



Europe
2018



Radboudumc
university medical center



D4 & E4: MEDUWA-Vecht(e)

D4: **Alfons Uijtewaal**, The EU INTERREG-VA MEDUWA-Vecht(e) project, a general introduction, post@huizeaarde.nl

D4: **Ad Ragas**, Estimation and prioritization of hospital pharmaceutical (API) emissions, a.ragas@fnwi.ru.nl

E4: **Paul Leenders**, Plasma Activated Water Treatment, paul.leenders@vitalfluid.nl

E4: **Martien Graumans**, The use of plasma activated water and UV/H₂O₂ for the degradation of cyclophosphamide in wastewater, martien.graumans@radboudumc.nl

Disclosure

Potential conflict of interest	None/see below
Relationships with commercial companies	Company names:
<ul style="list-style-type: none">• Sponsorship / research money• Fee or other financial compensation• Shareholder• Other relationship, (please specify)	<ul style="list-style-type: none">• None• None• Triodos Bank NL• None

As a requirement of accreditation, The Royal Dutch Medical Association (KNMG) requires speakers to begin their presentations with a disclosure slide to make any financial relationships between speakers and commercial companies transparent.



Estimation and prioritization of hospital pharmaceutical (API) emissions

Ad Ragas^{1,2}, Cornelis van Loon¹, Marijn Gülpen¹, Kevin Tipatet¹, Birgit Hanssen¹, Rik Oldenkamp¹

¹ Radboud University Nijmegen, Department of Environmental Science, Nijmegen, The Netherlands

² Open Universiteit, Faculty of Management, Science & Technology, Heerlen, The Netherlands

