Testimony of Tee L. Guidotti
To the
House Committee on Transportation and Infrastructure
Subcommittee on Water Resources and Environment

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Chairwoman Johnson and Members of the Subcommittee, I am Tee L. Guidotti, a physician and professor in environmental and occupational health at the George Washington University School of Public Health and Health Services. I am here today representing only myself but I have served as a consultant in public health and risk management to water and public health agencies, most notably the District of Columbia Water and Sewer Authority.

My testimony today is in three parts:

1. An overview of trace organic contaminants, especially pharmaceutical agents.
2. An overview of emerging contaminants of concern of a more local nature
3. General policy considerations, especially the problem of simultaneous compliance

My written testimony summarizes my oral remarks and includes a PowerPoint presentation and a briefing paper. All are available in full to the Subcommittee.

Trace Organic Contaminants

The emergence of novel contaminants in source water is not a surprise. In the environmental health community, we have known for many years that trace organic and other contaminants were present in low concentrations in surface water that was the source for intake into the drinking water system. Advanced testing technology have quantified the amounts but neither the levels nor the range of contaminants should be a surprise.

People take drugs and excrete them into wastewater. When have unwanted drugs they discard them, often down the toilet. Not surprisingly, then, pharmaceutical agents are present in the water downstream, which has become someone else's drinking water source. Yet another source is pharmaceutical use in agriculture. We have become aware of the presence of these contaminants because we have gone looking for them and because measurement technology is now sophisticated enough to find them at very low concentrations.

Currently, these contaminants are present in very low concentrations, parts per billion (one drop of water in an Olympic-size swimming pool) or trillion (one drop of water in a thousand pools). These levels are probably not enough to affect human health but if levels rise for whatever reason this possibility cannot be ruled out. For species that live in the aquatic environment and that may bioaccumulate some of these agents, however, there is a real possibility of environmental impacts and ecosystem effects. This is

especially true for agents that exert hormone-like effects (so-called "endocrine disruptors").

Technologies to treat these agents vary in their effectiveness. Many technologies seem to reduce many organics a little, but some are only removed appreciably by singular and expensive technologies, such as ultraviolet treatment.

Trace organics (especially pharmaceutical agents) are widely dispersed, passed along from town to town downriver, and reflect broader patterns of consumption of medication. It is hardly surprising that the list of cities which have identified these agents in their source water is growing. Where ever there are concentrations of people, these agents are going to be downstream and will enter source water for the next community down the line.

This problem therefore requires a national effort to achieve a solution before a serious health hazard emerges. I suggest that such an effort would consist of at least the following:

1. A national commitment to and comprehensive programs of watershed protection and upstream source protection. This will involve land use planning to ensure compatible uses in watershed areas.
2. "Take-back programs" that allow pharmaceuticals to be returned to the point of purchase of convenient, safe disposal sites and that discourage disposal down the toilet or into trash destined for a landfill.
3. Well-designed evaluation programs to determine national trends for the increase or decrease of levels in source water. (Operational monitoring for each and every utility is probably not cost-effective and are unlikely to change the timetable for technological upgrading.)
4. Research programs to develop robust but cost-effective water treatment technologies that are "multivalent", that is, that breakdown or remove a broad spectrum of contaminants.
5. Deployment of technologies to remove contaminants on the intake side is probably best done as a program of continuous and monitored improvement rather than as a crash program. There are many possible unintended consequences and the risk or threat does not seem to justify a disruptive effort that might divert resources away from upgrading basic water treatment and source protection. It is better to get it right than to get it done quickly.

Other Emerging Contaminants

Emerging contaminants are chemicals that are not regulated nationally as water contaminants and have not traditionally been recognized as water pollutants. Most emerging contaminants other than pharmaceutical agents and nanoparticles appear to come from what are called "point sources", release sources that are geographically restricted. The emerging contaminants of greatest interest at the moment are often related to Superfund NPL sites or local industrial sources.

