

H2Uh-Oh: Do You Need to Filter Your Water?

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“The quality of drinking water in the United States is among the best in the world,” says University of Arizona water-safety expert Kelly Reynolds. “However, outbreaks of disease from drinking water do still occur and can lead to serious or sometimes fatal health consequences.”

Sometimes bacteria are the culprit. Sometimes it’s viruses. Sometimes it’s parasites. Then there are the thousands of drugs and household and industrial chemicals—most of them unregulated—that wind up in the rivers, streams, reservoirs and underground springs that provide our drinking water.

What’s a drinker to do?

“For years, people said that America has the cleanest drinking water in the world,” William K. Reilly, the Environmental Protection Agency’s administrator under President George H. W. Bush, told *The New York Times* last year.

“That was true 20 years ago. But people don’t realize how many new chemicals have emerged and how much more pollution has occurred. If they did, we would see very different attitudes.”

Part of the problem: “The regulatory system is, frankly, slow to respond to emerging threats to water safety,” says Shane Snyder, a water-contaminant expert and professor of environmental engineering at the University of Arizona.

Here’s some of what may be lurking in your tap water...and why you may not be able to rely on your local water utility to keep you safe.

Germs

“We estimate that 19.5 million illnesses occur each year in the United States that are caused by microorganisms in drinking water,” says University of Arizona microbiologist Kelly Reynolds. Particularly vulnerable are older adults, young children and people with weakened immune systems.

The culprits: viruses (primarily Norovirus), bacteria (like *Campylobacter*, *E. coli*, and *Shigella*) and cysts that are produced by protozoa like *Cryptosporidium* and *Giardia*. They can cause diarrhea, headaches, and, in rare cases, chronic conditions like reactive arthritis.

How do germs get into drinking water?

- Contaminated surface water. About two-thirds of Americans get their water from surface water sources like reservoirs, lakes and rivers. “And all surface waters, no matter how pristine, contain waterborne pathogens from birds and animals, such as *Campylobacter* and *Salmonella*,” notes Reynolds.

Surface water can also harbor gastrointestinal germs that are flushed down the toilet by humans when they’re sick. How do they get into waterways? Blame it, at least in part, on the weather.

The water systems that serve some 40 million Americans—often older systems in the Northeast, the Great Lakes region and the Pacific Northwest—carry sewage and storm water in the same pipes. When water from heavy or sustained rains overloads a system, the overflow—wastewater along with rainwater—is discharged into rivers and creeks to prevent it from backing up.

At least 40,000 sewage overflows occur each year in the United States. And that wastewater could become your drinking water after it’s been treated by your local water utility. Since treatment plants can’t eliminate 100 percent of the germs, some can get through to your tap.

Climate change will likely add to the stress on water utilities in the Northeast and Midwest if, as predicted, it results in more and heavier precipitation there. Researchers at Johns Hopkins University in Baltimore found that heavy downpours preceded half of the 548 reported waterborne disease outbreaks in the United States from 1948 to 1994.⁽¹⁾

- Contaminated groundwater. “Historically, groundwater supplies were thought to be free of disease-causing microorganisms because the soil naturally filters them out,” says Reynolds. But viruses and other microbes from contaminated septic tanks, landfill leaks, or inadequate disposal of animal waste or wastewater can end up in water beneath the surface.

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The Environmental Protection Agency now requires utilities to disinfect groundwater that has a history of contamination.

Leaks in the distribution pipes.

Disease-causing microorganisms can also get into drinking water after it leaves the treatment plant. About a quarter of the nation's water distribution pipes are in poor condition, with leaks, cracks and corrosion. On average, a city loses 18 to 44 percent of its water from leaking pipes, notes Yale University microbiologist Stephen Edberg.

Those pipes are often buried in the same trenches as sewer pipes. Changes in water pressure can allow contaminants in the soil to be sucked into the water pipes, fouling the drinking water.

"The proportion of disease outbreaks linked to breaches in the water distribution has increased over the past decade," says Reynolds, "and it's going to be a continuing problem."

- *Plumbing.* In 2004, University of Arizona researchers measured bacteria in the tap water of seven Tucson homes. The EPA limits the amount of these bacteria—which in most cases are harmless—to no more than 500 per milliliter of drinking water. Tucson's public water averaged only about 50, so it was relatively clean.