E-mail: a.ragas@fnwi.ru.nl



Problem definition

Radboudumc - Nijmegen



- Academic hospital
- $\approx 35,000$ patients annually (day care)
- ≈ 600 beds

UMC Utrecht

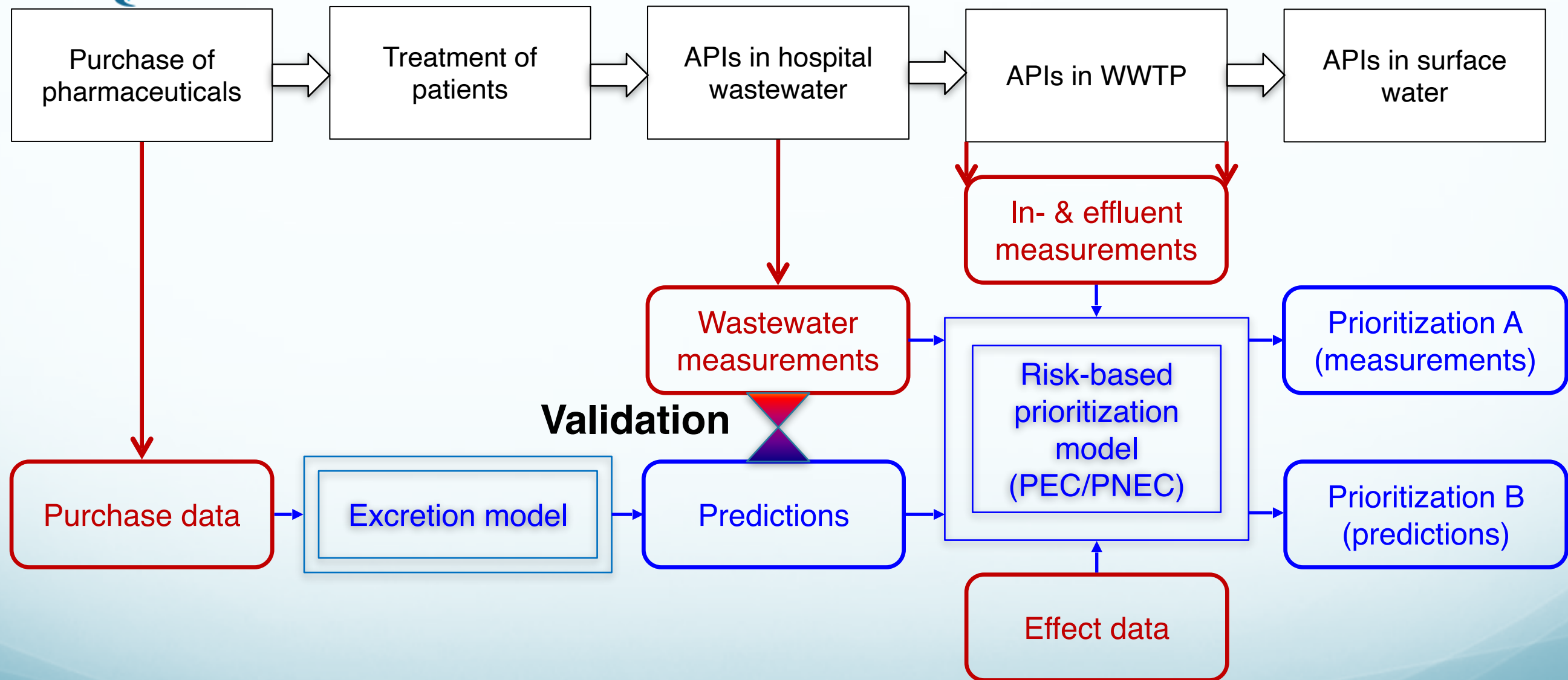


- Academic hospital
- $\approx 30,000$ patients annually (day care)
- $\approx 1,000$ beds

“How can we reduce the environmental impact of pharmaceuticals prescribed and used in our hospital?”