These include the following:

- Silver nanoparticles (which are bactericidal – they are an even greater problem in wastewater and may soon be as ubiquitous as trace organics)
- N-nitrosodimethylamine (which has characteristics like MTBE, which caused huge problems and may also become widespread as a disinfection byproduct)
- Perfluorinated compounds (including C8)
- Perchlorate (which can also occur naturally)
- 1,4-Dioxane (not to be confused with dioxin)
- 1,2,3-trichloropropane (called TCP, which is a bigger threat to groundwater)
- PBDE and PBBs (out-of-production fire retardants, not to be confused with PCBs)

These other, point-source emerging contaminants need to be handled in different ways specific to the local situation, to include:

1. Systematic research and tracking where they are known or most likely to occur.
2. Further toxicological investigation to support risk assessment, in order to determine the level of risk they present.
3. Targeted development of remediation technology, which of necessity is likely to be site-specific.

Simultaneous Compliance

The recognition of another, very heterogeneous set of water pollutants raises another issue which should be considered before additional regulation is proposed to deal with these issues.

Water utilities (and all regulated entities, really) are required to comply with many different regulations. What happens when they are incompatible?

An example of this occurred in 2001 when the newly promulgated Disinfection Byproduct Rule was proposed. Water utilities switched their disinfection regimes to chloramine in order to comply with the regulation, which was an entirely reasonable thing to do. In some places, most notably Washington DC, the resulting change in water chemistry had an effect on the internal surface of lead service lines (water pipes delivering drinking water from the main to the house), which still supply many homes, and lead-containing fixtures and solder which still exist in many homes. The result was exceedances under the Lead and Copper Rule. EPA is well aware of this problem and has convened meetings to address it.

One social consequence of this problem is that we are seeing the emergence in some quarters of an activist movement to ban chloramine, based on misunderstanding an the absence of science. We are also seeing the emergence of a nihilistic attitude against disinfection altogether in favor of only filtering water, which is even worse. This is a very bad idea which could usher in new epidemics of waterborne disease, especially diarrhea.

The health consequences would be catastrophic if this latter opinion carried the day but my reading of this movement is that it is best read as a troubling signal of unease and confusion.

We must deliberate and use the best science available to us and sponsor additional studies if we do not have the science we need. We need to be careful that as the water contaminant issue becomes more complex, the regulatory framework does not create unintended consequences. The regulatory framework needs to address water as a complex system, not by individual contaminants alone.

The best way to do this is, in my opinion:

1. Adopt new regulatory models, such as multi-contaminant, multiple risk models.
2. Connect regulation of source water and drinking water by reconciling the Cleat Water Act and the Safe Drinking Water Act.
3. Conduct research on implementation and outcomes at the level of utilities and the factors that make water chemistry so different from one community to another.
4. Imbed public health research and practice, including active involvement of the CDC, in the development of regulatory frameworks.
5. Acknowledge the role of education and communication for an informed public that can actively participate in ensuring that water, our most valuable resource, is clean, safe and protected.
6. Provide a clear message to the public as to why disinfection is critical to health

Conclusion

In closing, the emergence of novel contaminants in source water is not a surprise and the demonstration that there are emerging contaminants in other watersheds is to be expected. Pharmaceuticals and some other emerging contaminants are widespread and require a federal commitment for research and development for robust treatment options. Others are local issues and solutions will have to be addressed to local conditions. Whatever is done, regulations and mitigation efforts should be carefully weighed so as not to introduce unexpected consequences, as we have seen with disinfection byproduct control measures.

Thank you for the opportunity to present this testimony.

