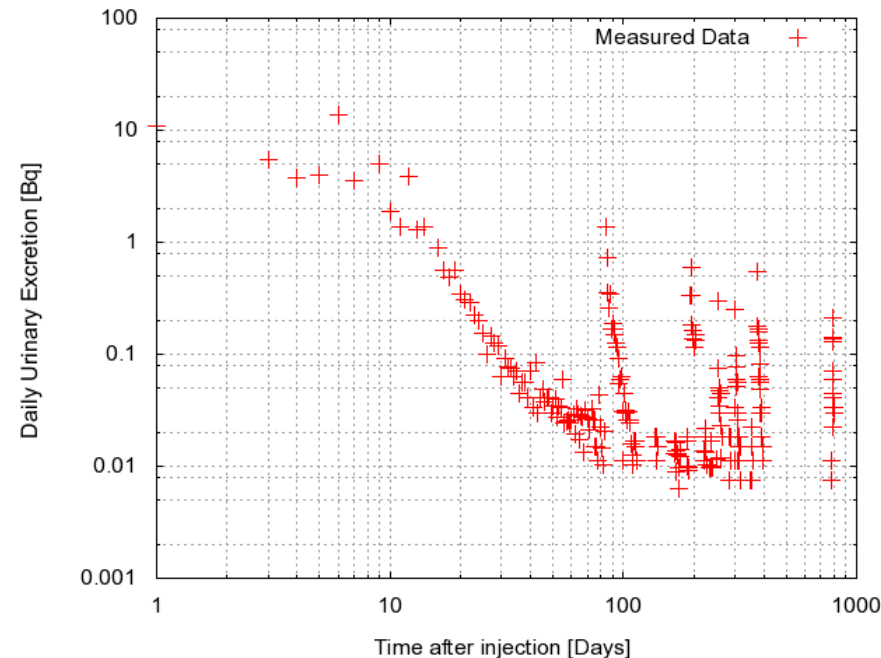
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Decorporation Therapy with DTPA

- Dose assessment after incorporation of Pu and Transuranium elements requires biokinetic models of urinary excretion for estimation of intake
 - ICRP Models for (undisturbed) biokinetics available
- Urinary Excretion pattern is disturbed by DTPA Therapy
 - some (mostly case specific) models are available in literature
- For „best“ Dose assessment → late Treatment
- For „best“ Treatment efficacy → early Treatment

