pills
Pharmaceutical Input and Elimination from Local Sources

Friday, November 25th 2011

KBG Kirchliches Bildungszentrum für Gesundheitsberufe Gelsenkirchen (Germany)

Symposium

Pharmaceuticals in the Water

Objectives and Conditions

– Documentation –

EMSCHER GENOSSENSCHAFT

ON BEHALF OF THE PILLS PARTNERSHIP

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

The Symposium



General aim of the here summarized event was to discuss with about 70 participants about objectives and potential solutions for the reduction of pharmaceutical residues in the aquatic environment.
The participants came from different institutions, such as research instituts, industry, municipalities, water boards, authorities, consumer protection and hospitals.
The existence of micropollutants in the aquatic environment is known for a long time already and many scientific studies give reason for concern. Besides precautionary activities to reduce the emission of micropollutants advanced wastewater treatment at point sources can be seen as a part of the solution. The Emschergenossenschaft therefore started in 2007 a european cooperation project with 6 partners out of 6 countries to deal with sources, effects, objectives and uncertainties to gain experiences and knowhow about the options of point source wastewater treatment at e.g. hospitals.

Within PILLS - „Pharmaceutical Input and Elimination from Local Sources“ two water boards (the German Emschergenossenschaft and the Dutch Waterschap Groot Salland), two scientific research institutes (Eawag from Switzerland and CRP Henri Tudor from Luxemburg) and two universities (from Limoges, France, and the scottish Glasgow Caledonian University) work transnationally together on research and establishing technologies for the reduction of pharmaceutical residues in wastewater and as well on the communication of the problem.
The symposium was aiming at the dissemination of information about the status quo of the PILLS project and to discuss solution options by integrating the opinions and experiences of the participants: How important are aspects such as multiresistant germs, energy consumption and costs or legislative amendments to deal with pharmaceutical residues in water?


Ladies and Gentlemen,

since the Emschergenossenschaft started the PILLS project in 2007 we carried out every year an event here in Gelsenkirchen:

- the PILLS launch conference in November 2008 in the local science park,
- the symposium „pharmaceuticals in water“ in November 2009 here in the ecclesiastical education centre for health profession,
- the topping-out ceremony for the pilot treatment plant in November 2010,
- and the official operation start of that facility in July 2011.

Today's presentation of interim results and experiences of our PILLS partners and the presentations of the invited experts is aiming at a factual and practical contribution to the public debate and opinion forming.
In media, reporting often is focusing on the appearance of “effeminated” male fishes and cancer risks in surface water. The assumed effect of hormones from contraceptives is recently completed by new findings on interactions with cancer diseases.
Coming from a water board with the aim of an integrated view onto the whole water cycle we see ourselves very much on duty as actors, because treatment plants are not the problem but can be part of the solution. Nevertheless we work within complex interdependences:

- many micropollutants in surface waters are detected in the last years due to improved analysis techniques;
- about 50 million chemicals are existing but about 5.000 are identified yet to be potentially endangering the environment;
- in total 3.000 active medical substances are on the market but only 180 can be measured in the water yet;
- often no verified information is present about the effects on humans or environment but for precaution reasons the need for action is obvious.

Modern treatment plants are designed for the elimination of biologically removable substances and nutrients – so far no cost-benefit or maintenance experiences on the elimination of pharmaceuticals under day-to-day conditions have been elaborated.
So besides the PILLS project two additional advanced treatment facilities are run by Emschergenossenschaft/Lippeverband: at the treatment plant Hünxe (here a partial flow is discharged via a membrane filtration to have one-to-one comparison with purification results from conventional treatment) and Bad Sassendorf (here 13.000 citizens live and 1.200 beds in 6 hospitals exist, so the Lippeverband treatment plant was completed with an ozonisation step).
Here in Gelsenkirchen the hospital with 560 beds is connected to the PILLS pilot facility. Supported by membrane technology, ozonisation and powdered activated carbon various test series are run to gain knowledge about the most effective methods. Additionally the used technologies show experiences regarding maintenance costs and demands, taking not only energy and material supply into account but also staff costs.