Research Setup





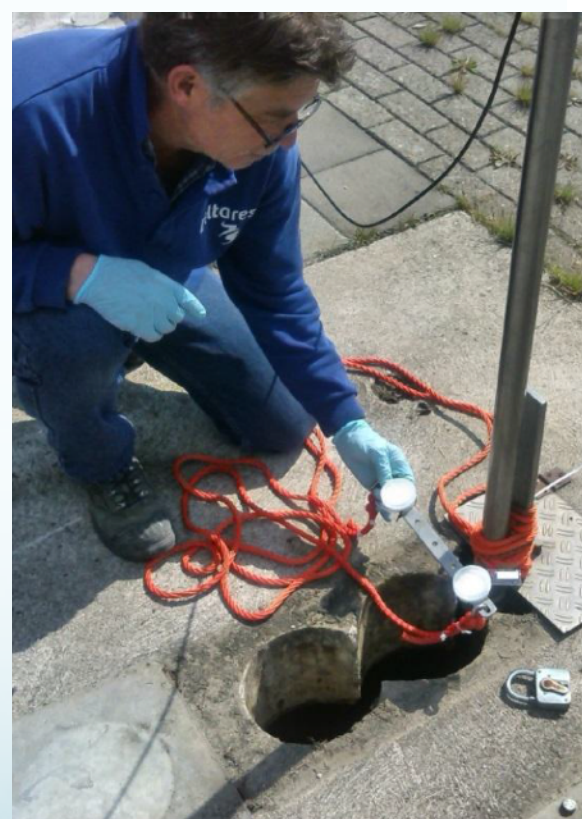
Substances & Measurements

Deltares

Enabling Delta Life



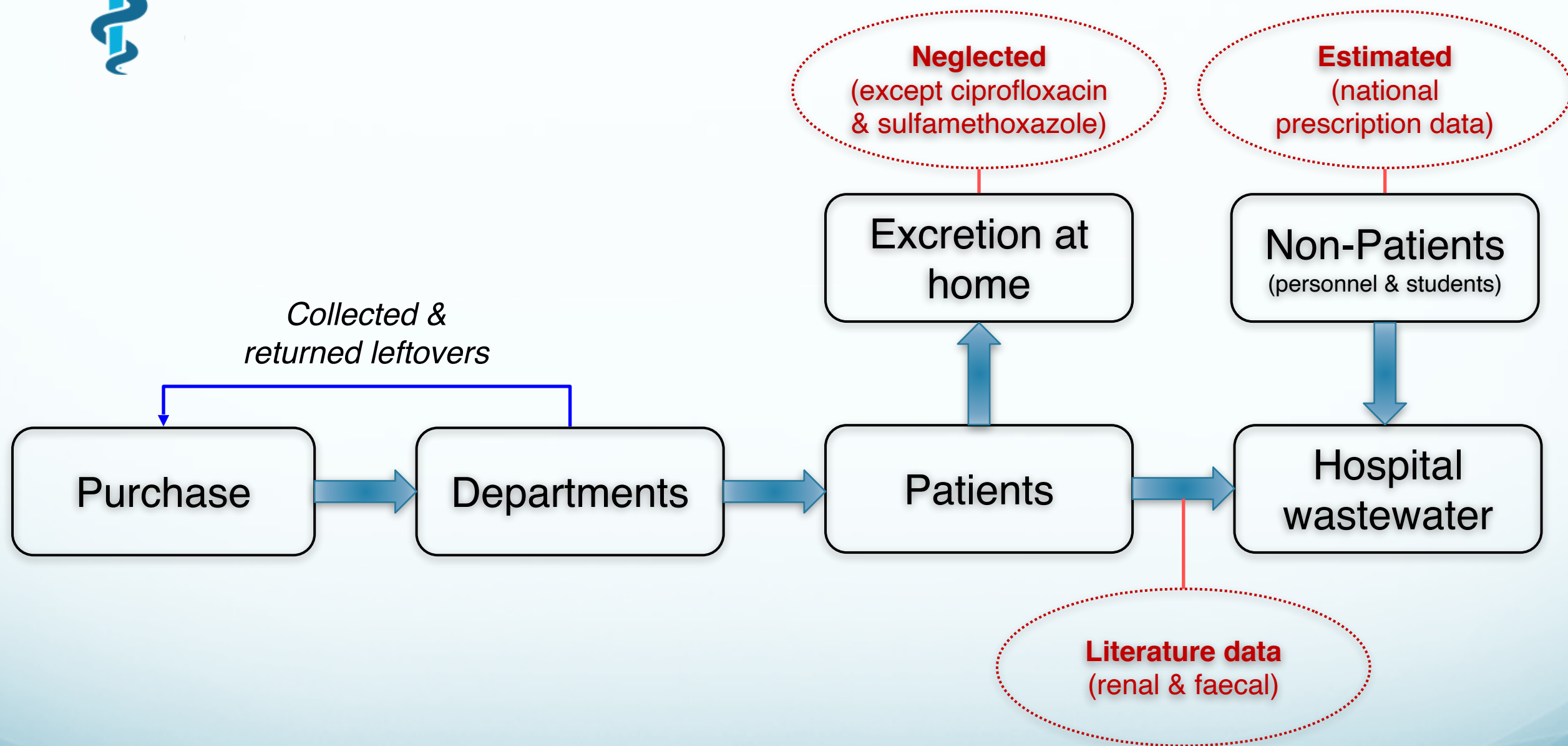
Passive sampling



Antibiotics	Azithromycin
	Ciprofloxacin
	Sulfamethoxazole
	Trimethoprim
Antineoplastics	Cytarabine
	Ifosfamide
Contrast Media	Iomeprol (Nijmegen)
	Iopromide (Utrecht)
NSAIDs	Diclofenac
	Ibuprofen
	Naproxen
	Acetaminophen (paracetamol)
Others	Carbamazepine (anti-epileptic)
	Gemfibrozil (cholesterol)
	Metformin (diabetes)
	Metoprolol (high blood pressure)
	Fluoxetine (Prozac)