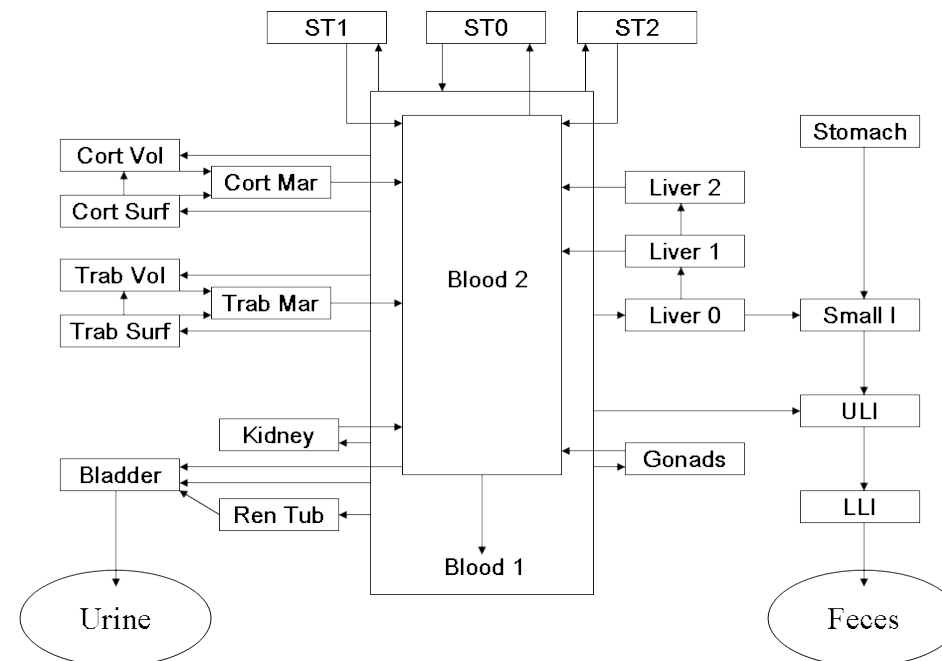


model needed



Modeling of DTPA-decorporation therapy

- CONRAD/EURADOS model
 - model for undisturbed biokinetics of Pu (Leggett et al. 2005)



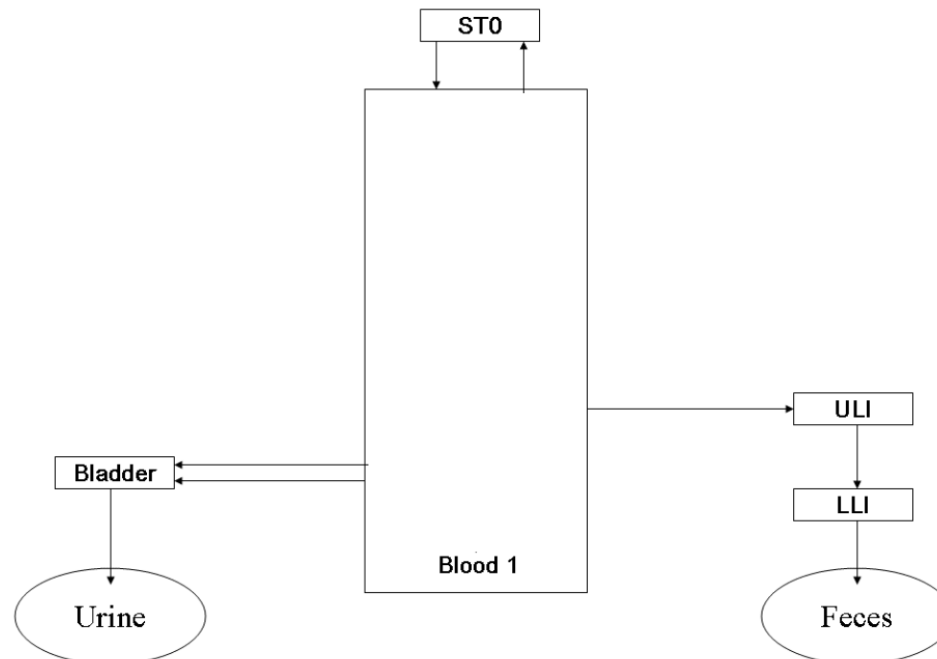
System y: undisturbed Pu-Biokinetics
(Leggett et al. 2005)

Modeling of DTPA-decorporation therapy

- **CONRAD/EURADOS model**

- model for undisturbed biokinetics of Pu (Leggett et al. 2005)
- interaction of Pu and DTPA (modeled explicitly)

	biokinetics	complexation
$\frac{dx_i}{dt} =$	$-\sum_{j=1}^n k_{ij} x_i + \sum_{j=1}^n k_{ji} x_j$	$-KR \cdot f(x_i, y_i)$
$\frac{dy_i}{dt} =$	$-\sum_{j=1}^n k_{ij} y_i + \sum_{j=1}^n k_{ji} y_j$	$-KR \cdot f(x_i, y_i)$
$\frac{dz_i}{dt} =$	$-\sum_{j=1}^n k_{ij} z_i + \sum_{j=1}^n k_{ji} z_j$	$+KR \cdot f(x_i, y_i)$



Systems x + z: DTPA and Pu-DTPA biokinetics (based on ICRP 53)

