Rachel's Environment & Health News
#614 - Drugs In The Water
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A new class of water pollutants has been discovered during the past six years.[1] Pharmaceutical drugs given to people and to domestic animals --including antibiotics, hormones, strong pain killers, tranquilizers, and chemotherapy chemicals given to cancer patients --are being measured in surface water, in groundwater, and in drinking water at the tap. Large quantities of drugs are excreted by humans and domestic animals, and are distributed into the environment by flushing toilets and by spreading manure and sewage sludge onto and into soil.

German scientists report that anywhere from 30 to 60 drugs can be measured in a typical water sample, if anyone takes the time to do the proper analyses.[2] The concentrations of some drugs in water are comparable to the low parts-per-billion (ppb) levels at which pesticides are typically found.[1] To some people this is reassuring, but others are asking, "What is the long-term effect of drinking, day after day, a dilute cocktail of pesticides, antibiotics, pain killers, tranquilizers and chemotherapy agents?" Of course no one knows the answer to such a question --it is simply beyond the capabilities of science to sort out the many chemical interactions that could occur in such a complex chemical soup. The only solution to such a problem would be prevention.

The first study that detected drugs in sewage took place at the Big Blue River sewage treatment plant in Kansas City in 1976. The problem was duly recorded in scientific literature and then ignored for 15 years.[3] In 1992, researchers in Germany were looking for herbicides in water when they kept noticing a chemical they couldn't identify.[4] It turned out to be clofibric acid (CA), a drug used by many people in large quantities (1 to 2 grams per day) to reduce cholesterol levels in the blood.[1] Clofibric acid is 2-(4)-chlorophenoxy-2-methyl propionic acid, a close chemical cousin of the popular weed killer 2,4-D.[1] Based on that early discovery, the search for clofibric acid (CA) in the environment was stepped up.

Since 1992, researchers in Germany, Denmark and Sweden have been measuring CA and other drugs in rivers, lakes, and the North Sea. To everyone's surprise, it turns out that the entire North Sea contains measurable quantities of clofibric acid. Based on the volume of the Sea, which is 12.7 quadrillion gallons (1.27 x 10E16 gallons), and the average concentration of CA, which is 1 to 2 parts per trillion (ppt), researchers estimate that the Sea contains 48 to 96 tons of clofibric acid with 50 to 100 tons entering the Sea anew each year.[1] The Danube River in Germany and the Po River in Italy also contain measurable quantities of clofibric acid.[5,6] Of more immediate concern to humans is the finding that tap water in all parts of the city of Berlin contains clofibric acid at concentrations between 10 and 165 ppt.[5] The water supplies of other major cities remain to be tested.

As a result of this European work, a few U.S. researchers are now beginning to pay attention to drugs in the environment. Individual scientists within the U.S. Food and Drug Administration (FDA) have been concerned about this problem for a decade,[7] but so far FDA has taken the official position that excreted drugs are not a problem because the concentrations found in the environment are usually below one part per billion (ppb).[2]

Drugs are designed to have particular characteristics. For example, 30% of the drugs manufactured between 1992 and 1995 are lipophilic, meaning that they tend to dissolve in fat but not in water.[8] This gives them the ability to pass through cell membranes and act inside cells. Unfortunately, it also means that, once they are excreted into the environment, they enter food chains and concentrate as they move upward into larger predators. Many drugs are also designed to be persistent, so that they can retain their chemical structure long enough to do their therapeutic work. Unfortunately, after they are excreted, such drugs also tend to persist in the environment. A landfill used by the Jackson Naval Air Station in Florida contaminated groundwater with a plume of chemicals that has been moving slowly underground for more than 20 years. The drugs pentobarbital (a barbiturate), meprobamate (a tranquilizer sold as Equanil and Miltown) and phensuximide (an anticonvulsant) are still measurable in that groundwater plume. [8,pg.362]

When a human or an animal is given a drug, anywhere from 50% to 90% of it is excreted unchanged. The remainder is excreted in the form of metabolites --chemicals produced as byproducts of the body's interaction with the drug. Researchers report that some of the metabolites are more lipophilic and more persistent than the original drugs from which they were derived. Because of the complexity of the chemistry involved in drug metabolism, and the interactions of the metabolites with the natural environment, Danish researchers say is it "practically impossible to estimate predicted environmental concentrations (PEC) of any medical substances with available knowledge."[8,pg.385]

Yet U.S. regulatory policy for new drugs depends entirely upon estimating concentrations that might result from excretion. When a new drug is proposed for market, FDA requires the manufacturer to conduct a risk assessment that estimates the concentrations that will be found in the environment. If the risk assessment concludes that the concentration will be less than one part per billion, the drug is assumed to pose acceptable risks.[2] FDA has never turned down a proposed new drug based on estimated environmental concentrations, and no actual testing is conducted after a drug is marketed to see if the environmental concentration was estimated correctly.