Emerging Contaminants in US Waters

THE GEORGE WASHINGTON UNIVERSITY

Briefing for
House Committee on Transportation and Infrastructure
Subcommittee on
Water Resources and Environment

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GWU SPHHS

Background

- We've known this was coming for years.
- Ecosystem and human health effects
- Incomplete health data
  - Typical of an emerging issue
  - Health outcome data will be hard to obtain
- Distrust of water safety
  - Substantially aggravated by lead issue
  - Beginnings of a public movement against disinfection – very dangerous

Pharmaceutical Agents

- Pharmaceuticals are designed to have a biological impact, but at relatively high concentrations
- Lack tests for many effects
  - EPA has tried for endocrine disruptors – controversy
  - Significance in dispute
- Pharmaceutical residues may be transformed
  - Biotransformation in surface water
  - Reactions with free chlorine
- Chemical mixtures may have unpredictable effects.
  - Theoretical concern

This is not exactly a surprise.

Health Risk - Plausible

- Ecotoxicity more likely than human toxicity
- Most likely effects are endocrine disruption
  - Hormones and cell signaling
  - Can have effects at much lower levels than other chemicals: dosage issues and relevance of indicators
- Pharmaceuticals are present in very low concentrations: ppb, ppt
  - Too low for most toxic effects
  - Allergic reactions if levels rise?
- Antibiotic-resistance?
  - Most likely where local accumulation
  - Documented for antibiotics in feed

1 ppb = 1 drop of water in an Olympic-sized swimming pool

Perception of Risk

- Perception, rather than data, drives public reactions.
- Addressing perceptions
  - We have known about this problem for years.
  - Attention in part due to much improved measurement technology and surveys.
  - Health effects not so easy to rule out
- Need a comprehensive message on water quality.
  - Enormously complicated by the lead issue.
  - Strategic risk communication effort

Is it a threat to me and my family?

Recommendations for Pharmaceutical Contaminants

- Continued research required
  - Are levels rising, is distribution changing.
  - Improved means of water treatment
  - Need to evaluate trends across country in a systematic way
- Operational monitoring is probably not necessary at this time.
  - Very expensive
  - Little useful information
  - Technology is the bottleneck, not recognition.
- Systemic approach needed:
  - Risk assessment to address uncertainty
  - Risk management to control effluent
  - Risk communication and risk perception

Management of Risk - National

- Coordinated approach to human health effects and contaminant mixtures (FDA, EPA, CDC, USGS)
- Integration of pharmaceuticals into the CDC's Environmental Health Tracking Program
- Interagency collaboration at the local, state and national level in conducting assessments
- Control agricultural practices that release antibiotics and steroids into source water.
- Change TSCA and integrate screening with FDA
  - Require pharmaceutical companies to assess the environmental impact of new pharmaceuticals.
  - Model should be REACH. This won't happen.

Management of Risk - Local

- Pharmaceutical Take Back Programs
  - Collaboration with pharmacists
  - Proper disposal of medications
  - Public education
  - Removing barriers to take back programs.

- Invest in drinking and wastewater treatment upgrades and infrastructure.
- This is really a national issue, not a local one.
- Watershed protection and upstream management.

Other Emerging Contaminants

- Unregulated on a national level
- Point source for most, esp. NPL sites and industrial facilities
- Much uncertainty in toxicology but levels tend to be very low
- Technology for removal varies, can be expensive
- Bottled water as an alternative may be poor risk-risk calculation, except where locally high levels.
- Disinfection byproducts constitute some emerging contaminants, e.g. NDMA

Emerging Contaminants (Unregulated)

- Silver nanoparticles
  - Used in bactericidal products, use will increase
  - Highly toxic to bacteria
  - Bigger problem is effect on sewage treatment facilities
- N-nitrosodimethylamine (NDMA)
  - Antioxidant and amination product; food; air pollution
  - Found around rocket fuel production sites to 3000 ppt
  - Miscible in water; similarities to MTBE
  - Easily broken down by photolysis
  - Probable human carcinogen (a nitrosamine)
  - California has set standard of 3 ng/L (ppt)
  - US EPA Regions 3 and 6 use 0.42 ppt alert

Emerging Contaminants (Unregulated)