Excretion Model



Prioritisation

$$\text{Risk} = \frac{PEC}{PNEC}$$

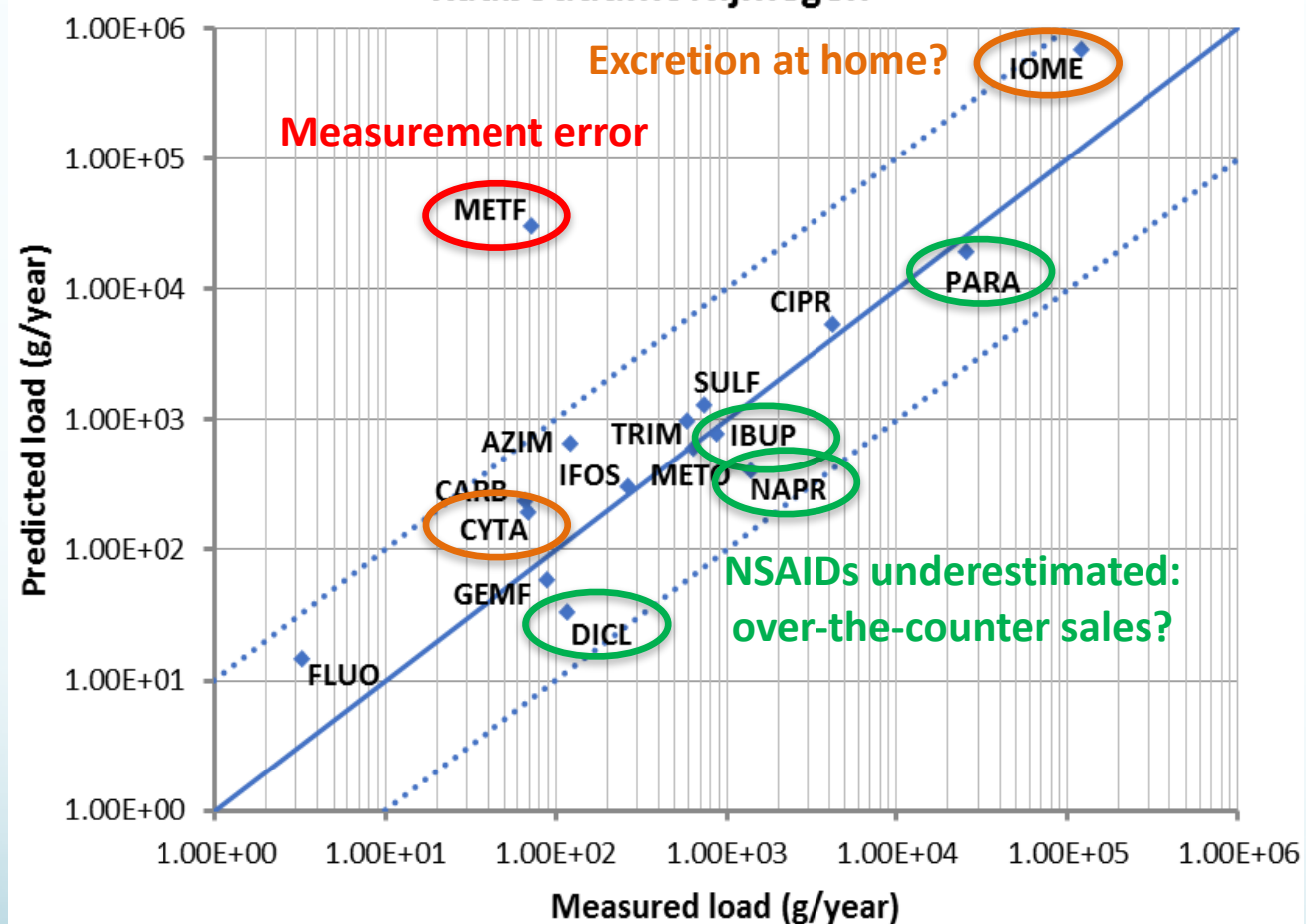
Measured or Predicted Concentration

Predicted No Effect Concentraiont (from literature)

