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Not Entirely Clear

In Virginia, Water Chlorination Is Blamed for Miscarriages. Below the Surface, the Science on the Issue Is Murky

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Chlorine is a near-perfect disinfectant, most health experts agree, killing deadly bacteria and other tiny organisms in the water supply cheaply and effectively and saving hundreds of thousands of lives annually in the United States.

The Centers for Disease Control and Prevention (CDC), in fact, ranks chlorinated water among the greatest public health achievements of the 20th century, right up there with penicillin and vaccines. Thanks to chlorine treatment, the chronic outbreaks of cholera and dysentery that plagued crowded American cities through the 18th and 19th centuries are gone.

Ah, if only chlorine didn't cause cancer – and now, maybe, miscarriages. Plaintiffs in a high-profile Virginia lawsuit claim a byproduct of chlorination has caused some women in their community to have miscarriages.

While the benefits of chlorination are beyond debate, the science regarding its potential harms is inconclusive.

Chlorine reacts with organic material in the water supply – dead leaves, vegetation, farm runoff – to produce chemicals called trihalomethanes (THM), some of which cause cancer in laboratory animals exposed to extremely high doses. Based on years of animal and human studies suggesting, but not establishing, a causal relationship between THMs and cancer, the Environmental Protection Agency (EPA) suspects that THMs in tap water cause a small number of bladder cancers in humans. As a result, the EPA set a limit for THM concentrations in 1979 at 100 parts per billion (ppb). It lowered this to 80 ppb, effective January 2002.

THMs' effect on pregnancy is far less certain, according to the EPA. A billion-dollar class action lawsuit has been filed in Chesapeake, Va., where residents fear that drinking tap water led to miscarriages in the 1980s and 1990s. So far, animal studies have shown only that high doses of THMs can cause birth defects, not miscarriages. And in human studies, "the direct evidence is quite weak now," said David Savitz, who chairs the Epidemiology Department at the University of North Carolina (UNC) School of Public Health in Chapel Hill.

Savitz, who has studied this issue for over a decade, has recently embarked on the largest study to date of THMs' possible link to miscarriage. The

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project, due to be completed in 2005, is being funded by the American Water Works Association, whose members include major utility companies.

Complicating this research, Savitz said, are the facts that even routine miscarriage rates are hard to quantify and that estimating direct exposure to THMs is extremely complex.

No Chlorine: A Bad Thing

It is sparklingly clear to health experts that an absence of chlorine in the water is a bad thing. The World Health Organization estimates that 25,000 children die daily worldwide from illnesses associated with contaminated drinking water.

Cholera was absent from the Americas for nearly a century until an outbreak occurred in Peru in 1991 and spread to neighboring countries. More than 4,000 people died that year, 6,000 more have died since then and the threat of cholera lingers, according to the Pan American Health Organization.

"There's no question that a lack of chlorine allowed cholera to spread in Peru," said R. Bradley Sack, a professor at the Bloomberg School of Public Health at Johns Hopkins University. The outbreak was the result of a gradual breakdown of Peru's water quality control during the prior decade, he said.

The Science of Miscarriage

Only in developed nations, where cholera and dysentery are virtually nonexistent, have the possibly deleterious effects of chlorination become a health issue. The trick is finding a balance between the deadly effects of too little chlorine in the water and the possible long-term effects of too much.

The primary studies showing a relationship between tap water and miscarriages were conducted in California in the 1990s. The researchers found that, in one of the three counties studied, women who drank tap water were at least twice as likely to experience miscarriages as those who drank bottled water. (There was no disparity between tap and bottle drinkers in the other two counties.)

The two lead researchers, Shanna Swan, now a research scientist at the University of Missouri, Columbia, and Kirsten Waller, now a senior scientist with the Sequoia Foundation in La Jolla, Calif., theorized that something in the water supply of that one county was responsible for the higher rate of miscarriages. Their follow-up study, published in 1998, found that women who drank five or more glasses of tap water daily in communities where the level of THMs in the water supply averaged above 75 ppb were about 65 percent more likely to experience miscarriages than women who drank less of that water or who used a different water source. A THM called bromodichloromethane, the researchers suggested, was a possible culprit.

Similar studies have not found such a link. In research conducted in the early 1990s, Savitz and his colleagues at UNC found that the source of a woman's drinking water and the levels of THMs in that water did not increase the miscarriage rate, and, conversely, that the more water women drank, the lower their risk of premature delivery or delivering a low-birth-weight baby.

Savitz noted, however, that communities with THM levels above 100 ppb may have experienced a slightly higher rate of miscarriages. This possibility, coupled with the California findings, is prompting his large-scale study.

One factor that will need to be addressed, Savitz said, is how to measure THM exposure.

"Annual utility-wide averages allow for huge variation in levels over the years and across the utility," Swan said. For example, THM levels may spike above 100 ppb during the summer because of proliferating aquatic grasses and other organic materials in reservoirs. But there are no scientific data, even in rats, showing danger from these brief peaks.

Then there's the shower issue. Michele Lynberg, an epidemiologist with the CDC, said that in addition to swallowing water with THMs, people absorb significant amounts through the skin: during showers, in the kitchen when boiling water, swimming in a chlorinated pool. So switching from tap water to bottled water for drinking may not significantly reduce your exposure. One CDC-funded study found that people had higher levels of THMs in their blood after taking a 10-minute shower than after drinking a liter (about four glasses) of tap water.

Further Complications

The difficulty of establishing a normal rate of miscarriage also complicates matters. While about 25 percent of all confirmed pregnancies result in miscarriages, many more occur before a woman realizes she is pregnant. Some experts have estimated that 50 percent of all fertilized eggs are excreted within days of conception. Factors proven to increase the risk of miscarriages include smoking, alcohol and drug use, multiple sexual partners, previous contraceptive use and age. The additional effect that THM exposure might have is therefore difficult to determine, Savitz said.

In the case of Chesapeake, a city of about 200,000 in the Hampton Roads area, the community was never out of EPA compliance for THMs, according to health officials there: Levels sometimes rose above 100 ppb but not on average for a whole year. THM concentrations now average 40 ppb, said Nancy Welsh, director of the Chesapeake Public Health Department.

Likewise, the major water facilities serving the Washington area all report being in compliance with the EPA standards, with their THM averages for 2001 below the new limit of 80 ppb.

Chesapeake's low levels of THMs are largely the result of its new reverse-osmosis water treatment process, which removes organic material from the water supply. But the process is too costly for many cash-strapped municipalities and not always practical for the largest systems. Other methods for reducing THMs include lowering chlorine levels, which raises the risk of water-borne diseases, and disinfecting the water supply with ozone or a combination of chlorine plus ammonia. Yet even these measures are not perfect.

"We are finding more and more that alternative disinfectants may also have negative impacts" on health, said Philip Singer, director of the UNC's Drinking Water Research Center. Ozone, for example, creates its own

harmful byproducts and it is less effective at killing microbes.

Any movement away from chlorine will need to be undertaken carefully, the EPA warns – at the risk, so to speak, of throwing out the baby with the bath water.

Christopher Wanjek last wrote for the Health section about anti-aging scams.

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