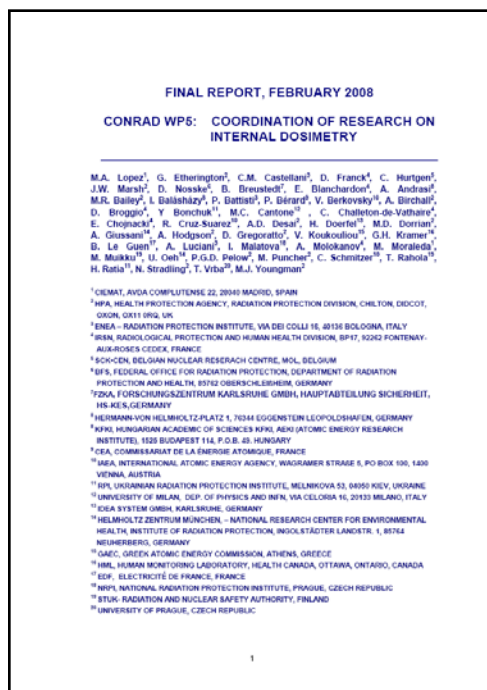
Modeling of DTPA-decorporation therapy

- **CONRAD/EURADOS model**

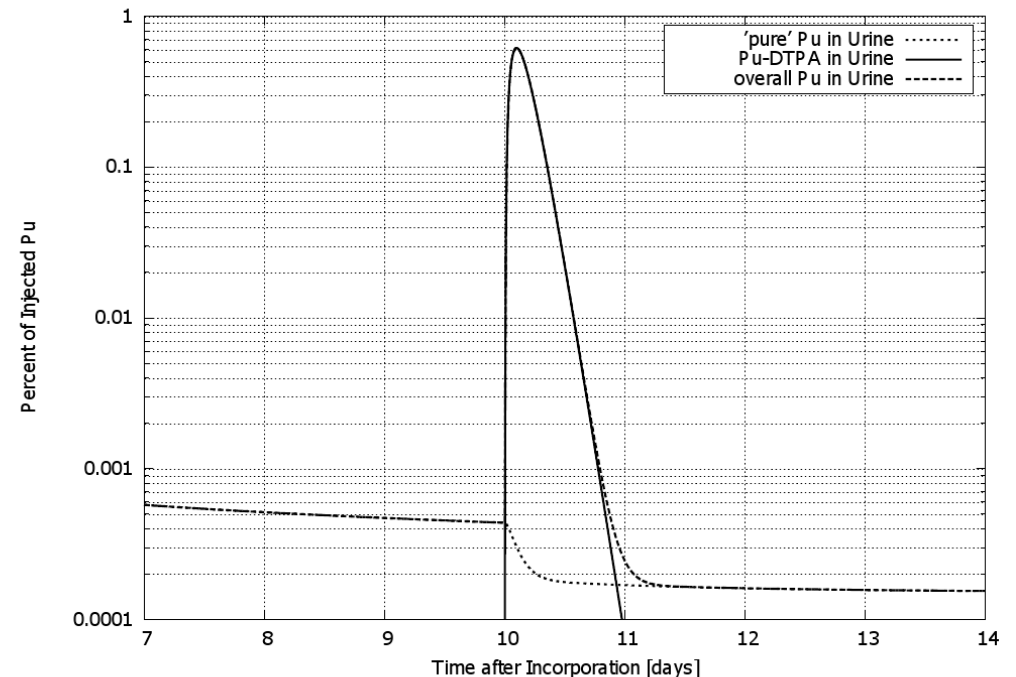
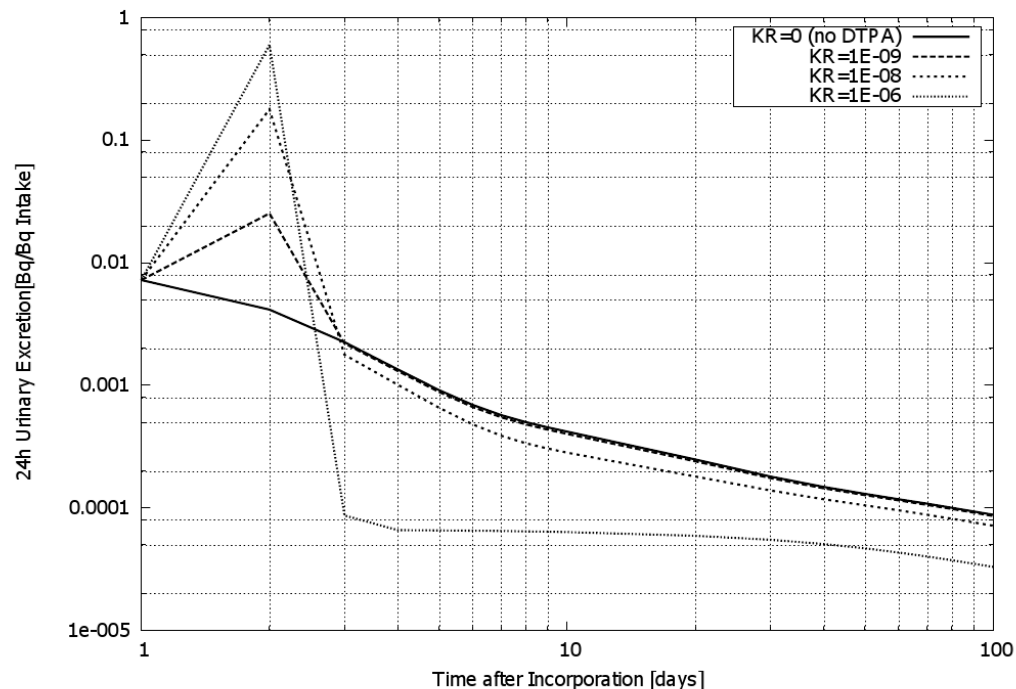
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→ “The CONRAD approach”

