Drugs and Chemicals Straight from the Tap

Evidence is mounting that many of the poisons that are polluting our waterways, our water supplies and our bodies are sourced from pharmaceutical drugs and personal care products.

by Sherrill Sellman, ND © 2005

GetWell International
PO Box 690416
Tulsa, OK 74169-0416, USA
Email: golight@earthlink.net
Website: http://www.ssellman.com

PHARMACEUTICAL AND PERSONAL CARE POLLUTANTS (PPCPs)

Have you ever wondered what happens to the hundreds of millions of prescription drugs and over-the-counter medications that are swallowed daily throughout the world? Probably not! So, here's something to ponder as you're sipping your morning coffee or relaxing in your spa bath.

Up to 90 per cent of every drug that a person takes into their body is either excreted from the body totally unchanged or is broken down into an active metabolite before being flushed down the toilet and into the sewerage system, ultimately finding its way into the water supply. But there's one more step to this chain of events: this chemical potpourri eventually returns to us every time we turn on the kitchen faucet.

In addition to pharmaceutical drugs, there's another group of chemicals sneaking into the water supply. More than 10,500 chemical ingredients are used to manufacture what is collectively known as personal care products. These are products that most of us can't imagine living without: the moisturisers, cleansers, bubble baths, shampoos, fragrances, deodorants, mouthwashes, sunscreens, etc. It is now proven that vast numbers of these chemicals interfere with our endocrine, neurological, respiratory and immune systems.

This collection of chemical compounds is now officially known as Pharmaceutical and Personal Care Pollutants (PPCPs), a label which refers in general to any product consumed by individuals for personal health or cosmetic reasons. PPCPs comprise a broad, diverse array of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, fragrances, cosmetics, sunscreen agents, diagnostic agents, nutraceuticals, biopharmaceuticals and many others. Until recently, little if any thought had been given to the consequences from the staggering quantities of chemicals that are washed down the sink, flushed as human waste down the toilet or rinsed from our bodies into drains.

According to Dr Christian G. Daughton, EPA scientist and a leading researcher in the PPCP field, "the amount of pharmaceuticals and personal care products entering the environment annually is about equal to the amount of pesticides used each year".[1]

Many pharmaceutical and personal care products have persistent chemicals and compounds that remain biologically active even when they are disposed of in landfills and water systems. Hospitals, doctors' offices, veterinary clinics, farms, ranches and even the average home are major contributors to the PPCP overload. Other sources include unused medications, which are commonly flushed down the toilet, leaks from failing septic systems and discharges from wastewater treatment plants. It's indeed a most sobering thought to realise that our personal grooming habits as well as our reliance on pharmaceutical drugs may, however unwittingly, be contributing to a global PPCP problem.

It is reasonable to surmise that the occurrence of PPCPs in water supplies is not a new phenomenon; it's just that it remained unrecognised for decades. Current knowledge about PPCPs is due to remarkable advances in science that have enabled the detection of compounds in water at infinitesimal concentrations. These advances have finally piqued interest in the extent of the presence and persistence of PPCPs in water, as well as their effects on aquatic organisms and, most importantly, their possible effects on human health. The fact is, no one really knows how these chemical mixtures might be altering our health. But there are plenty of clues. Many chemicals are designed to profoundly affect human physiology. Dr Daughton warns that it wouldn't be surprising if they affected fish, birds, frogs and insects as well. However, unlike pesticides, these drugs—as well as shampoos, sunscreens and other personal care products—are not examined for

their effect on the environment before they're placed on the market. "This is surprising," Daughton says, "especially since certain pharmaceuticals are designed to modulate endocrine and immune systems." Hence, they have "obvious potential as endocrine disruptors in the environment".[2]

Even though it is now recognised that PPCPs have permeated sensitive ecosystems, very little research has ever been conducted on their potential effects. No municipal sewage treatment plants are engineered for PPCP removal. The risks posed to aquatic organisms (by continual life-long exposure) and to humans (by long-term consumption of minute quantities in drinking and bathing water) are essentially unknown.

While the major concerns to date have been with the promotion of pathogen resistance to antibiotics and the disruption of endocrine systems by natural and synthetic sex steroids, the consequences of many other PPCPs are unknown.

RECENT RESEARCH INTO THE PPCP PROBLEM

Many government officials are uneasy discussing these dangers, and so are the water utilities. In the USA, this is a new, emerging, environmental problem. Little is being done to limit drugs entering the water supply, and scientists are baffled not only by the scope of the problem and lack of effective water testing and purification systems but also by the paucity of research.