Not so in most of the homes. Water from kitchen and bathroom faucets in the seven houses averaged more than 3,000 bacteria per milliliter. Levels varied among homes (one had virtually none, while another had 13,000 bacteria), and from day to day within the same house. Bathroom tap water in two homes averaged 2,400 bacteria first thing in the morning, then dropped to 140 after running the water for 30 seconds.⁽²⁾

Where do the bacteria come from?

"If you have pets that lick the faucet, or children with dirty hands who play with the faucet, or if you handle raw meats and then touch the faucet, bacteria can enter the pipes and grow," says Reynolds. "They get backwashed into the pipes, where they can form a layer, or biofilm."

Another potential source of bacteria is stagnant water sitting in pipes. "Maybe you're on vacation or maybe you have a second home," says Reynolds. "Bacteria can grow in pipes while you're gone, and then you can get a big dose when the water is turned back on again."

The antidote: "Flush out the system by letting the water run until it's as cold as it gets," suggests Reynolds. "That will certainly rinse out bacteria that haven't established a biofilm on the inside of the pipes."

If a bacteria biofilm has developed, it could loosen over time as the water faucet is used, says Reynolds, "and a chunk can break off and you can suddenly get exposed to a big dose of bacteria. It could be a significant health risk."

What to Do

Use a filter that has been certified for microbiological purification by the Water Quality Association (WQA), NSF International or Underwriters Laboratories (UL).

Lead

It's clear that lead can damage the brains and nervous systems of children. But it may also cause high blood pressure, cataracts, decline in mental abilities and kidney problems in adults. (See *Nutrition Action*, March 2005, cover story.)

"We're learning that older adults should also be concerned about lead poisoning," says researcher Marc Edwards, a professor of civil and environmental engineering at Virginia Tech University in Blacksburg.

"Recent studies have shown that low levels of lead in the blood that we once considered safe are causing health problems in adults. No one thinks to ever look for it in older people." (The most common symptoms are abdominal pain, headache, fatigue, muscular weakness, and pain, numbness or tingling in the extremities.)

The evidence that lead affects the brain is troubling. In one study of nearly 600 women aged 47 to 74, those with higher levels of lead in their bones scored worse on memory and other cognitive tests than those with lower levels.⁽³⁾ The women with higher lead had scores comparable to women who were three years older.

Where does lead in water come from?

"The lead or brass service lines that connect the community water supply from streets to homes in older cities can leach lead," says Edwards. So can the lead solder or brass and lead plumbing fixtures inside many buildings.

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“Sometimes just one tap in a house might be providing water loaded with lead,” notes Edwards. “It could be because some plumber had a bad day and did some sloppy soldering 40 years ago when your house was being built.”

A Case in Point

The ex-mayor of a North Carolina town had suffered from chronic fatigue for years. “The kitchen tap in her apartment was perfectly clean,” Edwards reports. “It was her bathroom faucet that had just outrageously high amounts of lead.” All it took was an occasional drink of water from the bathroom tap.

Another potential source: hot tap water, which can contain high levels of dissolved lead.

“We’re finding that there’s quite a heavy use of hot tap water by the elderly to make tea, coffee, soup, and other foods,” says Edwards. “And some devices that are used to heat water—like coffeemakers and those electric heating coils that are submerged directly into a cup of water—can dissolve high levels of lead into the water. It’s safer to take cold water and heat it in a teapot on the stove.”

What to Do

“People shouldn’t panic, because the vast majority of taps in this country are safe,” says Edwards. “Maybe only one out of 100 faucets is dispensing hazardous levels of lead into the water.” That may not seem like many, says Edwards, “but if that’s your family and that’s your house, it’s not good.”

For about \$20 per sample, you can have your water tested for lead. But testing isn’t 100 percent reliable.

“We’re discovering that little pieces of lead particles or solder, or lead rust that has corroded, can flake off the insides of pipes,” says Edwards. “And that can deliver very, very high doses of lead” that a one-time test can miss.

The solution: a filter that removes lead at the faucet for all the water you use for cooking and drinking. “If there’s a lead problem, it’s probably coming from your plumbing, so you’ve got to treat it right at the end of the system,” says Edwards.

“Chlorine is an extremely good disinfectant for killing disease-causing bacteria and viruses in drinking water,” says Paul Westerhoff, director of Arizona State University’s

School of Sustainable Engineering and the Built Environment. “Plus, it’s cheap.”

That’s why more than half the country’s water treatment plants use chlorine. Another 30 percent use chloramine, a combination of chlorine and ammonia. Others use ozone. But there’s a downside to those disinfectants.