(published in final report of CONRAD WP5, paper in RPD)

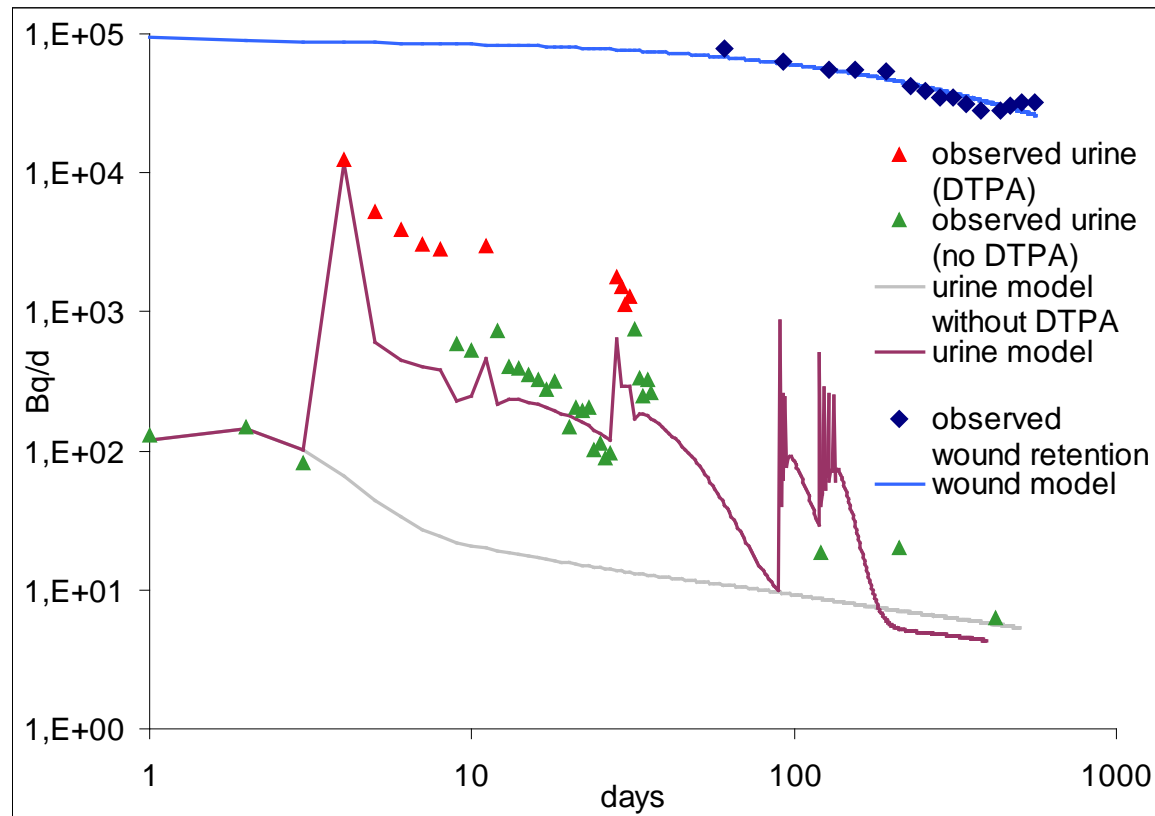


- Some Results of the CONRAD/EURADOS approach
 - ☺ Chelation kinetics and simulation of the early urinary excretion peak



Modeling of DTPA-decorporation therapy

- Some Results of the CONRAD/EURADOS approach
 - ☺ Chelation kinetics and simulation of the early urinary excretion peak
 - ☹ Unable to predict the lasting effect of DTPA



- Some Results of the CONRAD/EURADOS approach
 - ☺ Chelation kinetics and simulation of the early urinary excretion peak
 - ☹ Unable to predict the lasting effect of DTPA
- lessons learned:
 - The problem turned out to be more complicated than assumed
 - The complexation process dominates excretion
