Pharmaceuticals, personal care products could taint swimming pools

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Credit: Wikipedia.

A new study suggests pharmaceuticals and chemicals from personal care products end up in swimming pools, possibly interacting with chlorine to produce disinfection byproducts with unknown properties and health effects.

Chlorination is used primarily to prevent pathogenic microorganisms from growing. Previous research has shown that many constituents of urine including urea, uric acid, and amino acids, interact with chlorine to produce potentially hazardous disinfection byproducts in swimming pools. However, chemicals from pharmaceuticals and personal care products, or PPCPs, also could be interacting with chlorine, producing potentially harmful byproducts.

"The whole motivation for examining pharmaceuticals and personal care products is that there is this unknown potential for them to bring about undesired or unexpected effects in an exposed population," said Ernest R. Blatchley III, a professor with a joint appointment in the Lyles School of Civil Engineering and the Division of Environmental and Ecological Engineering at Purdue University. "There are literally thousands of chemicals from pharmaceuticals and personal care products that could be getting into swimming pool water."

A research group led by Ching-Hua Huang, a professor in the School of Civil and Environmental Engineering at the Georgia Institute of Technology, has developed an analytical technique that identifies and quantifies 32 pharmaceuticals and personal care products in water.

"Because professor Huang had already developed an analytical method, which is a non-trivial effort, we thought, 'Why not use it and see what we find in swimming pools?" said Blatchley, working with Huang and former Purdue doctoral student ShihChi Weng, now a postdoctoral fellow at Johns Hopkins University. Water samples were taken from indoor swimming pools in Indiana and Georgia.

Findings are detailed in a research paper that appeared in December in the journal *Environmental Science and Technology* Letters. Of the 32 chemicals investigated, the researchers detected three: N,N-diethyl-m-toluamide, known as DEET, the active ingredient in insect repellants;

caffeine; and tri(2-chloroethyl)-phosphate (TCEP), a flame retardant.

"The other 29 could have been present at concentrations below the detection level," Blatchley said. "And because there are literally thousands of pharmaceuticals, this is just a small subset of compounds that could be present in swimming pools. The main issue is that the release of chemicals into a place like a swimming pool is completely uncontrolled and unknown. I don't want to be an alarmist. We haven't discovered anything that would be cause for alarm right now, but the bottom line is we just don't know."

Some chemicals are volatile, which means they can escape into the air to be inhaled. Others can be ingested or absorbed through the skin.

"Swimmers are exposed to chemicals through three different routes: You can inhale, you can ingest and it can go through your skin. So the exposure you receive in a swimming pool setting is potentially much more extensive than the exposure you would receive by just one route alone," Blatchley said.

His previous research has shown that certain airborne contaminants are created when chlorine reacts with sweat and urine in indoor swimming pools. Pharmaceuticals may get into swimming pool water from personal care products applied to the skin such as insect repellant, makeup and sunscreen. Many pharmaceuticals that are ingested are not fully metabolized by the body and are excreted in sweat and urine.

"Urine, I think, is really the primary mode of introduction," Blatchley said. "When it comes to pharmaceuticals, these are chemicals designed to be biologically active at pretty low concentrations. Birth control pills, for example, contain hormones. If those chemicals and others are present, especially in a mixture in a water sample that humans are going to be exposed to, then what are the consequences of that? That is a

largely unanswered question."

The findings also suggest the potential for accumulation of topically applied PPCP compounds in pools.

"Not surprisingly, the concentration of DEET was much higher in Georgia than in Indiana," he said. "Generally, the results of this study point to the importance of proper hygiene habits of swimmers."

The detection method uses techniques called liquid chromatography and tandem mass spectroscopy.

"We also performed experiments in the lab under much more controlled conditions where we took pure compounds of these PPCPs and we exposed them to chlorine to see how fast they react," Blatchley said. "It turns out some react very quickly and others very slowly or not at all. We did that because we are interested not only in the chemicals that may end up in the swimming pool, but also, once they do end up there, what happens to them? Do they degrade? If so, what do they degrade to? These too are unanswered questions."

The research paper was authored by Weng; Georgia Tech doctoral student Peizhe Sun; Weiwei Ben, a visiting scholar at Georgia Tech from the Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences; Huang; Purdue graduate student Lester T. Lee; and Blatchley.

According to the federal Centers for Disease Control and Prevention, recreational water illnesses (RWIs) are caused by germs spread by swallowing, breathing in mists or aerosols, or having contact with contaminated water. RWIs also can be caused by chemicals in the water or chemicals that evaporate from the water and cause indoor air quality problems. A wide variety of RWI infections include gastrointestinal,

skin, ear, respiratory, eye, neurologic, and wound-related. The most commonly reported RWI is diarrhea.

The research is ongoing.

"What we are planning to do is look at, for example, sales statistics for pharmaceuticals and personal care products to see which ones of these various compounds are sold in the largest quantities and then to consider their structure and which of them could accumulate in a swimming pool and might react with chlorine to produce other compounds," he said.

In the previous research led by Blatchley, it was shown that uric acid in urine generates potentially hazardous "volatile disinfection byproducts" in swimming pools by interacting with chlorine. The disinfection byproducts include cyanogen chloride (CNCl) and trichloramine (NCl_3). Cyanogen chloride is a toxic compound that affects many organs, including the lungs, heart and central nervous system by inhalation. Trichloramine has been associated with acute lung injury in accidental, occupational, or recreational exposures to chlorine-based disinfectants.

The previous research suggested that about 93 percent of uric acid introduced to pools comes from human urine.

More information: "The Presence of Pharmaceuticals and Personal Care Products in Swimming Pools" *Environ. Sci. Technol. Lett.*, 2014, 1 (12), pp 495–498 DOI: 10.1021/ez5003133

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