Together with the PILLS partners it is a matter of concern for the Emschergenossenschaft to develop technical research facilities on a large scale and to operate them under realistic day-to-day conditions to gain experiences about cost-benefit, effects and limits for the elimination of micropollutants: what technology works best to eliminate pharmaceutical residues and multiresistant bacteria from the waste water and how is the framework like for treatment at point sources such as hospitals, care homes or medical centres?
The PILLS project wants to sensitize public and call for an integrated approach for a sustainable reduction of pharmaceutical micropollutants. It is important to us to have an eye on the whole track – meaning the life cycle of the substances from production via consumption to disposal.
Consequently we follow this approach and from 2012 on we plan a new local project to „tracking down trace substances” in a sub catchment area. In cooperation with the local community and stakeholders the aim is

- to analyse the use and consumption of micropollutants with focus on pharmaceuticals (including veterinary medicines),
- to point out possibilities of avoidance and reduction of environmental input, starting at the sources, and
- to sensitize the public, pharmacists, medical profession and all affected parties.

Besides technical and scientific approaches especially politics and authorities are asked to support the framework for an integrated action, for example by

- establishing a “water traffic light” for already existing medicine (to symbolize red or green light regarding toxic or eco-friendly substances),
- changing the legal frame,
- optimizing or expanding “take back systems”,
- development of removable “water friendly” pharmaceuticals,
- adapting the doses to the needs of human bodies,
- changes of prescription practices,
- adapted advices in pharmacies and drugstores,
- information about changing habits regarding the use of pharmaceuticals.

We think that only interdiciplinary actions can help to protect the aquatic environment against critical micropollutants. Therefore we have set the focus of this symposium on „realistic objectives to cope with micropollutants” and “framework for point sources”.

Dr. Jochen Stemplewski

Programme

08:30 **Registration and Coffee**

09:00 **Welcome and Introduction**
Dr. Jochen Stemplewski
CEO Emschergenossenschaft

09:15 **Chemicals in the Environment – Risk Assessment and Risk Management**
Prof. Dr.-Ing. Adolf Eisenträger
Head of Department Pharmaceuticals, Chemicals,
Environmental Testing The Federal Environment Agency, Dessau (Germany)

09:35 **Pharmaceutical Input – Approaches for Minimizing**
Prof. Dr. Klaus Kümmerer
Director of the Institute of Sustainable and Environmental Chemistry,
LEUPHANA University of Lüneburg (Germany)

09:55 **Questions & Answers**

10:15 **Talk – Interim Findings of the PILLS Project**
Moderation Petra Voßebürger and Joachim Lück, IKU GmbH

Dr. Herman Evenblij - Waterschap Groot Salland (The Netherlands)

Dr. Kai Klepiszewski - Resource Centre for Environmental Technologies – CRP Henri Tudor (Luxembourg)

Dr. Issa Nafo - Emschergenossenschaft (Germany)

10:55 **Coffee Break**

11:25 **Workshop I**
Realistic Objectives in dealing with Micropollutants

Workshop II
Framework for Action at Point Sources

12:15 **Coffee Break**

12:30 **Conclusions and Outlook**
Dr. Jochen Stemplewski
CEO Emschergenossenschaft

Exhibition of Workshop Results and Opinion Poll Flipcharts

13:00 **Lunch Snack**
Optional: Site Visit at the PILLS Pilot Plant Marienhospital

Chemicals in the Environment – Risk Assessment and Risk Management

Prof. Dr.-Ing. Adolf Eisenträger Head of Department Pharmaceuticals, Chemicals, Environmental Testing; The Federal Environment Agency, Dessau (Germany)

- Persistent and long-life chemicals can not be fetched back – they are spread all over the world and cause harm to humans and eco systems: For example the most utilized insecticide since the 1940ies, DDT, can still be detected today in the arctic ice though it was mostly forbidden step by step in most countries after publications about its eco-toxicity in the 1970ies.
- General assessment criteria for hazardous substances:
  - persistence = P
  - enrichment capability, bio accumulation = B
  - toxicity = T
  - spaciousness of the spread
- The risk assessment considers danger (potentially appearing harm) and the probability of its occurrence, whereas the proportionality in relation to the intended effects needs to be taken into account. For example pesticides are designed to cause harm to selected organisms, so benefit and harm have to be weighed against each other.

