Hospital wastewater in the Capital Region of Denmark

-discharges of pollutants and the need for solutions

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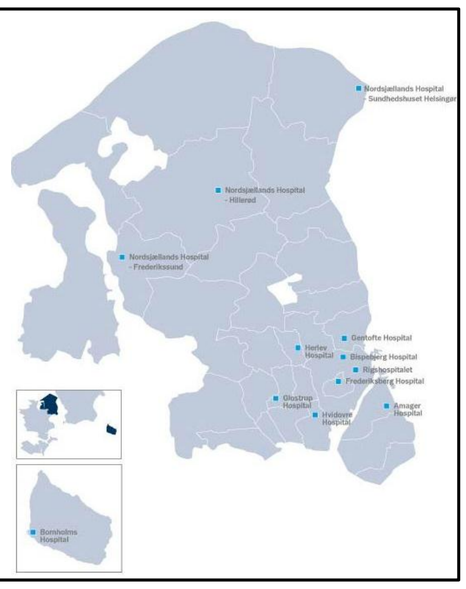
Hospital wastewater- is there a problem?

During recent years there has been increased focus on the emission of hospital wastewater due to the complex mix of chemicals, pharmaceuticals and microorganisms it contains. Although hospital wastewater is treated at municipal wastewater treatment plants, these are not designed to remove many of the pollutants in hospital wastewater, and harmful substances can therefore pass through the treatment plant and into the receiving water area. In Denmark, authorities, including the Minister of Environment, have also expressed concern and the need to regulate hospitals in the same manner as other industries. The region has responded proactively to the authorities' focus on hospital wastewater by initiating a thorough risk assessment of pharmaceutical and chemical discharges from the region's hospitals. Mapping of pharmaceutical and chemical consumption has been central to the investigation of the scale and impact of hospital wastewater discharges. Combined with a detailed understanding of wastewater generating activities, wastewater volumes and sewer pipe networks across hospital departments, it has been possible to define the risk posed by each individual hospital. Risk assessment has also identified the pharmaceuticals and chemicals that are environmentally critical and ultimately made it possible to identify possibilities for implementation of BAT (Best Available Technology). Figure 1 illustrates the region's activities leading to the identification of BAT.

The Capital Region of Denmark

The Capital Region of Denmark provides healthcare and regional development for 1.7 million people or approx. 30% of the population of Denmark, in addition to doing research. The Capital Region encompasses 12 hospitals as well as numerous psychiatric and other centres in and around Copenhagen, Northern Zealand and Bornholm. Being on the leading edge with regard to sustainability and the environment is a top priority for the Capital Region of Denmark.



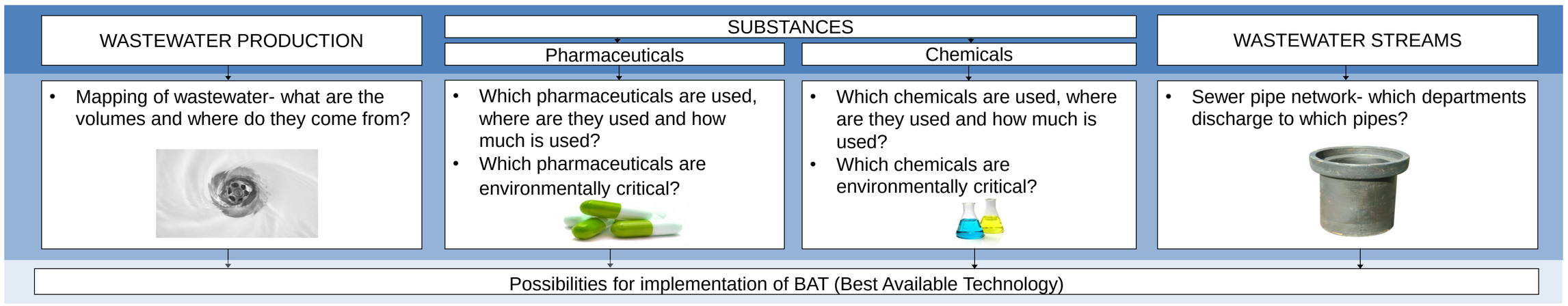


Figure 1- Overview of the region's work with hospital wastewater, from mapping to identification of solutions/BAT

Pharmaceuticals in hospital wastewater

Pharmaceuticals are specifically designed to have an effect on the human body. This, however, also means that they often have an effect on other living organisms, even at very low doses. While the effect of pharmaceuticals is desired in the patient they're used to treat, their effects are unwanted in the environment. Pharmaceuticals are to a large degree excreted by the human body, primarily via urine, and therefore end in wastewater.