 - The fitting of the model to published data is most dependant on the accuracy of the activity measurements

- Pending Questions for modeling

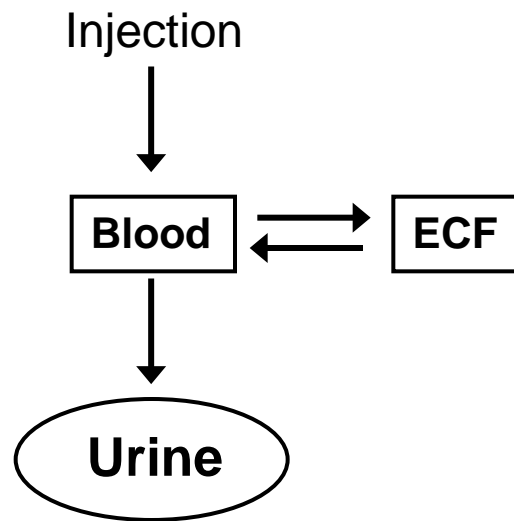
(as identified by CONRAD/EURADOS group)

- What are the relative contribution of the site of contamination (e.g. lung or wound) and of the systemic retention compartments to the amount of decorporated Pu?
- What is the influence of DTPA versus Pu concentration ratio on decorporation efficacy?
- How does the chelation of plutonium by DTPA depend on chemical speciation of the actinide?
- ... **and many more**

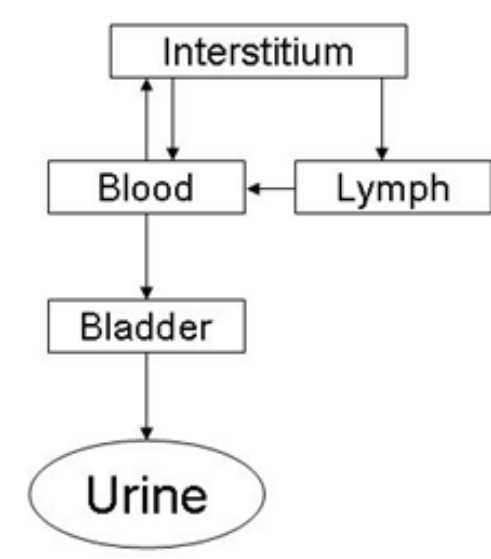
➔ Lots of work still to do in the further development of the CONRAD/EURADOS Model

