

# Pharmaceuticals in Our Waters: An Emerging Concern

*By Scott Stoner*

Pharmaceuticals have almost certainly been in the state's and nation's waters since people began manufacturing and taking medicines. Along with personal care products, pharmaceuticals are just part of the universe of emerging contaminants that are attracting media and government attention.

As analytical methods improve, the environmental occurrence of a broadening range of pharmaceuticals and personal care products (PPCPs) has been acknowledged. Although much is yet to be understood about long-term, low-level exposure, a growing body of evidence suggests there are a variety of potential environmental and health effects. While pharmaceuticals are only one group of emerging contaminants, the potential risk they pose to human and aquatic life necessitates early action. As a precautionary measure, programs to divert pharmaceuticals from our wastewater stream are an essential part of the solution. In the longer term, improved methods of treating wastewaters will also be needed.

Of the approximately 30 million chemical compounds that have been identified to date; nearly half are commercially available. More and more are being added each year, yet only a tiny fraction are monitored or regulated. New York, a leader among states in water protection programs, has established ambient water quality standards for several hundred chemicals. New York State Department of Health (NYSDOH) drinking water standards have a 50 ppb limit for unspecified organic contaminants. PPCPs, however, are rarely tested for at the low levels that may be present in water and wastewater.

Pharmaceuticals are designed to have a biologic consequence. They are intended to cause some effect in the living organism. They may also be resistant to some forms of degradation, in order to retain their biological activity through manufacture, shipping, storage, and retail distribution. Significant portions of some drugs pass through the body unchanged, or are metabolized to a different biologically active substance. These substances may be excreted unchanged, conjugated, or metabolized, and enter municipal wastewater (i.e. sewage) treatment plants (WWTPs) not specifically designed to treat them. The removal efficiency of a WWTP will vary based on its treatment processes and the characteristics of the chemical in question.

Numerous studies have clearly demonstrated the occurrence of PPCPs in streams receiving WWTP effluents. These come from the myriad of individual consumers of medicines (both via drugs that pass through the body as well as flushing of unused or expired products) and from specific sources such as hospitals, nursing homes, and pharmaceutical manufacturing facilities.

PPCPs may also be detected in leachate from landfills that have received PPCPs for disposal and/or biosolids from a wastewater treatment plant. While modern landfills are designed to collect the leachate generated, the leachate is typically taken to a wastewater treatment plant where release of PPCPs could potentially occur.

The land application of biosolids is another potential pathway for PPCPs to enter the environment. In addition, the land application of animal manure may also contribute to PPCPs entering the environment from veterinary drugs used to treat farm animals, and cleaning agents

used at a farm. Septic tank effluent may also contain PPCPs which could be discharged to the environment through leachfields.

### **Potential Concerns for Human Health and Aquatic Life**

Although the human health effects of the *intended uses* of pharmaceuticals are well known, the effects on humans and aquatic life from these chemicals at low levels in water are not well characterized. The US Environmental Protection Agency has stated that, to date, scientists have found no evidence of adverse human health effects from PPCPs in the environment, but additional research is necessary.

#### *Human Health*

A number of health concerns (*e.g.*, microbial antibiotic resistance, endocrine disruption, psychotropic action) have been raised about the presence of pharmaceuticals in water bodies used as drinking water sources. The majority of environmental research has focused on testing of sewage treatment plant influent, effluent, receiving waterways downstream of agricultural and industrial facilities, and drinking water source waters. Very limited data are available for finished drinking water. Testing has looked at different classes of pharmaceuticals and at different representative compounds from various pharmaceutical classes. Not all compounds or pharmaceutical classes have been looked for, and the presence of some compounds at a single test point can vary with time and season. When detected, concentrations of pharmaceuticals in water are generally reported to be low -- in the nanogram to low microgram per liter range (part per trillion or part per billion, respectively).

In general, concentrations for all categories of pharmaceuticals detected in drinking water sources (parts per billion or parts per trillion) are well below levels associated with human health effects and there is very limited information on identities and levels of pharmaceuticals in finished drinking water. The scarcity of research regarding the prevalence and level of specific pharmaceuticals in finished drinking water makes assessment of the potential for human health effects from the presence of pharmaceuticals in water bodies used as drinking water sources uncertain.

#### *Aquatic Life*

The risk to aquatic life from PPCPs in water is perhaps of greater immediate concern than human health impacts. Fish, other aquatic animals, and invertebrates are exposed continuously to contaminants in water throughout their entire life, including sensitive, developmental life stages.

Some PPCPs with certain chemical characteristics (*i.e.*, low water solubility, lipophilic and resistant to biodegradation) might be bio-accumulated from very low concentrations in water to concentrations in fish tissue potentially capable of stimulating a biological response. PPCPs that are capable of mimicking hormones, known as endocrine-disruptors, are particularly problematic because hormone systems function at very low concentrations. Harmful impacts to fish reproduction have already been attributed to a variety of wastewater-derived contaminants, including PPCPs, pesticides, and industrial chemicals that mimic the hormone estrogen.

### **Specific Studies on Levels of Pharmaceuticals in New York State Waters**

The NYSDOH, in conjunction with the New York City Department of Environmental Protection, has conducted limited research in the NYC Watershed. The NYSDOH studies

indicated that although some target pharmaceuticals were consistently detected in WWTP effluent, they were not consistently detected in the reservoir system. When they were detected, the target pharmaceuticals were well below any levels that have been demonstrated to be associated with human health effects.

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