However, in Europe the response has been quite different. In the 1980s, the issue of PPCPs emerged as a serious area of investigation. A study in Germany, which has been at the forefront of this research, found PPCPs in treated and untreated sewage effluent, surface water, ground water and drinking water. Most commonly found were anti-inflammatory and pain-killing drugs, cholesterol-lowering drugs, anticonvulsants and hormones from oral contraceptives. Samples from 40 German rivers and streams turned up residues of 31 different PPCPs.[3]

A study by Thomas Heberer and Hans-Jurgen Stan of the Technical University in Berlin found significant amounts of antibiotics, ibuprofen, cholesterol-lowering drugs, hormones (oestrogen) and chemotherapy agents in Berlin's water supply, while Swiss researcher Hans-Rudolf Buser of the Swiss Federal Research Station in Wädenswil found cholesterol-lowering drugs in Swiss lakes. British scientists have estimated that more than a tonne of aspirin and a tonne of morphine derivatives flow down just one small river in northeast London every year.[4]

According to Bent Halling-Sorensen, professor of analytical chemistry at the Royal Danish School for Pharmaceuticals: "Between 30 and 90 per cent of an administered dose of most antibiotics to humans and animals is excreted with the urine." The problem is particularly acute in the fish-farming industry, where 70 to 80 per cent of drugs administered end up in the environment.[5]

The PPCP problem gained prominence in the United States in 2002, when results from the US Geological Survey's (USGS) sampling of 139 streams showed detectable, although minute, quantities of PPCPs targeted by researchers, the most frequent being steroids and nonprescription drugs. Antibiotics, prescription medications, detergents, fire retardants, pesticides and natural and synthetic hormones were also present.[6]

A BIRTH CONTROL PILL WITH YOUR COFFEE?

Synthetic oestrogen hormones are taken by millions of women worldwide as oral contraceptive control or hormone replacement therapy. Oestrogens are also prescribed to men for prostate cancer treatment. Both natural and synthetic oestrogens enter sewage treatment plants in large quantities; so do oestrogen-mimicking chemicals originating from the degradation of surfactants and plasticisers. Is it possible that steroid hormones could interfere with vulnerable hormonal receptors in living creatures? The jury is in…and the answer is "Yes!"

Results from a Canadian study provided concrete evidence of just what exposure to these chemicals portends. For three years, Canadian scientists added birth-control pills to a remote and pristine Ontario lake set aside for research to measure this impact. The result: all male fish in the lake—from tiny tadpoles to large trout—were "feminised", meaning they had egg proteins growing abnormally in their bodies.[7] This was an unmistakable sign of hormone disruption. Feminised male fish have now been found in rivers and streams throughout the world.

In river otters, frogs and other living aquatic populations, the effect is the same: the presence of female hormones is making the male species less male—much less male. For instance, in the US state of Washington, scientists have found that synthetic oestrogens are drastically reducing the fertility of male rainbow trout. Another source of hormone contamination comes from the cattle industry. Hormones are leaking into streams and ground water from the 30 million hormone-implanted cattle in US feedlots. The endocrine-disrupting effluent caused "significant alterations in the reproductive biology" of fish immediately downstream from a large Nebraska feedlot. The male fish had about one-third less testosterone and testes about half as big as unexposed fish upstream. The female fish had about two per cent less oestrogen and four per cent more testosterone than females from the uncontaminated section of the stream. In addition, lab tests confirmed that feedlot effluent contained a complex and potent mix of androgens (male sex hormones) and oestrogens (female hormones).[8]

Theo Colborn, senior scientist at the World Wildlife Fund (WWF) and co-author of *Our Stolen Future*, is very worried about pharmaceutical oestrogens mixing with chemicals already present in streams. "You can liken it to side effects of a prescription drug—you don't know how it's going to interact with the over-the-counter drugs you're taking. For example bisphenol A, a component of plastic, causes female mice to reach puberty earlier than normal. Bisphenol A forms a weak bond with the body's estrogen receptors. It can scramble a cell's natural communication system and cause it to replicate too quickly. That, in turn, raises concerns about breast cancer in women. What happens if this compound, which is active at low levels of exposure, combines with estrogen from a birth control pill in the water? At this point, it's still unclear." Colborn fears it "could have long-term health effects".[9]

