

Environmental Impact of Micropollutants Present in Urine

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4. PRODUCTIVE SANITATION



Background

- In a western society wastewater produced ~120 L/person/d
- Humans consume large amounts of various pharmaceutically active ingredients (PhAI's)
- Large portion of compounds is excreted via urine and faeces
- Compounds enter wastewater treatment plants (WWTPs) via urine and faeces
 - Dilute with other wastewater
 - Small molecular weight of compounds
 - Enter the environment at μgL^{-1} or ngL^{-1} concentrations

→ Micropollutants



Background

- Urine comprises ~1 % of the wastewater produced
 - 1-1.5 L/person/d
- Municipal wastewater as main exposure route
 - Improper disposal of un-used or expired drugs + human metabolism
 - Compounds can be transformed back to active substances at WWTPs
 - Transported to the receiving waters
- Urine diversion and NoMix-technology good alternatives
 - Reduction of load to WWTPs
 - Recycling of nutrients
 - Removal of micropollutant source



Background

- Current legislation in European Union (EU) doesn't recognize the concept of "urine"
 - Only chemically pure urea
 - No testing of micropollutants from manure or WWTP sludge
- Urine usage is associated as a risk for pharmaceutical residues ending up in the agricultural fields
- The growing demand of fertilizers and lack of proper sanitation in developing countries
 - Recycling of nutrients via urine separation and reuse



Aim of the study

○ Studied

- The use of selected pharmaceutical and hormonal compounds in Finland
- Pharmaceuticals widely used in developing countries that may elicit negative environmental impacts

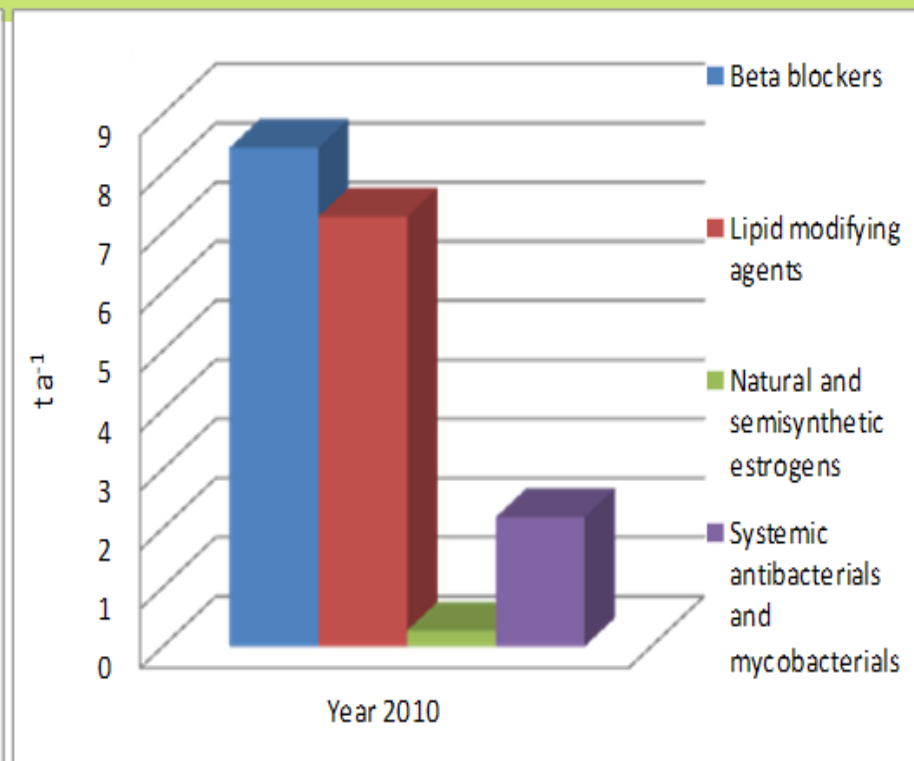
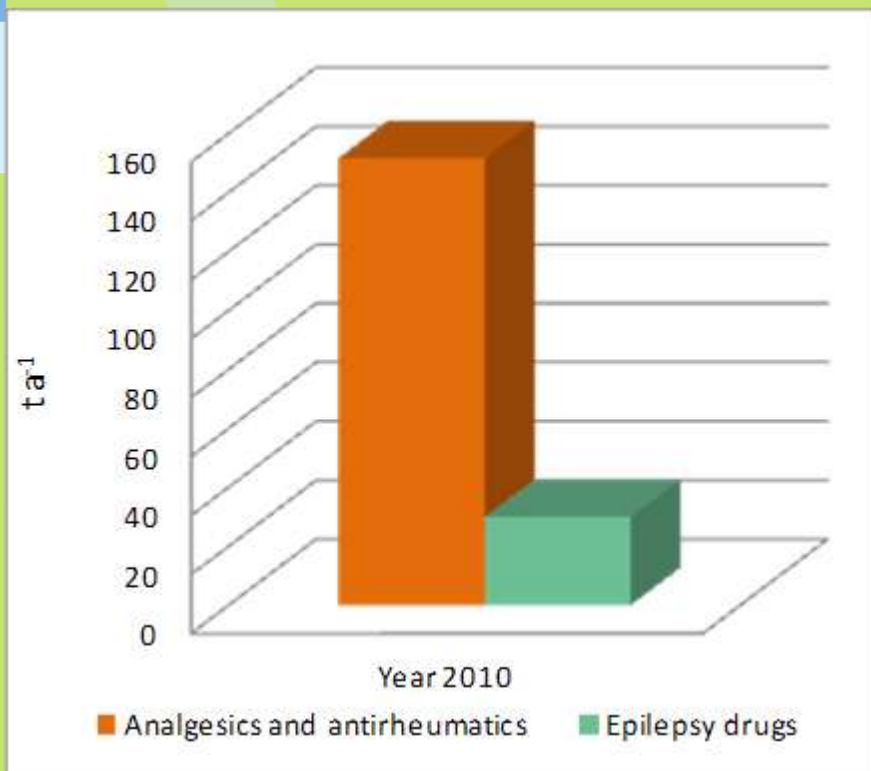
○ Consumption of pharmaceuticals calculated as