- Perfluorinated compounds (inc. C8)
  - Nonstick coatings, stain-resistant fabric treatment
  - Locally high contamination where industrially used
  - Bioaccumulate, immunotoxicity among reptiles
  - So far human health risk not apparent
- Perchlorate
  - Rocket fuel, explosives; also occurs in food
  - Highly soluble in water; concentrated brines sink
  - Very controversial
  - EPA DWEL 24.5 ppm (thought protective)
- 1,4-Dioxane (not to be confused with dioxin)
  - Solvent, widespread use
  - Probable human carcinogen (IARC)
  - US EPA Regions 3 and 6 screening level 6.1 ppb

Emerging Contaminants (Unregulated)

- 1,2,3-Trichloropropane (TCP)
  - Solvent and feedstock
  - Low solubility in water, local groundwater hazard
  - Human carcinogen (California)
  - CA standard for water 5 ppt
- PBDE and PBB (not to be confused with PCBs)
  - Fire retardants , no current production
  - Bioaccumulate, bioconcentrate
  - Occurs in sediment, slow release to surface water
  - Thyroid toxicity, risk level unclear
  - IARC: possible human carcinogens
  - Strict regulation in Europe (DK, A)

Simultaneous Compliance

- We are reaching a point where some regulatory requirements may conflict and interfere with one another.
- This what happened with the current push to control disinfection byproducts (DBP).
- Complying utilities risk inadvertently violating Lead and Copper Rule (LCR) unless further treatment of water.
- Similar unanticipated consequence emerging with NDMA and chloramination
- This is contributing to an unjustified perception that chloramine is unsafe.

Simultaneous Compliance: A Case

- Disinfection Byproduct Rule
  - Controlling DBP is a priority because they are suspected of causing cancer in humans and reproductive outcomes (although the evidence for the latter suggests not).
  - EPA promulgated the DBP Rule
  - The ensuing change in water chemistry caused lead levels to rise in home water taps.
  - This caused a violation of the Lead and Copper Rule (LCR). Observed first in Washington, DC.
  - Source of lead is fixtures in the home and lead service lines, not source water contamination.
  - Passivation (with orthophosphate) ameliorated problem.

Simultaneous Compliance: Issues

- This is not simply a problem of coordination.
- Need further research to anticipate these unintended consequences
- Research needs to be programmed with input from utilities caught in the middle.
- Emergence of a nascent anti-chloramine movement is a potential challenge.
  - Currently scattered opposition to chloramines, occasionally any disinfection agent
  - Disinfection is essential for public health.
  - Complaints include unconfirmed symptoms such as itching: need to be addressed
  - Position may be ill-founded but difficult to address without accessible research and risk communication.

Rapid Public Health Policy Response Project

April 2008

School of Public Health and Health Services

Pharmaceuticals are in the Drinking Water: What Does It Mean?

THE GEORGE WASHINGTON UNIVERSITY MEDICAL CENTER
WASHINGTON DC

URL: *www.gwumc.edu/sphhs/about/rapidresponse/index.cfm.*

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About this Paper

In cities across America, trace concentrations of pharmaceuticals — hormones and antibiotics, psychiatric and cardiac medications, and painkillers and blood thinners, among them — are moving into surface water, and from there into the drinking water. Neither the steps in place to treat wastewater before it is discharged into waterways, or drinking water before it gets to the tap, are adequate to eliminate them entirely. There may be no immediate health effects at the tiny concentrations in which these drugs have been detected, but scientists worry about the consequences of long-term, low-level exposure.

The federal government does not currently regulate the level of pharmaceuticals in the drinking water and utilities are not required to monitor it. As science accumulates about the scope of this issue, it may be appropriate to consider new strategies for identifying drugs in the water supply, assessing health risks, expanding water treatment options, and setting upper-level standards for contaminants of concern.

For more information about pharmaceuticals in the drinking water, contact:

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About the Rapid Public Health Policy Response Project

The Rapid Public Health Policy Response Project of the School of Public Health and Health Services at The George Washington University presents data and other background information on breaking public health stories. The goal is to educate the public, policymakers, legislators, health care providers, the media and others in order to promote informed decisionmaking.