Evidence is already mounting on the impact of hormone mimics on humans. Studies have found that the average Englishman produces only a third as much sperm as a hamster. Average sperm counts in men have dropped by more than half over the past 50 years—from about 160 million millilitres of semen to 66 million.[10] Could oestrogen-laced water contribute to sharply

falling human sperm counts? In Europe, researchers have tied a decline in sperm counts to levels of oestrogenic hormones in the environment.[11]

What about the effects on women and children? Unfortunately, the rising numbers of breast and uterine cancers, early puberty and hypospadias (a birth defect of the urethra and penis) reveal a most disturbing picture. It not difficult to imagine how unnatural exposure to potent oestrogen hormones as well as oestrogen mimics could be seriously and irrevocably altering critical hormonal signalling for adults as well as even more vulnerable infants and children.

ANTIBIOTICS: TOO MUCH OF A GOOD THING

The release of antibiotics into waterways is particularly worrisome. Scientists at the Centers for Disease Control found eight antibiotics in the aquatic environment: trimethoprim, sulfamethazine, sulfamethoxazole, sulfadimethoxine, erythromycin, roximthromycin, lincomycin and enrofloxacin.[12]

In addition, US farmers use 70 per cent of all the antibiotics produced as a prophylactic treatment as well as a growth promoter for their cows, pigs and chickens. A huge amount of antibiotics-infused manure eventually finds its way into waterways and ground water.[13]

Detection of antibiotics in drinking water is of particular concern. The presence of these chemicals in the environment can lead to the development of resistant bacterial strains, contributing to antibiotic resistance. Some of the antibiotics detected were Class 1 drugs (the type used when other antibiotics don't work).[14] Why is it that other antibiotics are less effective? No controversy there: general overprescribing and overdispensing of antibiotics by physicians and farmers.

A bacteria-phobic public now uses millions of pounds annually of triclosan, a broad-spectrum antimicrobial agent.[15] Triclosan is a derivative of the herbicide 2,4-D. It is the active ingredient found in thousands of products such as antibacterial soaps, deodorants, mouthwashes, sponges and household cleaners. Triclosan's popularity has contributed to the antibiotic resistance problem.

If triclosan-initiated antibiotic resistance weren't bad enough, researchers at the University of Minnesota found that when triclosan in water was exposed to sunlight, it converted into a dioxin. When first exposed to sunlight, triclosan becomes a mildly toxic chemical. The problem occurs when it becomes treated with chlorine at water treatment plants; it then breaks down to something even more potent.[16] What is particularly ironic is that the use of triclosan-treated products has never been proven to be superior to regular soap and water.[17]

DRINK YOUR PROZAC, CALL ME IN THE MORNING

An estimated 157 million prescriptions for antidepressants were dispensed in the US in 2002.[18] That's a lot of happy pills. The most popular kind is the selective serotonin reuptake inhibitors (SSRIs), which include Prozac, Zoloft, Luvox and Seroxat/Paxil.

In August 2004, major headlines in Britain announced that Prozac had been found in UK drinking water. Environmentalists described the situation as "hidden mass medication of the unsuspecting public". Since the UK, like the US, has no monitoring for levels of Prozac or other PPCPs, a serious public health crisis is brewing. In the UK, there has been a 166 per cent increase in antidepressant prescriptions since 1991—up to 24 million prescriptions a year. In fact, many countries around the world have had an exponential increase in the use of Prozac and other similar antidepressants.[19]

What might the drinking of Prozac-laced water portend? Animal studies offer some insights. Limited research shows that SSRIs elicit certain behaviours in shellfish. For example, bivalves' reproductive functions, including spawning, oocyte maturation and parturition, are regulated by serotonin. Researchers have found traces of Prozac and other antidepressants in the liver, muscle and brain of bluegill fish in Texas, as well as traces in people who don't take Prozac but do eat fish.[20]

Low-level exposure to fluoxetine, the active ingredient of Prozac, delays both development in fish and metamorphosis in frogs. The researchers strongly suspect that results implicate a disruption of thyroid function. "We know that the thyroid levels peak with metamorphic climax, when the legs and arms form and the tail resorbs. We believe that fluoxetine inhibits the thyroid, so we're measuring the thyroid hormone levels next."[21]

No one really knows what might be the effect when whole populations, including pregnant women and children, are getting traces of antidepressant drugs through their water supplies. It is known, however, that serious side effects of SSRIs include depression, insomnia, hallucinations, self-mutilating behaviour and violence. In fact, there are more questions about the possible side effects of PPCPs on humans and aquatic life than there are answers. It is a truly daunting task to assess the possible harmful effects of just one PPCP, much less the thousands that are in our water systems. And what might be the consequence of all those incalculable permutations of drug mixtures? It's all a big question mark.