The first step in the region's work with identifying possibly critical pharmaceuticals in hospital wastewater was to map pharmaceutical consumption based on registered pharmaceutical sales data. For calculation purposes pharmaceutical discharge was considered equal to consumption, based on the conservative assumption of 100 % excretion from patients. Based on consumption data it was possible to identify the pharmaceuticals, that each hospital was a point source for (point source defined as at least 2 % of the total discharge within the WWTP catchment area). This definition is important, since industrial wastewater regulation focuses on point sources of pollution and not on diffuse sources. Also, predicted concentrations in the water environment were calculated, which allowed for comparison with ecotoxicological no-effect limits and determination of which pharmaceuticals were environmentally critical. Figure 2 gives an overview of the method used to identify environmentally critical pharmaceuticals.

Chemicals in hospital wastewater

Hospitals consume a large amount of very different chemicals such as common cleaning agents, disinfection agents, lubricants, paints and specialised laboratory chemicals. Some chemicals don't enter wastewater while others do, and those that do can present a risk to the water environment.

The region has worked extensively to identify and quantify the consumption of the most hazardous chemicals at its hospitals. The very first step was to identify and list the chemicals used at the hospitals. The next step was to identify the chemicals that enter wastewater. The chemicals not entering the waste water were excluded in the further work. Thereafter, an assessment of the environmental hazardousness of the chemicals were carried out – using either environmental classification data or data on the chemicals' biodegradability at aerobic conditions, potential for bioaccumulation and ecotoxicity. Chemicals assessed as harmless or as being removed in wastewater treatment plants were excluded. For the remaining chemicals, consumed amounts were taken into account. Harmful chemicals consumed in environmentally significant amounts at the hospitals were then identified in a list of environmentally critical chemicals for each hospital. Figure 3 gives an overview of the method used to identify environmentally critical chemicals.

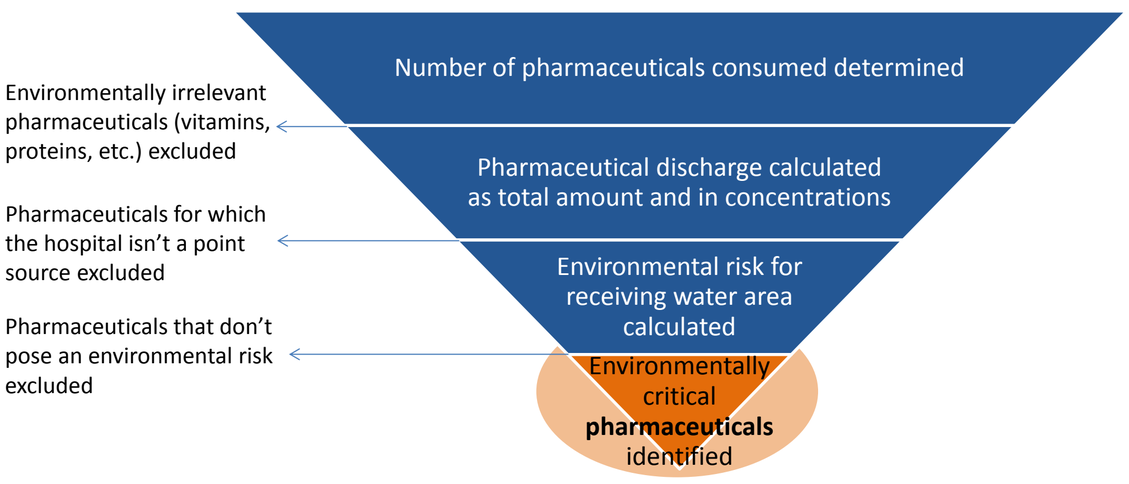


Figure 2- Method for identification of environmentally critical pharmaceuticals discharged via hospital wastewater