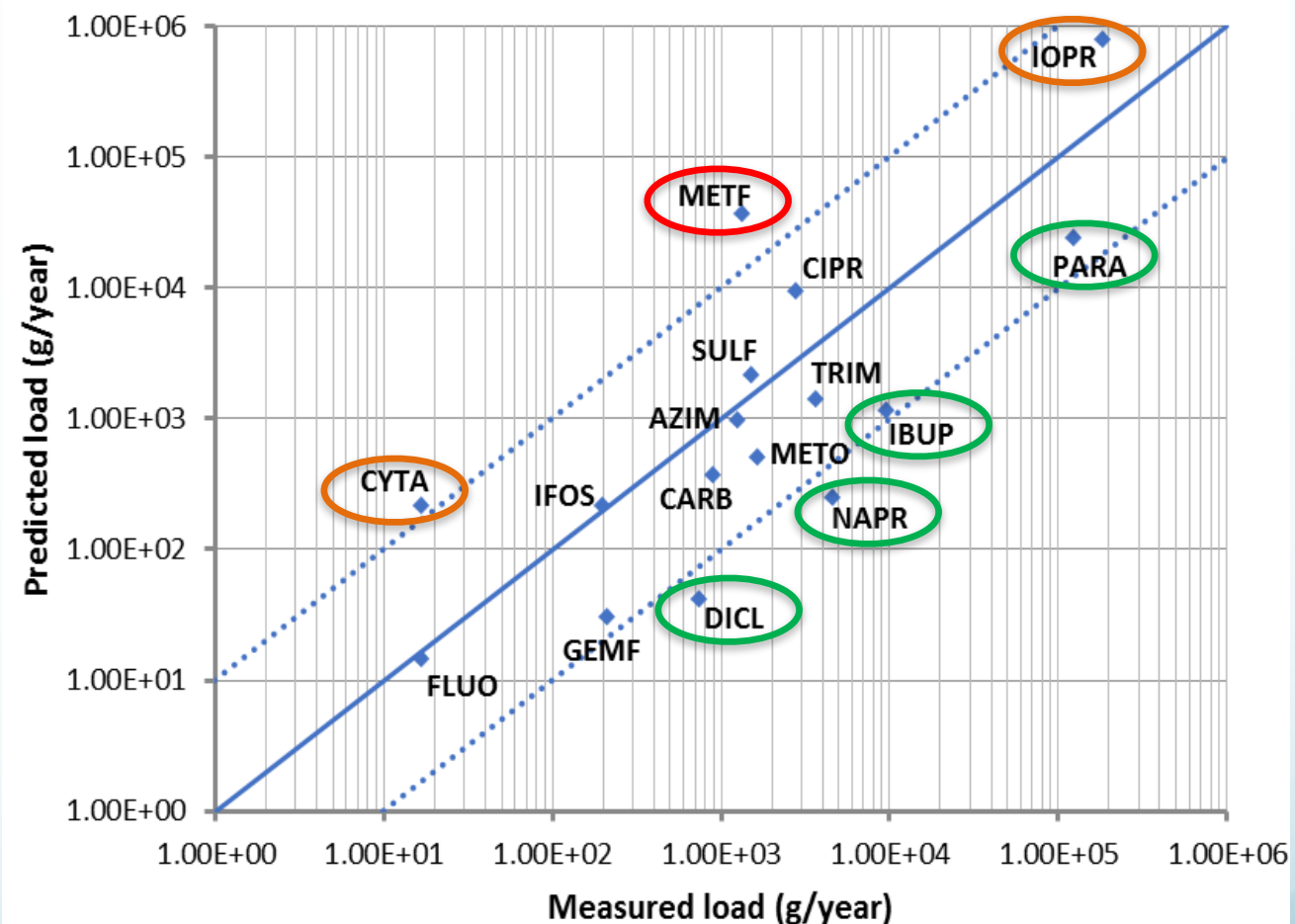


Validation Results

Radboudumc Nijmegen



Utrecht UMC





Prioritization Results

Radboudumc Nijmegen	Radboudumc Nijmegen	
	MEC-based	PEC-based
Sulfamethoxazole	1	1
Ciprofloxacin	2	4
Azithromycin	3	2
Iomeprol/Iopromide	4	3
Paracetamol	5	6
Ibuprofen	6	5
Metoprolol	7	8
Naproxen	8	13
Carbamazepin	9	7
Trimethoprim	10	10
Cytarabine	11	9
Gemfibrozil	12	15
Fluoxetine	13	12
Ifosfamide	14	14
Diclofenac*	15	16
Metformin	16	11

- *Ranking is quite stable*
- *Antibiotics (i.e., sulfamethoxazole, ciprofloxacin & azithromycin) dominate*
- *Prioritization results are quite sensitive to selection of toxicity data underlying the PNEC, e.g. diclofenac*



Actions?

