



Good Chemistry for Swimmers

By Bob G. Vincent



Swimming pools are amazing venues for recreation and exercise. They are also reservoirs of all the substances swimmers introduce into them. In addition to the substances that swimmers apply to themselves while at the pool, the average swimmer adds low levels of personal care products like deodorant, skin lotions, sprays and makeup, especially if they fail to shower before entering the pool. Additionally, according to a [2009 Water Quality & Health Council survey](#), one in five adult Americans admits to having “peed in the pool,” introducing not only urine,

but potentially low levels of caffeine and pharmaceuticals. It is estimated that the average swimmer also introduces trace amounts of fecal matter into the pool. Add to this mix needed disinfectants (see: *fecal matter* reference), and you have all the makings of a chemistry experiment in a large “bath tub.”

A [recent publication by Weng et al.](#)¹ in the new *Environmental Science and Technology Letters* provides a glimpse into a new effort to detect pharmaceuticals and personal care products (PPCPs) in swimming pools. This article provides some of their insights and conclusions.

Step 1: Field Experiments

The researchers sampled three chlorinated swimming pools: one located in Georgia and two in Indiana. Of 32 substances tested for, only three are reported as detected. In the first round of sampling the researchers detected only the insect repellent DEET. DEET, caffeine and the flame retardant TCEP were detected in the second round of sampling —most at low part per trillion levels. A part per trillion is equivalent to one drop of detergent in enough

Pharmaceuticals in the Environment

The US Geologic Survey has documented the occurrence of pharmaceuticals, hormones and other organic wastewater contaminants in ground and surface waters of the US. [USGS reports](#) generally very low concentrations (less than one part per billion) in streams. The [USGS determined](#) stream contaminants may be transported into adjacent shallow groundwater, which could be tapped through water supply wells. [Weng et al.](#) note that most water treatment facilities have not been designed to remove or degrade PPCPs.

¹ Weng, S.C., Sun, P., Ben, W., Huang, C, Lee, L. and Blatchley, E.R. (2014). “The presence of pharmaceuticals and personal care products in swimming pools,” *Environmental Science & Technology Letters*, 1, 495-498.

dishwater to fill a string of railroad tank cars 10 miles long.² The highest DEET levels were found during the summer in the pool located in Georgia, the southernmost geographic location (2 parts per billion; a part per billion is equivalent to a pinch of salt in 10 tons of potato chips³). DEET is likely introduced into pools on the bodies of swimmers who use insect repellent.

One of the two pools in Indiana supplemented chlorination treatment with UV treatment within the timeline of sample collection. Because the investigators found DEET both before and after UV treatment, they concluded that DEET degradation is slow and not promoted by supplemental UV treatment. Caffeine, they suggest, probably enters via swimmer urine and perspiration. The researchers point out that about 97 percent of caffeine is metabolized by the body, with only about three percent of the amount ingested excreted unchanged. The fact that it was found in pool water, therefore, is a testimony to the popularity of coffee, tea and other caffeinated drinks.

It is unclear, according to the author, how the flame retardant TCEP enters pool water.

Step 2: Bench-scale Experiments

“Field experiments” were followed by “bench-scale” experiments in the laboratory to determine how PPCPs react with disinfectants. The researchers examined the fate of five compounds they identified as being the most likely to accumulate in pools: naproxen, ibuprofen, caffeine, DEET and acetaminophen. In the experiments, two of them, naproxen and acetaminophen degraded within six hours of exposure to chlorine, which is consistent with their absence in the field tests⁴. Caffeine, ibuprofen and DEET, however, reacted much more slowly, with 80 percent of these substances still present after 24 hours. Whereas a slow degradation rate is consistent with the presence of DEET in the field samples, the researchers speculate that the absence of ibuprofen and caffeine could be related to the fact that they were introduced via urine after degradation through human metabolism, rather than simply washed from the skin, as in the case of DEET.

Keeping Swimming Healthy

So far, researchers have only “dipped their toes” into the swimming pool of PPCP research and much more work needs to be done. It is important to remember that levels of PPCPs in pools are very, very low and only detectable because scientists today have powerful analytical tools at their disposal. The known benefits of swimming, including exercise and social interaction, far outweigh any potential risks due to exposure to low levels of contaminants. But as scientists continue to probe the chemistry of swimming pool water, one thing is becoming clear: Swimmers contribute to overall pool chemistry

² From: “Understanding Risk,” online. Available: http://www.analysisonline.org/site/aoarticle_display.asp?sec_id=140002434&news_id=140002554&issue_id=5&pg=26

³ See: Zane Satterfield, “What does ppm or ppb mean?” Available: <http://www.nesc.wvu.edu/ndwc/articles/ot/fa04/q&a.pdf>

⁴ The researchers note that the disinfection byproducts that may have been produced by chlorine-susceptible PPCPs were not the subject of their interest.

through their hygiene practices, and can play a role in minimizing the presence of contaminants in the pool. Please share these tips with the swimmers in your life:

- Take a cleansing shower before swimming to remove perspiration, trace fecal matter, makeup, perfumes, deodorant and lotions
- Use the pool deck shower between pool uses
- Don't pee in the pool
- Stay out of the water when experiencing diarrhea
- Observe all rules concerning swim diapers and diaper changing
- Teach children that the pool water is not drinking water

Bob G. Vincent is an Environmental Administrator in the Florida Department of Health. He manages Department of Health programs for Healthy Marine Beaches, Safe Drinking Water, Water Well Surveillance and Public Pools and Bathing Places.