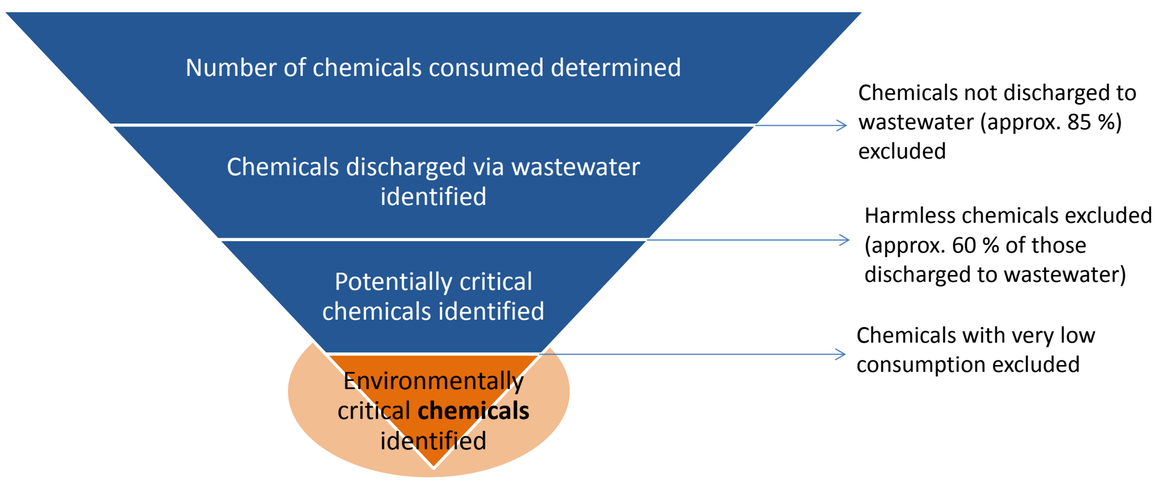


Figure 3- Method for identification of environmentally critical chemicals discharged via hospital wastewater

Substances in focus

Based on the region's mapping and risk assessments, it has been possible to get an overview of which substances are environmentally critical in receiving water areas. It was also shown that while many pharmaceuticals are used to a large extent in the domestic sector, some pharmaceuticals are used almost exclusively at hospitals (90-100 % of total consumption occurring at hospitals). This means that hospitals are important point sources for a number of specific pharmaceuticals. Environmentally critical chemicals (harmful and used in environmentally significant amounts) were also identified via mapping efforts.

Examples of environmentally critical **pharmaceuticals** identified include:

- *Antibiotics (ciprofloxacine, sulfamethoxazole)*
- *Cytostatic drugs (capecitabine, nilotinib)*
- *Psychiatric drugs (buprenorphine, duloxetine)*
- *Painkillers (diclofenac)*
- *Heart medication (amlodipine, propranolol)*

Examples of environmentally critical **chemicals** identified include:

- *Disinfectants (sodiumhypochlorite)*
- *Chelating agents (EDTA)*
- *Corrosion inhibitors (benzotriazole)*
- *Laboratory chemicals (hematoxylin)*

Solutions and technologies

Based on results of its own research and studies from across Europe pointing to the risks associated with hospital wastewater, the region is looking into an innovative solution where hospital wastewater is treated locally rather than at the centrally-located municipal treatment plant. The region has been involved in lab and pilot scale testing of different treatment technologies and is currently constructing a full scale test wastewater treatment plant at one of its hospitals (see Figure 4 for illustration). The development of a treatment solution has been an important aspect of the region's work together with the mapping and risk assessment activities. Among the region's goals is that hospital wastewater not pose any risks to receiving water bodies. Furthermore, the region's ambition is to reuse treated wastewater for technical and recreational purposes, transforming hospital wastewater from a problem to a resource. The region is also looking into other solutions/BAT including substitution/collection of specific substances.

***Lab and pilot scale** testing of wastewater treatment technologies for hospitals*

***Full scale** test wastewater treatment plant under construction at Herlev Hospital*

Figure 4- The region has worked to develop a treatment solution for hospital wastewater. First lab and pilot scale tests of different treatment technologies were conducted (pictured at left). The results have led to the design of the full scale test treatment plant currently under construction (pictured at right).