German chemists have found that many drugs can be measured at environmental concentrations that exceed one ppb. And of course several drugs measured together can exceed one ppb. Furthermore, there is ample evidence from research conducted during the past decade showing that some chemicals have potent effects on wildlife at concentrations far below one ppb. For example estradiol, the female sex hormone (and a common water pollutant), can alter the sex characteristics of certain fish at concentrations of 20 ppt, which is 1/50 of one ppb.[2]

Another problem resulting from drugs in the environment is bacteria developing resistance to antibiotics. The general problem of antibiotic- resistant bacteria has been recognized for more than a decade. (See REHW #402.) Antibiotics are only useful to humans so long as bacteria do not become resistant to their effects. Hospital sewage systems discharge substantial quantities of antibiotics into the environment.[9] Bacteria exposed to antibiotics in sewage sludge, or water, have an opportunity to develop resistance. Janet Raloff of SCIENCE NEWS quotes Stuart Levy, who directs the Center for Adaptation Genetics and Drug Resistance at Tufts University in Boston, saying, "[T] hese antibiotics may be present at levels of consequence to bacteria -- levels that could not only alter the ecology of the environment but also give rise to antibiotic resistance."[2]

What can we learn from the emergence of this new problem?

1) Hospitals and the health care industry are the major sources of these problems, especially antibiotics and chemotherapy chemicals.[10] The large national coalition of environmental and health groups, Health Care Without Harm,[11] might consider tackling this difficult but important problem.

2) Sewage sludge provides a major pathway by which drugs enter the environment. Until the drug problem is understood and controlled, it provides a solid scientific rationale for labeling sewage sludge a dangerous soil amendment, the use of which should be forbidden.

3) For a long time, people have worried that the world was going to run out of natural resources. It is now apparent that we have run out places to throw things away. There is no place left where we can throw away exotic substances without affecting people or wildlife

(upon whose well being we ultimately depend).

From the viewpoint of disposal, not many decades ago the world still looked pretty empty. Today there can be no doubt that the world is full --full of people armed with double-edged technologies. To survive in a full world will require quite different attitudes. We need to curb our numbers. We need to curb our technologies. We need to curb our appetites. And we need to operate from a position of humility. We should assume that anything we do will have negative consequences on the rest of the planet. We must limit our technological interventions into nature long before we have definitive scientific proof of harm. This is the principle of precautionary action, and if we don't adopt it, nature will get along just fine without us.

--Peter Montague (National Writers Union, UAW Local 1981/AFL-CIO)

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[1] Hans-Rudolf Buser and Markus D. Muller, "Occurrence of the Pharmaceutical Drug Clofibric Acid and the Herbicide Mecoprop in Various Swiss Lakes and in the North Sea," ENVIRONMENTAL SCIENCE AND TECHNOLOGY Vol. 32, No. 1 (1998), pgs. 188-192.

[2] Janet Raloff, "Drugged Waters," SCIENCE NEWS Vol. 153, No. 12 (March 21, 1998), pgs. 187-189.

[3] C. Hignite and D.L. Azarnoff, "Drugs and drug metabolites as environmental contaminants: chlorophenoxyisobutyrate and salicyclic acid in sewage water effluent," LIFE SCIENCES Vol. 20, No. 2 (January 15, 1977), pgs. 337-341.

[4] H.J. Stan and Thomas Heberer, "Pharmaceuticals in the Aquatic Environment," ANALUSIS MAGAZINE Vol. 25, No. 7 (1997), pgs. M20-M23.

[5] Thomas Heberer and H.-J. Stan, "Determination of Clofibric Acid and N-(phenylsulfonyl)-Sarcosine in Sewage, River, and Drinking Water," INTERNATIONAL JOURNAL OF ENVIRONMENTAL ANALYTICAL CHEMISTRY Vol. 67 (1997), pgs. 113-124. And see: Thomas Heberer and others, "Detection of Drugs and Drug Metabolites in Ground Water Samples of a Drinking Water Treatment Plant," FRESENIUS ENVIRONMENTAL BULLETIN Vol. 6 (1997), pgs. 438-443.

[6] "Pille im Brunnen [Pills in the Fountain]," DER SPIEGEL No. 26 (June 24, 1996), pgs. 154-155, translated for us by Thea Lindauer, Annapolis, Maryland.

[7] Personal communication from Maurice Zeeman, U.S. Environmental Protection Agency, March, 1998.

[8] B. Halling-Sorensen and others, "Occurrence, Fate and Effects of Pharmaceutical Substances in the Environment --A Review," CHEMOSPHERE Vol. 36, No. 2 (1998), pgs. 357-393.

[9] Andreas Hartmann and others, "Identification of Fluoroquinone Antibiotics as the Main Source of umuC Genotoxicity in Native Hospital Wastewater," ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY Vol. 17, No. 3 (1998), pgs. 377-382.

[10] T. Steger-Hartmann and others, "Biological Degradation of Cyclophosphamide and Its Occurrence in Sewage Water," ECOTOXICOLOGY AND ENVIRONMENTAL SAFETY Vol. 36 (1997), pgs. 174-179.

[11] Contact: Charlotte Brody, Health Care Without Harm, c/o CCHW Center for Health, Environment and Justice, P.O. Box 6806, Falls Church, Virginia 22040. Phone (703) 237-2249. See www.noharm.org.

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