Karyn Feiden, an independent consultant who writes about public health and health care, provides editorial support for this project. Financial support comes from the Public Health and Policy Group of Pfizer, Inc.

April, 2008

Pharmaceuticals are in the Drinking Water: What Does It Mean?

Traces of many pharmaceuticals are entering the drinking water of numerous American cities. That conclusion is based on a decade of scientific research and advances in methods to detect minute concentrations of chemicals in the water. The issue gained renewed attention in early March, when the Associated Press publicized the results of its five-month investigation: "A vast array of pharmaceuticals — including antibiotics, anti-convulsants, mood stabilizers and sex hormones — have been found in the drinking water supplies of at least 41 million Americans," reported the news service.[1]

The findings raise important questions about the environmental and human effects of low concentrations of water-borne chemicals, and about the adequacy of systems in place to treat both wastewater and drinking water. At current levels, pharmaceutical residues are unlikely to pose an immediate risk to human health, but the long-term consequences of individual chemicals, and combinations of chemicals, are unknown, especially as concentrations rise. Recent findings, said Tee L. Guidotti, MD, MPH, chair of the Department of Environmental and Occupational Health in GW's School of Public Health and Health Services, "are a wake-up call, but not an alarm."

How should public agencies and local water authorities respond?

From Wastewater to Drinking Water

Pharmaceuticals enter the water supply through human, agricultural, and veterinary practices. When we ingest drugs, our bodies absorb some of them, excreting the rest through bodily wastes. Unused pharmaceuticals may also be flushed down the toilet, poured down the drain, or allowed to leach from landfills. In urban areas, pharmaceuticals in household wastewater travel through a sewer system to a treatment plant, and then are discharged into surface water (lakes, rivers, and streams). In rural areas, they are processed through septic systems and may enter groundwater (the water that permeates soil and rock, and accumulates in underground aquifers). Surface water and groundwater are the interconnected sources for most drinking water.

Contaminants that evade wastewater treatment: Conventional wastewater treatment was not designed to break down pharmaceuticals, and it is not efficient at doing so. But in the past, we did not even know those contaminants were present. Breakthroughs in chemistry and refinements in measurement technology in recent years have allowed environmental scientists to detect chemicals at increasingly lower concentrations. The levels being detected today are measured in the parts per billion (equivalent to one drop of water in an Olympic-sized swimming pool, or a single blade of grass in a football field) or parts per trillion (that drop of water in one thousand pools, that blade of grass in one thousand football fields).

In 1999 and 2000, the United States Geological Survey (USGS) conducted the first "national reconnaissance" of organic wastewater contaminants, with an eye towards

determining their concentration in the nation's streams.[2] USGS chose to look for 95 compounds, including:

- Human and veterinary antibiotics (e.g., doxycycline, tetracycline and sulfa drugs)
- Prescription drugs (e.g., analgesics, antidepressants, and drugs designed to lower cholesterol, reduce hypertension, and prevent blood clots)
- Steroids and reproductive hormones
- Caffeine
- Chemicals commonly found in plastics, insecticides, fragrances, fire retardants and solvents

The USGS found what it was looking for. Eighty percent of the water samples researchers took from 139 streams in 30 states contained at least one of the 95 contaminants under study. Most contained a lot more — researchers found an average of seven contaminants in each water sample.