Principle of environment risk assessment

It is the aim of regulatory ecotoxicology to guarantee the protection of the environment and to regulate substances if necessary. Formal methods are needed to assess the environmental risk of a substance:

PEC/PNEC = environmental concentration / (lowest effect/safety factor)
> 1 = risk
PEC = predicted environmental concentration
PNEC = predicted no effect concentration

Due to lacking measurements the characteristics of a substance are analysed under laboratory conditions and an abstraction of the environmental effects is carried out, e.g. via modelling with the objective to estimate the environmental concentration (PEC).
Using reference organisms to assess the effects of substances the concentration is evaluated that does not cause any environmental impact, including uncertainties (PNEC).
Beyond legislative regulation (e.g. in permission procedures) there are only limited options in dealing with pharmaceuticals in the environment. Possible actions regarding the reduction of water pollution can be seen within the design process of pharmaceuticals concerning environmental aspects („green pharmacy“) as well as the emission management in water engineering (for example improvements of treatment technologies or special purification facilities at „hot spots“).
Dealing with pharmaceuticals calls for more problem awareness at medical professions, pharmacists, consumers, disposal behaviour and in general the existence of take back systems.

Pharmaceutical Input – Approaches for Minimization

Prof. Dr. Klaus Kümmerer, Director of the Institute of Sustainable Environmental Chemistry, LEUPHANA University of Lüneburg (Germany)

Micropollutants in the aquatic environment have their origin not only from about 35,000 t pharmaceuticals per year in Germany, but from more than 100,000 chemical substances in the EU in products used daily, such as washing powder, pesticides, cosmetics,… or by-products, for example from incineration or traffic, such as dioxin, PAH, … Furthermore many chemicals and pharmaceuticals are not produced within the EU with far-reaching guidelines and control mechanisms but in countries without environmental regulations.
Regarding the „end-of-pipe“ strategy it is anticipated that the substances can be eliminated or at least reduced by

- adsorption (sludge, activated carbon),
- membrane (bio-, membrane filtration, ultra filtration, …),
- advanced oxidation (ozone, fenton-, photo-, …),
- sand filtration.

Furthermore metabolites produced by human metabolism or transformation products from chemical, physical or biologic reactions need to be considered, probably even more harmful than the original substances.
Therefore the approach of wastewater treatment short- or medium term can be partly helpful, but needs energy and material supply, can not be targeted at the elimination of every substance, can cause unexpected metabolites and is not realistic in all countries – so this approach is not necessarily sustainable.

More helpful is the medium term approach via the consumption. Patients, medical professions, pharmacists, industries – the consumer's behaviour and the knowledge about environmental effects is in Sweden for example driven by client instructions in pharmaceutical packs with a kind of “traffic light” system. Hereby at least the avoidance of some substances, meaning the “not-consumption”, can be influenced.

More success can be expected from the long-term strategy Benign by Design with the aim of pharmaceutical production of

- inherent environmental safe substances,
- easily biodegradable substances
- no exposure,
- no effects, no risk.

Finally the objective is as well research for the ongoing development of already existing pharmaceuticals aiming at better degradability and minor harm effects. Examples show that this can be achieved partly by small interventions into the chemical structure. This strategy and new ways of thinking are right at the beginning of research. This calls for other education and mental structures but enables on the other side to get access to new markets.
Conclusion: A more sustainable strategy of minimizing pharmaceutical residues in the environment forces us to think more local and global, to reduce the flow of substances and to achieve a mix of measures as close to the source as possible.

QUESTIONS & STATEMENTS

„Especially hormones in water bodies have their origin from contraceptives that are consumed in private households, don't they?"

„What sense makes the advanced treatment of hospital waste water in a densely populated area if afterwards the purified discharge is led into the municipal sewer system again – together with the pharmaceutically burdened waste water out of the households?"

„How can we achieve legislative regulations for everyone and where shall the wastewater then be treated? And chiefly – who will pay? The health insurances? Or via private wastewater fees?"

„I like playing the devil's advocate: So far nobody died from pharmaceutical residues in drinking water but many people die from road accidents. So where's the economic relationship gone if we spend so much money in advanced wastewater treatment?"

Which minimizing objectives are realistic for what? Regarding the whole water cycle: At which part of the cycle reductions can be established how?