“Chlorine combines with organic matter that is naturally found in water to form hundreds of compounds called disinfection byproducts, or DBPs,” says Westerhoff. Chloramine and ozone produce smaller amounts of DBPs.

The EPA regulates the 11 most common and best-studied DBPs. Nine of the 11 cause cancer in laboratory animals.⁽⁴⁾

“This is an absolutely clear-cut case of humans being exposed to chemicals that are known to be toxic in high doses,” says David Savitz of the Mount Sinai School of Medicine in New York. “We all drink this water.” (The EPA estimates that 94 percent of Americans consume foods and beverages that are made with chlorinated water.)

“The question is whether the DBPs are present at high enough levels to have measurable adverse effects on our health,” Savitz explains. Researchers have focused on bladder cancer and pregnancy.

- Bladder cancer. “Using water with elevated levels of DBPs over years or decades does appear to be associated with a small increased risk of bladder cancer,” says Savitz.

A 2004 meta-analysis of studies pooled from the United States, Canada, France, Italy, and Finland found that men—but not women—whose tap water contained an average of more than 1 part per billion of DBPs (the legal limit is 80 ppb) had a 24 percent greater risk of being diagnosed with bladder cancer than men who had no more than 1 ppb in their water.⁽⁵⁾

The EPA estimates that from 2 to 17 percent of the 56,000 new cases of bladder cancer each year in the United States may be caused by DBPs in drinking water. When the agency slightly lowered the maximum levels of some DBPs permitted in water in 2006, it estimated that the move would prevent about 275 cancer cases a year.

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New research suggests that breathing in some DBPs and absorbing them through the skin could be more harmful than swallowing DBPs. Roughly half of our exposure to chlorinated water comes from washing with it and being near running water and flushing toilets, notes Savitz.

- **Pregnancy.** “Tap Water can Increase Risk of Miscarriages During First Trimester,” warned the *Associated Press* headline in 1998. In a study of roughly 5,000 pregnant women in northern California, those who lived where the tap water contained more than 75 parts per billion of disinfection byproducts were nearly twice as likely to miscarry, but only if they drank at least five glasses of water a day.⁽⁶⁾

But a later study by Savitz found no link between DBPs and miscarriage in 2,400 pregnant women in Texas, Tennessee, and North Carolina.⁽⁷⁾ “It was a pretty sophisticated study and it didn’t corroborate the California research,” says Savitz, then at the University of North Carolina in Chapel Hill.

Levels of the 11 regulated DBPs in drinking water have dropped by 60 to 90 percent since the early 1970s. “Their regulation has led to a huge improvement in drinking water quality,” notes Westerhoff.

But there are more than 600 DBPs in water, and “new research over the last decade suggests that some of the unregulated ones that occur at very low concentrations are actually more genotoxic than the 11 regulated ones,” he adds.

Genotoxic compounds damage DNA and can cause cancer. Among the metropolitan areas with the highest levels of the 11 regulated DBPs: Baltimore, Boston, Little Rock, Phoenix and Washington, DC.

What to Do

Use a water filter that’s certified to reduce volatile organic compounds (VOCs), which include DBPs.

Other Chemicals

“There’s growing evidence that numerous chemicals in water are more dangerous than previously thought, but the EPA still gives them a clean bill of health,” Linda Birnbaum, director of the government’s National Institute of Environmental Health Sciences, told *The New York Times* in December 2009.

“These chemicals accumulate in body tissue. They affect

developmental and hormonal systems in ways we don’t understand.”

Some examples:

- **Atrazine.** It’s the pesticide most often found in drinking water, especially in the Midwest, where it’s applied to cornfields to kill weeds. It’s also widely used on lawns, in parks, and on golf courses.

All of the watersheds monitored by the EPA, and some 40 percent of groundwater samples from agricultural areas, test positive for atrazine, according to the Natural Resources Defense Council.

In some studies, women living in areas with higher levels of atrazine in the drinking water were more likely to have lower-birth-weight babies. And in two studies, women in those areas were at higher risk of having babies with gastroschisis, a birth defect in which the intestines, stomach, or liver push through a hole in the abdominal wall.⁽⁸⁾

The EPA limits atrazine in drinking water to 3 parts per billion when averaged over an entire year. But people in agricultural areas may be exposed to much higher levels when use of the pesticide spikes during the growing season. The EPA says that it is reevaluating the safety of atrazine, and will decide “whether new restrictions are necessary to better protect health and the environment.”