The study was not a definitive finding on the nature or extent of the problem. The target compounds were only a subset of the organics likely to be in wastewater and the USGS deliberately chose many sites downstream of urban and agricultural areas, where contamination is more likely. Nonetheless, with its finding of contamination "in a wide variety of hydrogeologic, climatic, and land-use settings across the United States," USGS concluded that the wastewater treatment steps intended to return clean water to the nation's waterways do not effectively control pharmaceuticals.[2]

Numerous studies in the United States and Europe have had similar results, suggesting a global problem. An October 2005 report estimated that 100 different pharmaceuticals had already been identified in surface water.[3] For example:

- USGS researchers found "a complex mixture of pharmaceuticals, wastewater chemicals, pesticides and trace metals" in the watershed region of Boulder Creek, Colorado.[4]
- Acetaminophen, caffeine, codeine, antibiotics, and warfarin were among the compounds detected in the outflow of a high school septic system in western Montana. That research also indicated that an antibiotic, a mood-stabilizing drug used to treat bipolar disorder, and nicotine had penetrated local aquifers.[5]
- After reviewing the pharmaceutical load in proximity to seven wastewater treatment plans along the Ebro river basin in Spain, researchers concluded, "wastewater treatment plants are hot spots of aquatic contamination concerning pharmaceuticals of human consumption."[6] Likewise, surface and groundwater in Germany contained trace pharmaceuticals, including a cholesterol regulator, painkillers and drugs to prevent seizures.[3]

"The bottom line is that wastewater treatment somewhat reduces, but does not entirely eliminate trace pharmaceutical compounds in wastewater," said Tee L. Guidotti.

Reaching the tap: Eventually, some of those compounds make their way into household drinking water. The Associated Press study, which was based on a review of scientific literature and government databases, extensive interviews, and surveys of major water providers in the nation's 50 largest cities and elsewhere, concluded that municipal water in at least 24 major metropolitan areas contain pharmaceutical residue.[1]

The scope of the emerging issue is undoubtedly far greater since many water utilities do not routinely test municipal drinking water for pharmaceuticals,[1] either because they can not afford to do so, or because they are reluctant to venture into an area where research is limited and the federal government has not provided guidelines. Moreover, utilities that do test may not share their results with the public (there are no federal requirements mandating disclosure, although the U.S. Environmental Protection Agency [EPA] says it "encourages" utilities to do so).[7]

Drinking water treatment varies by location, but typically combines coagulation and sedimentation techniques, which allow contaminants to clump together and settle out, and is usually disinfected with chlorine or chloramine. There is often a filtration step in the process before water is considered suitable for consumption. None of these conventional methods removes significant amounts of organic contaminants. More costly technologies, especially ozone and granular activated carbon filtration, do significantly reduce the load, although traces of pharmaceutical remain even after their use.[8]

The Health Risks of Pharmaceutical Residue

The literature on the human health risks of trace pharmaceuticals is thin, but some researchers have suggested that they are too dilute to be of concern. "To date, no evidence has been found of human health effects from PPCPs [pharmaceuticals and personal care products] in the environment," states the EPA on its Web site.[9]

In one model, researchers first estimated "no effect concentrations" of 26 active pharmaceutical ingredients (APIs) — the concentration at which these ingredients would be expected to have no effect, even on sensitive populations. Based on comparisons to concentration levels that have been measured and reported in the published literature, they concluded: "No appreciable human health risk exists from the presence of trace concentrations of these APIs in surface water and drinking water."[10] (This study excluded hormonal residue, and in a separate presentation, one of the authors acknowledged a potential effect of hormones in the drinking water.[11])

Other researchers are less sanguine. Commenting on the "no effect" study, a scientist from the EPA's National Exposure Research Laboratory wrote, "There is still a scarcity of human health assessments for environmental exposure to pharmaceuticals, so it is premature to draw firm conclusions at this time and to extrapolate this limited assessment to pharmaceuticals beyond the 26 investigated."[12] That investigator noted that while some 3,000 pharmaceutical ingredients are in use today, environmental studies have looked at only about 150 of them.