Antibiotics

- Prescribe alternative antibiotics?
- Capture urine & treat? => see next presentation

Contrast fluids

- Capture urine & treat? => see next presentation



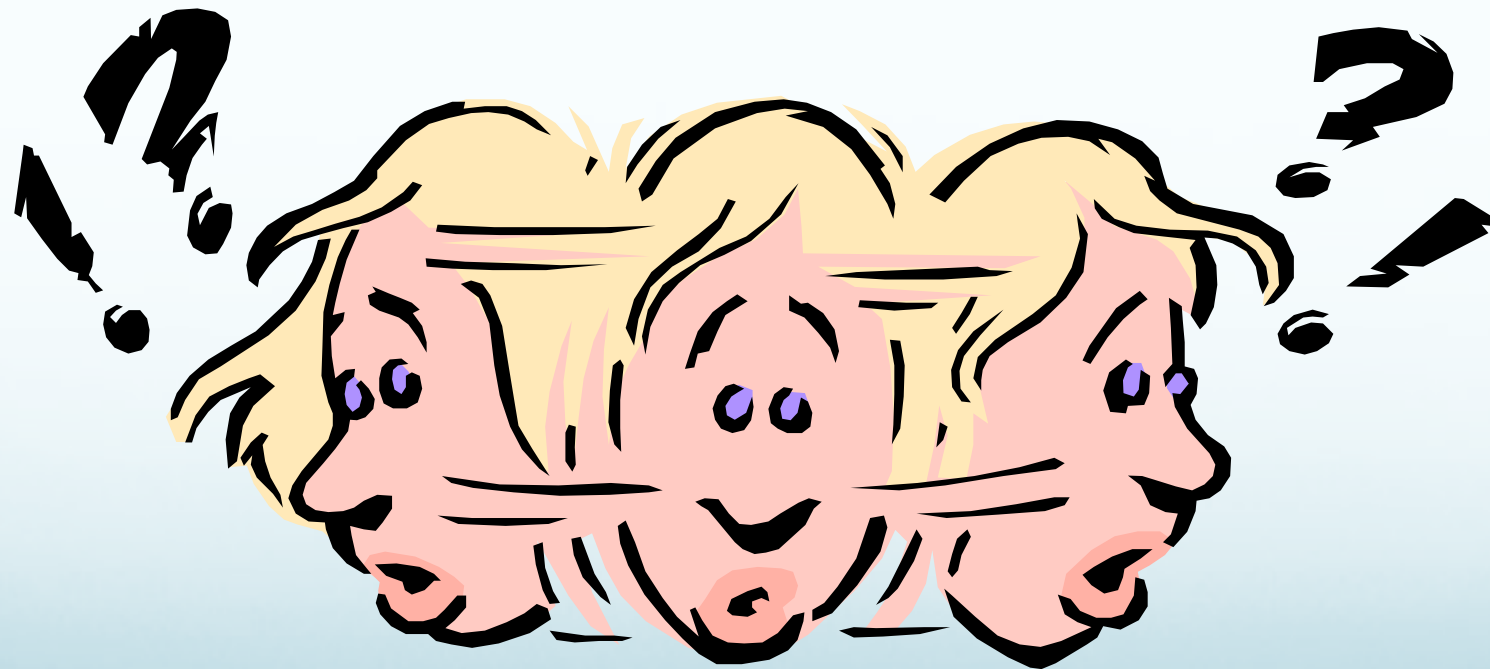
Conclusions

- API emissions from hospitals can be fairly well predicted based on hospital purchase data
- Emission estimation could be further improved:
 - Off-site API excretions (i.e., cytostatics and contrast media)
 - Over-the-counter drugs (i.e, NSAIDs)
 - Errors in measurement data
- **Future:** Assessment of all pharmaceuticals emitted by a hospital?