Modeling of DTPA-decorporation therapy

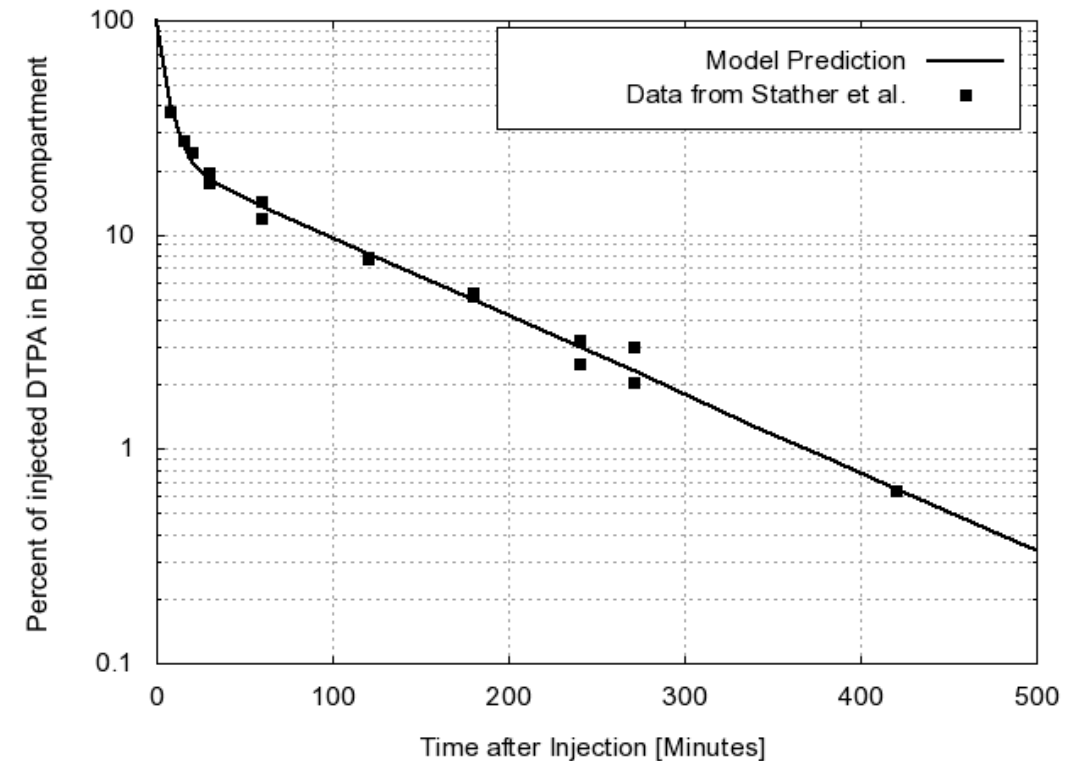
- first step
 - revised (draft) model for „pure/non-Pu“-DTPA
 - Based on data from Stather et al. (1983) obtained with ^{14}C -DTPA