$$C \left(\frac{\text{kg}}{\text{a}} \right) = DDD \text{ (g)} \times \frac{DDD}{1000 \text{ inh}} \times 366 \frac{\text{d}}{\text{a}} \times \frac{\text{inh}}{1000000}$$

| | | |
|-------|------------------------|--|
| where | C | consumption in kilograms per year |
| | DDD | defined daily dose (grams) |
| | $DDD/1000 \text{ inh}$ | daily doses consumed per 1000 inhabitants per year |
| | 366 | number of days in a year |
| | inh | amount of inhabitants |

Results

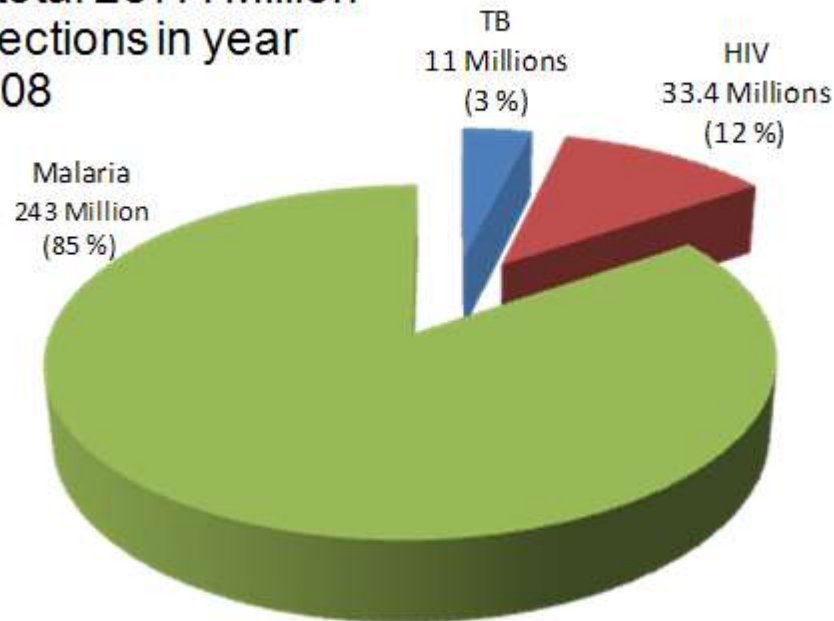
Pharmaceutical consumption in Finland 2010



- Many of these compounds are excreted into urine unchanged or as metabolites
- Compounds detected in environmental matrices

Results

In total 287.4 Million infections in year 2008



- Antimalarials
- HIV-drugs, used commonly in combinations with antibiotics to treat tuberculosis (TB)

Results

- In some parts of the world sanitation system is lacking.
- Lack of information concerning
 - Pharmaceutical consumption
 - Excreted amounts of active ingredients
 - Environmental impacts of pharmaceutical compounds



Results

- Multiple pharmaceutical compounds have been detected in the aquatic environment
 - Antivirals a new growing concern?
 - Can also accumulate in plants
 - Effects on human health?
 - Need to remove them before utilization of source separated urine as fertilizer
- **Need for more research**



Conclusions

- Data availability for pharmaceutical consumption in developing countries is inadequate
- Source separation and dry toilet technology provide a way to cut the risk chain
- More knowledge is needed on
 - the negative effects of pharmaceutically active ingredients
 - the possible risk caused by leaching and infiltration of them into the groundwater
 - the ways to remove them prior to utilizing source separated urine as a fertilizer



Future research needs

- Currently focusing on what happens to pharmaceutical compounds during urine storage
 - Recording concentrations of different compounds during that time
- Attention also paid on the hormonal activity of urine
 - By means of biotechnology, the estrogenic activity of urine will be studied



Thank you for your attention!

Contact details:

M.Sc. Sanna Pynnönen
E-mail: sanna.pynnonen@tut.fi
Tel: +358 40 198 1149



Prof. Tuula Tuhkanen
E-mail: tuula.tuhkanen@tut.fi

Postal address:

[Recipient name]
Tampere University of Technology
Department of Chemistry and Bioengineering
P.O. Box 541
33101 Tampere, Finland

