

Endocrine Disrupters as Emerging Contaminants in Wastewater

Endocrine disrupters are being discovered in wastewater across the nation. Scientists believe that these compounds may have detrimental effects on humans. This information brief explains endocrine disrupters, how they can affect animals and humans, where they are being discovered in wastewater, and how the issue may be addressed.

Endocrine Disrupters and Their Effects

The term “endocrine disrupters” generally means the synthetic chemicals and natural plant compounds that may affect the endocrine system—the communication system of glands, hormones, and cellular receptors that control the body’s internal functions. Many of these disrupters have been associated with developmental, reproductive, and other health problems in wildlife and laboratory animals.

Some medical and scientific experts suggest these compounds may affect humans in similar ways. Endocrine disrupters alter hormonal functions through several means:

- ▶ mimicking the sex steroid hormones estrogen and androgen by binding to hormone receptors, or influencing pathways
- ▶ blocking, preventing, and altering hormonal binding to hormone receptors, or influencing pathways

- ▶ altering production and breakdown of natural hormones
- ▶ modifying the making and function of hormone receptors

Endocrine Disrupters in Wastewater

The use and disposal of pharmaceuticals entering river and sewer systems can lead to endocrine disrupters. This may be related to the growing number of antibiotics, painkillers, and antidepressants in the population; prescription drug sales increased by an annual rate of 11 percent between 2000 and 2005.

The two largest sources of pharmaceuticals entering our wastewater treatment systems are from hospitals and homeowners. They enter the sanitary sewer primarily through excretion of partially metabolized pharmaceuticals by the human body, and the disposal of unused or expired medications down the drain or toilet.

Pharmaceuticals also enter surface waterways from the following sources:

- ▶ wastewater treatment plants that treat household, industrial, and business wastewater
- ▶ industrial wastewater discharges
- ▶ commercial animal feedlot operations
- ▶ surface application of manure and biosolids

Wastewater treatment plants are designed to remove conventional pollutants, such as suspended solids and biodegradable organic compounds, but they are not designed to remove low concentrations of synthetic pollutants, such as pharmaceuticals. A United States Geological Survey (USGS) monitoring study of waterways in 2002 found that 80 percent of the surveyed samples contained some pharmaceuticals, as well as fertilizers and flame-retardants.

The literature says pharmaceuticals probably have been in the environment for as long as we've been using them. They are being discovered now because analytical methodology has recently been developed that is sensitive at the parts-per-trillion level and lower. Increased detection has led to questions about risks to humans:

- ▶ What happens when organisms are exposed to multiple chemicals at the same time?
- ▶ What happens when chemicals bioconcentrate in living creatures or accumulate in sediment?

Some of the drugs in our waterways act upon more than one hormonal pathway. Some may end up in humans through multiple exposures (antibiotics through food and water); and exposure to mixtures of contaminants may lead to an adverse effect using one particular recipe. As medical doctor Marc Taylor of Connecticut has said in studying the issue, the problem is only going to

get worse as the population ages: “We’ll have to rely on the health of the fauna in our rivers to get hints about the consequences to people. The fish and amphibians are our canaries.”¹

The Situation in Minnesota

The Minnesota Pollution Control Agency (MPCA) has been working with the USGS since 2000 to investigate the significance, sources, and occurrence of compounds with endocrine-disrupting activity in Minnesota’s rivers and waste streams. Since 2004, both agencies also have an interagency agreement with a professor from St. Cloud State University to do further work.

The projects to date have helped identify the most common chemical compounds and the ones most likely to pose the highest risk to aquatic organisms through negative effects to reproduction and even increased mortality.

The interagency agreement is conducting the first longitudinal study in the United States, which will assess biological integrity and endocrine effects in four species of fish and chemical exposures at 40 locations along the Mississippi River from Bemidji to the Iowa border. The study will provide data on the extent of inter-sex along the river and by species of fish, along with links between abnormal physiology and chemical presence. (Inter-sex is an abnormal condition where testis have ovarian cells and structures.)

Work conducted by the USGS alone has shown that smallmouth bass in the Mississippi and other rivers can have a high occurrence of inter-sex. A current field study at a major metropolitan wastewater plant is examining effects in native fish species.

Waste pharmaceuticals in Minnesota may be classified as hazardous waste by either federal or state rules. The hazardous waste pharmaceuticals comprise up to 20 percent of all pharmaceuticals, but households are exempt from the classification. If a drug is not classified as hazardous, it is treated as infectious or biohazardous waste and is sterilized before landfill disposal.

Pharmaceuticals may be sewered in wastewater treatment plants under certain conditions, but this is not encouraged because the disposer has to undergo certain procedures before the pharmaceuticals are disposed of.

The generator of a waste has the responsibility to determine whether a waste is hazardous or not. However, for pharmaceuticals and other endocrine disrupters, wastewater treatment plants remove and treat only up to 50 percent of organic contaminants depending on the type and the treatment system. The remainder is passed through downstream.

¹ Elizabeth Royte, “Drugging Our Waters,” *OnEarth*, 28 (Fall 2006): 31.

Possible Future Initiatives

Initiatives to prevent contamination by endocrine disrupters can range from aggressive public education efforts to more costly regulation and enforcement. Many regulations on hazardous wastes and wastewater treatment systems have not been updated since the late 1970s, nor kept pace with the growing number of chemical compounds in the marketplace that should be watched for regulation. Health care providers often become confused about which pharmaceuticals may be hazardous or not, and how they should be disposed.

A strong public education program may be a way to alleviate concern over hazardous pharmaceuticals and also can be a tool to reduce the amount of medications that are flushed into the sewer system. Recommendations have included a labeling program like ones used to educate consumers about household pesticides. Some experts say the best approach is to remove toxic chemicals at the source rather than after disposal; take-back programs by the manufacturers of unused products would be a cost-effective solution.

Communities could add pharmaceuticals to their household hazardous waste collection programs, where consumers drop off the materials at designated sites once or twice a year. On the federal level, consumer and environmental organizations could encourage federal regulatory agencies to consider water quality impacts of toxic drugs as a regular component of their decision-making authority. State agencies could establish a more formal communication and recommendation process for pharmaceuticals between their hazardous waste and municipal wastewater managers. They also could discourage public wastewater treatment plants from approving any sewerage of pharmaceutical hazardous wastes that are known to be toxic.

Further Information

For more information about endocrine disruptors, see the following resources:

- ▶ Tom Arrandale, "Prozac in the Water," *Governing Magazine* 19: 12 (September 2006): 56-58.
- ▶ Gay Daly, "Hundreds of Man-Made Chemicals," *OnEarth* 27: 4 (Winter 2006): 20-27.
- ▶ David Ewing Duncan, "The Pollution Within: Our Toxic Homes," *National Geographic* 210: 4 (October 2006): 116-135.
- ▶ Minnesota Pollution Control Agency, "Healthcare, Hazardous Waste, and Wastewater," slide presentation (September 2006).
- ▶ Elizabeth Royte, "Drugging the Waters," *OnEarth* 28: 3 (Fall 2006): 26-31.

For more information about environmental protection, visit the environment and natural resources area of our web site, www.house.mn/hrd/issinfo/environ.htm.