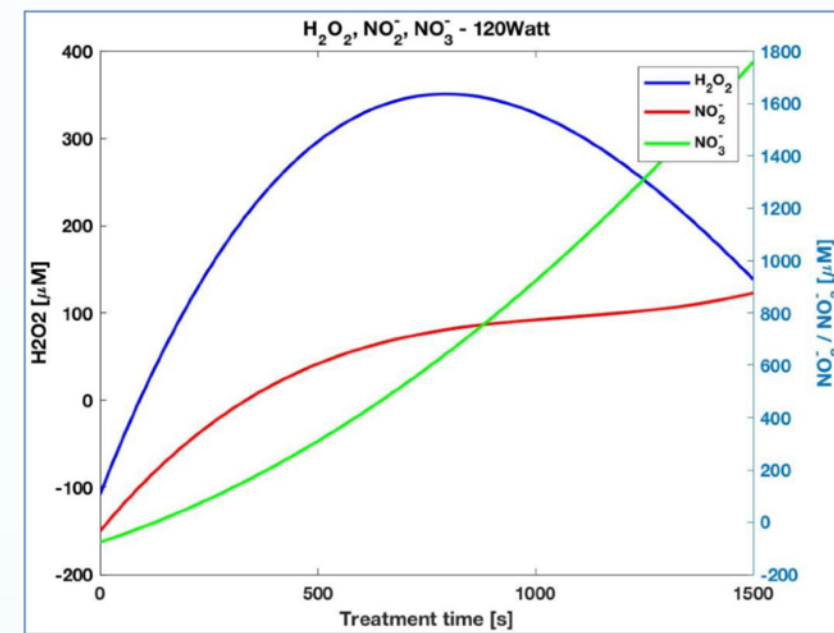
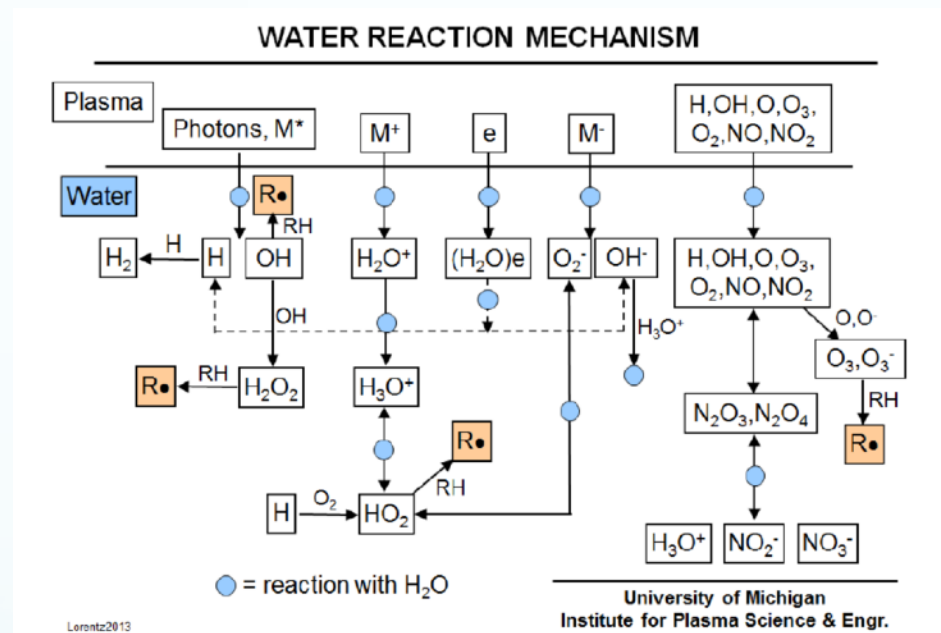
Many thanks to...

- *Erwin Roex* from Deltares (passive sampling)
- *Nicole Vink, Harriette Laurijsen & Eric Mimmel* from Radboudumc Nijmegen
- *Esther Willems, Henny Tussenbroek & Harry Wernert* from Utrecht UMC





Oxidative species



An avalanche of short lived reactive species are created in the plasma arc

ROS and RNS dissolve in water and have oxidizing properties



Europe
2018



Radboudumc
university medical center