WHERE DO WE GO FROM HERE?

The problem of this ubiquitous category of pharmaceutical and personal care pollutants has been clearly identified; the tricky part is what to do about it.

One most obvious action would be to choose non-toxic personal care products. They're better for your body and the environment. Reducing dependence on pharmaceutical drugs by using natural therapies is also another obvious step to take. Also, use the political process and make your feelings known at local, state and national levels. Support environmental organisations.

One practical solution to the flush problem would be a pharmaceutical take-back program, like those implemented in several European countries and in Australia and Canada. Maine, USA, recently legislated the creation of a drug mail-back program in which people are given envelopes they can use to send their unused drugs to the Drug Enforcement Administration. However, for the rest of the US, the solution is quite complex since there is neither a cohesive set of regulations nor guidance for unused drugs.

The addition of even more pharmaceutical drugs is looming in the near future. Presently, drug companies target about 500 known biochemical receptors in the human body. That number is soon expected to jump as much as 20-fold—to 10,000 targets. Dr

Daughton raises a disturbing thought. "The enormous array of pharmaceuticals will continue to diversify and grow as the human genome is mapped. This is adding exponentially to the already large array of chemical classes, each with distinct modes of biochemical action, many of which are poorly understood."

What about water sewage plants? According to Bill Turner, New Mexico's natural resources trustee: "It is a well-established fact that conventional sewage treatment technologies do not completely remove drug and chemical residues. Other methods, such as activated carbon filtration or treatment with ultraviolet light, likely would remove the drugs but could be costly."[22]

Reverse osmosis also removes many of the large-molecule PPCPs, but it is expensive for municipal treatment facilities. However, there is still a waste disposal issue: the used membranes themselves and a leftover stream of dirty water. Other options might include UV or ozone treatment, both of which are less costly than reverse osmosis. However, both UV and ozone treatments tend to create numerous oxidation products, thereby increasing the number of chemicals present.

So, if we can't rely on the municipal water treatment systems, it's really up to each person to find solutions. It's obvious that homes, restaurants, hospitals, schools and businesses must realise the importance of providing water that's not only free of pesticides and heavy metals but also PPCPs.

It has been shown that the most effective water purification system for removing all these contaminants, including PPCPs, is an activated carbon filtration system. Units are available which can filter your tap water, but it would be far wiser to install a whole home unit. Since the skin absorbs chemicals 600 times more effectively than through ingestion, all bathing water as well as drinking water should be adequately filtered. Make sure that, in the USA, the Water Quality Association (WQA) has accredited the system you select. To help people choose quality water treatment products, the WQA developed its Gold Seal Certification Program. The Gold Seal mark is internationally recognised as a symbol of quality and integrity. Investing in a high-quality whole-house water system using an activated carbon filtration method which purifies all the water used in your home, i.e., drinking, bathing and washing, would be your best line of defence. At the very least, use an activated carbon filtered system for all your drinking water.

The day may come when pharmaceutical and chemical companies will take responsibility for the life cycle of their products, when the government will enact protective regulations for PPCPs, and when new sewage treatment technologies will be developed and installed. But for right now, it seems that we're on our own.

In a world of connectedness, we are again painfully reminded that nothing we do exists in isolation. Our most ordinary choices, in this case the drugs we ingest and the personal care products we use, may have lifelong consequences not just for us but also for all the unsuspecting people and wildlife living downstream. Remember, everyone lives downstream from someone. ∞

About the Author

Sherrill Sellman, ND, author of the best-selling books *Hormone Heresy: What Women MUST Know About Their Hormones* (GetWell International, 1996, 2001 4th ed.) and *MOTHERS: Prevent Your Daughters From Getting Breast Cancer* (GetWell International, 2003), is an international lecturer and psychotherapist. She has contributed numerous articles to NEXUS, most recently "The Problem of Precocious Puberty" in 11/03. Sherrill can be contacted by phone on +1 (877) 215 1721 or by email at golight@earthlink.net. Her free monthly *HormoneWise* e-Digest is available at http://www.ssellman.com.

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