- **Perchlorate.** It’s an ingredient in solid fuels used for explosives, fireworks, road flares, and rocket motors. It also occurs naturally and is a byproduct that forms in bleach. And it can be detected in drinking water and groundwater in 35 states and in the urine of just about every American.⁽⁹⁾

In large amounts, perchlorate blocks iodine from reaching the thyroid gland, which can make it harder to produce thyroid hormone. Perchlorate may also block the transfer of iodine from mother to fetus, which can hinder normal growth.

California, Massachusetts, and New Jersey limit perchlorate levels in drinking water. In 2008, the EPA concluded that national perchlorate regulations wouldn’t produce a great enough public health benefit. The agency now says that it’s reevaluating its decision.

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“It’s extremely difficult for water utilities to remove perchlorate,” says University of Arizona water expert Shane Snyder. “The only technologies available are ion exchange, which is extremely rare in centralized water treatment systems, or a reverse osmosis system that’s also rarely used because it is energy-intensive.”

- **Drugs.** When you take an aspirin, or birth control pills, or Lipitor, or another drug, tiny amounts end up in the toilet bowl, where they’re flushed into the sewage system and, eventually, into a wastewater treatment plant.

“Conventional wastewater plants typically remove more than 90 percent of these compounds,” explains Snyder. “But even if you have 99.99 percent removal, that still leaves parts per trillion in the water which is subsequently discharged into rivers and streams.” And that water, with its drug residues, can eventually end up coming out of your tap.

While the traces of drugs in drinking water are one-ten-thousandth to one-hundred-thousandth the amount in any therapeutic dose, “I don’t know that we can completely dismiss the impact on human health,” says Snyder, “because we don’t know much about the toxicity of mixtures of drugs. But based on the concentrations of the individual compounds, harm to humans doesn’t appear to be likely.”

What to Do

- **Atrazine.** Use a filter that’s certified to reduce levels of volatile organic compounds (VOCs), which include atrazine.
- **Perchlorate.** Only reverse osmosis and ion exchange filters reduce perchlorate.
- **Drugs.** Claims that filters reduce drug residues are based on the manufacturers’ own tests. Official standards to verify the tests are in the works, though.

Is Bottled Water Better?

Is bottled water safer than tap water?

“There are not a lot of outbreaks associated with bottled water,” notes the University of Arizona’s Kelly Reynolds. But it’s not clear whether that’s because bottled water is less contaminated, or because it’s harder to pin outbreaks

on it.

“Bottled water gets distributed all over the country,” says Reynolds. “If it caused an outbreak, that might be hard to identify.”

In theory, purified bottled water should be safer. “Many bottled water companies start with tap water that has met all federal standards,” notes Reynolds. “And the companies often add an additional treatment”—something like ultraviolet light or ozone to further disinfect the water or reverse osmosis to remove chemicals. “So you do sometimes get a higher standard of treatment.”

The two big differences between tap and bottled water:

- The EPA, which regulates tap water, requires utilities to notify consumers when their water fails to meet legal standards. The FDA, which regulates bottled water, doesn’t require bottlers to do the same. (The EPA’s and FDA’s standards are essentially the same.) So bottled-water drinkers are unlikely to know about any violations.
- Tap water doesn’t come in plastic bottles that can end up in landfills.

Bottle Basics

Purified Water: Most likely municipal tap water that has been distilled or treated with a process like deionization or reverse osmosis to remove impurities. The two major bottled drinking waters, Dasani and Aquafina, are purified water.

Spring Water: Comes from an underground formation from which water flows naturally to the surface of the earth. May be collected only at the spring or through a borehole tapping the underground formation that feeds the spring.

Mineral Water: Contains not less than 250 parts per million total dissolved mineral solids when it emerges from its source. No minerals can be added.

Sparkling Bottled Water: Contains the same amount of carbon dioxide that it had as it emerged from its source. (Companies sometimes add CO₂ to replace what’s lost during bottling.) Depending on the source, it may be

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labeled something like “sparkling drinking water,” “sparkling mineral water,” or “sparkling spring water.”⁽¹⁰⁾

⁽¹⁾ Am. J. Public Health 91:1194, 2001.

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⁽¹⁰⁾ Adapted from International Bottled Water Association (bottledwater.org/content/labeling-0).

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