**Original Model
(Stather 1983)**

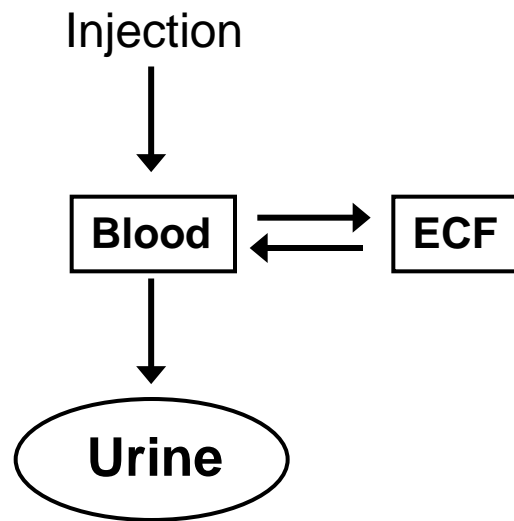


**CONRAD Model
(2009)**

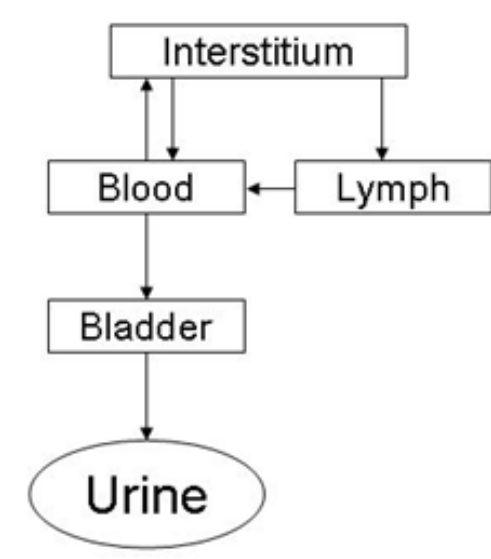


Modeling of DTPA-decorporation therapy

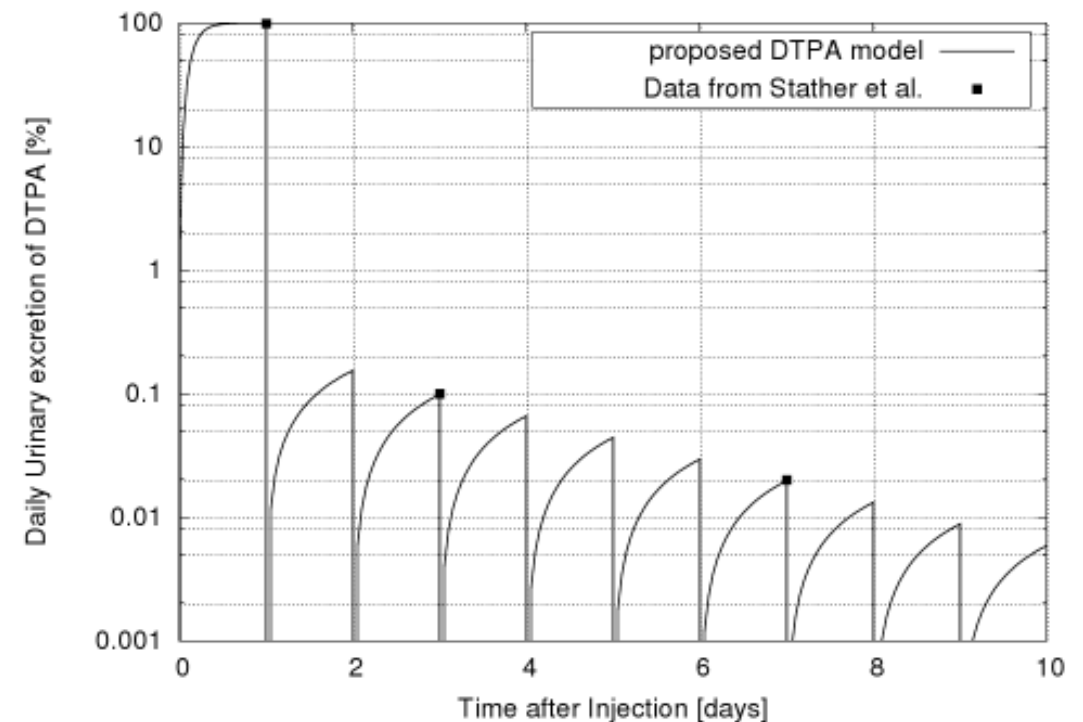
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**Original Model
(Stather 1983)**



**CONRAD Model
(2009)**



The EURADOS WG7 – DTPA task group



The authors thank the members of the CONRAD-DTPA group for their work and the many fruitful discussions during the development of the model presented here and look forward to continue working on this model in a task group of EURADOS WG7.

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