Who initiates / finances / supports possible information campaigns or staff trainings?

What meaning has precaution really for our society?

Are there avoidance strategies in the phase of production (here e.g. substitutes)?

In hospitals hormone are often used in therapies where they are not expected, for example for cancer treatment.

In general load and toxicity have to be considered differently. Not the volume but the resulting concentration is relevant for the effect!

Ongoing development of take back systems!

Separate waste water treatment for every hospital is doubtful. In individual cases, e.g. very specialized clinics, a check might be useful if an advanced wastewater treatment should be taken into consideration.

It is quiet important to inform, train and sensitize consumers, staff in hospital, in laboratories and medical centres and finally initiate changes in behaviour regarding pharmaceuticals.

The consumer's customs can hardly be influenced since commercial advertising tells them for years now that painkiller ointment available without prescription is a must in your sports bag.

Victims from antibiotic resistances and multiresistant germs become more and more obvious. Surely this comes not from drinking water, but it is a matter of our consumption and behaviour how the spreading of the problem occurs!

Often we know too less about metabolism and therapies of little children, elderly people or the emergence of cancer. Probably here the treatment is not really adapted and therapeutically exaggerated?

Micropollutants cannot be lumped all together – they have very heterogeneous effects that have to be assessed depending on protected charges (for example human health, quality of ecosystems, etc.).

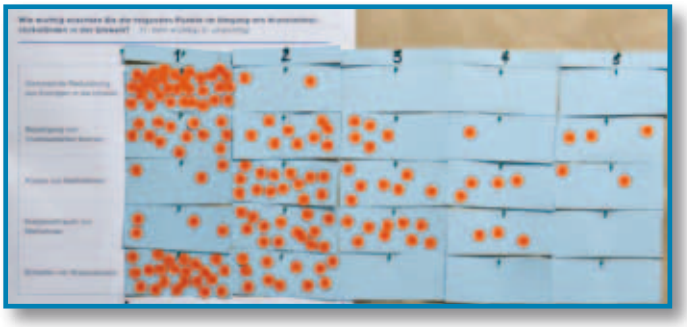
Compared to other topics in the sphere of chemical safety there are many open questions – there needs to be far more research!

Realistic risk awareness needs to be supported – reduce unadapted trouble making and scandal spreading!

The PILLS project wants to elaborate a „Multi Criteria Decision Analysis“ (MCDA). This tool should be designed to collect potential decision criteria that helps decision makers and stakeholders to form an opinion and support actions and measures.
The PILLS partners wanted to contribute to the discussions on european level, offering politics and project developers an instrument to understand the motivation and concerns of stakeholders.
Working for about 4 years now within the partnership it became more and more obvious that due to very different frame conditions in the 6 partner countries – such as social, cultural, political and administrative reasons – it is not possible to develop a tool that fits as a serious MCDA in all partner countries.
Nevertheless it seems important to the partners to give an overview about the feelings and arguments of the affected or contributing stakeholders. Therefore the participants of the symposium were asked to symbolize their estimation via stickers on an opinion poll flip chart, showing their statements to the questions ranked between „1 = very important“ to „5 = irrelevant“:

How important are the following aspects regarding the handling of pharmaceutical residues in the environment?

- Precautionary reduction of input into the environment
- Elimination of multiresistant bacteria and germs
- Costs of measures
- Energy consumption of measures
- Filling of knowledge gaps
- Voluntary initiatives for measures
- Legislative regulations for measures
- Prohibitions or stricter rules for chemical substances
- Reduction of private pharmaceutical consumption
- Appropriate disposal



The overview of the opinions showed a very clear tendency towards the precautionary measures to reduce the input into the environment.
From the participant's point of view the private consumption as well as the appropriate disposal, the filling of knowledge gaps and legislative initiatives are quite high in their ranking.
Of medium importance (on the scale from 1-5 more between 2 and 3) the participants assessed voluntary measures, multiresistant bacteria, costs and energy consumption.
Many participants of the symposium supported with their opinion the life cycle approach: A multistage strategy regarding consumer's behaviour together with legislative regulations (for example for chemical substances) and research are needed to reach in the long term the reduction of pharmaceutical residues in the environment.

Characteristics of the Waste Water Treatment Plant Gelsenkirchen Marienhospital

Basic Data Marienhospital Gelsenkirchen

N° of beds Marienhospital	560
Patients per year	70.000
Water consumption per year	60.000 m³

Basic Data Wastewater Treatment Plant

Nitrogen load of raw wastewater in population equivalents	1.600 PE (N_{ges})
Easily degradable organic load (within 5 days)	3.100 EW (BSB_5)
Max. wastewater inflow per hour	25 m³/h
Max. plant discharge per hour (Q_M)	11 m³/h
Max. plant discharge per day	200 m³/d
Size of pilot facility (floorspace)	220 m²
Volume of aeration tank	270 m³
Retention period of sludge in biological treatment	25 days (t_{TS})
Treatment technique MBR: submerged membrane	1.200 m²
Treatment technique O_3: ozonisation with 10 min retention period	3 – 10 mg/litre
Treatment technique PAC: powdered activated carbon	< 50 mg/litre

Additionally to the biological treatment in the membrane filtration the advanced treatment (ozone and activated carbon) are combined regarding order, dosing and retention period. The efficiency concerning the elimination of micropollutants, energy consumption and maintenance demands are reviewed.

Facility Components

- Treatment plant inlet pumping station (2 submerged pumps; 2 DRL DA 110)
- Fine sieve (1 mm mesh)
- Aeration tank (nitrification, denitrification)
- Membrane filtration
- Ozonisation
- Powdered activated carbon adsorption
- Sand filtration as post treatment
- Discharge sewer of treated water diameter 200 mm to Schwarzbach (creek)
- Additional facilities:
- Membrane cleaning tank
  - exhaust air treatment

Storm water project

Disconnection of paved areas from the sewer system 12.000 m²

Together with the disconnection a reshaping of the public Rhein-Elbe-Park was carried out in cooperation with the municipality of Gelsenkirchen, sewer works and a modification of the house and distribution system.

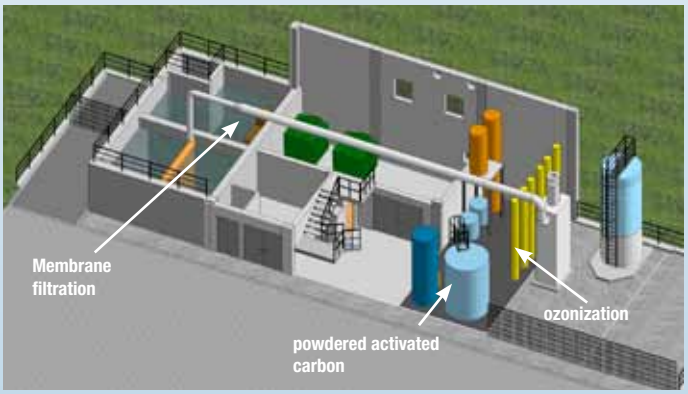
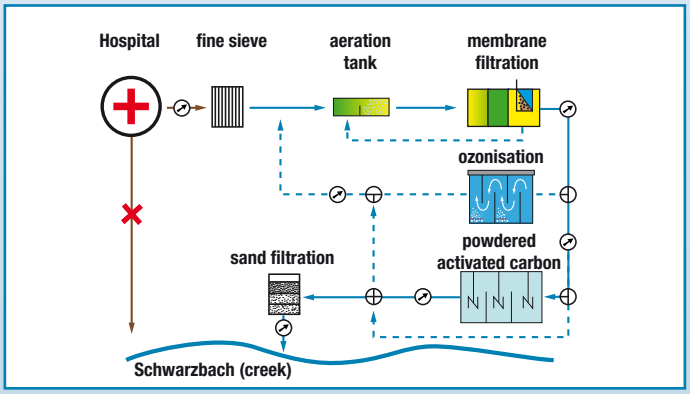


Illustration of the wastewater treatment plant



Flow chart

Impressum

Emschergenossenschaft
Kronprinzenstraße 24
45128 Essen

www.emschergenossenschaft.de

Additional information – in other languages, too – is available on the project web page www.pills-project.eu

Book the Date! The final conference of the PILLS project will be on September 19th/20th 2012 in Gelsenkirchen