The sparse research on an emerging problem reflects, in part, the fact that environmental toxicology has traditionally focused on the effects of acute exposure, rather than on low-level,

chronic exposure. A number of issues suggest the need for more knowledge about the potential health effects of highly dilute pharmaceuticals:

- In contrast to conventional pollutants, pharmaceuticals are deliberately designed to interact with the body at low concentrations in order to have a biological impact. They can also interact with cell receptors other than those targeted for therapeutic purposes.[9]
- A limited body of research demonstrates the plausibility of biological effects — of particular concern is a study that hints at an impact on the basic mechanisms of cell signaling[13] and another that suggests an additive effect when a mixture of pharmaceuticals is present.[14]
- Because pharmaceuticals are present at such low concentrations, tests capable of detecting any subtle biological effects need to be developed. The EPA has singled out neurobehavioral effects and the inhibition of efflux pumps (which transport molecules from cells and play a role in eliminating toxins from the body) as potential outcomes that should be measured. Subtle effects that accumulate may become significant.[9]
- Pharmaceutical residues may be transformed, possibly with toxic effects, through biodegradation and other interactive processes that occur in surface water, or as a consequence of reactions associated with drinking-water treatment.[15]
- Hormones and other chemicals that act by signaling and stimulating cell changes can have effects at much lower levels than other chemicals. Endocrine disruptors, which interfere with normal hormone function in animals and humans, are a special concern.[12]
- While current concentrations of pharmaceuticals are far below levels known to trigger allergies, vulnerable people could have allergic reactions if levels rise.
- The possibility that antibiotics released into the environment could promote local pockets of antibiotic-resistant bacteria, while largely speculative at this point, can not be ruled out. One study, for example, detected higher levels of antibiotic-resistant bacterial strains downstream from a swine-feeding facility, compared with upstream levels.[16]

An impact on the ecosystem is already apparent. "Exposure risks for aquatic organisms are much larger than those for humans," says the EPA, noting that these organisms are exposed continually, over many generations, to the higher concentrations of pharmaceuticals that linger in surface water.[9] Published studies have identified endocrine disruptions, reproductive effects, and renal deterioration in fish, among other damage.[4, 12, 17]

Meeting the Challenge

More information on the health risks of trace pharmaceuticals is clearly necessary. Until that occurs, the urgency of the need to lessen the flow of pharmaceuticals from treated wastewater

into drinking water is likely to remain controversial. The most appropriate strategies for action are likewise uncertain.

As emerging contaminants, pharmaceuticals in drinking water remain basically unregulated. There is likewise no federal requirement that utilities test water for the presence of drugs.[1] As the U.S. Geological Survey states, "Few of the detected compounds exceeded water-quality standards; however, many do not have water-quality standards."[18] According to an Associated Press report, the EPA reviewed 287 pharmaceuticals as potential candidates for regulation, and nominated only one — nitroglycerin, not because of its relevance to water contamination, but because of its potential use in explosives.[19]

Unless national standards are developed, monitoring mandates imposed, and adequate resources made available to ensure compliance, the decision to track the problem and invest in technologies to address it, will continue to be made at state and local levels. However, the incentive to act locally is complicated by the fact that investments in water treatment may not directly benefit the entity that makes those investments since contaminated wastewater often flows into neighboring communities.

D.C. water: Washington, DC illustrates the complexity of the issue, and the costs that are involved. The District's drinking water comes from upstream sources in the Potomac, with trace concentrations of pharmaceuticals supplied by upstream communities. The Washington Aqueduct, a branch of the U.S. Army Corps of Engineers, collects that water and supplies it to the DC Water and Sewer Authority (WASA) to distribute.* The Aqueduct is currently investing substantial resources to determine what treatments would be most effective in removing emerging pathogens, including pharmaceuticals.[20]

WASA also runs the Blue Plains sewage treatment facility, the world's largest advanced wastewater treatment plant. It has budgeted more than one billion dollars for future upgrades, including anaerobic digesters and advanced chemical treatment that would be expected to reduce the downstream discharge of pharmaceuticals and other organic contaminants into the Chesapeake Bay.[21] That means Washington has to pay huge sums to treat its water twice, once as it enters the system at the tap and again as it departs in wastewater.

Action steps: Federal standards would lead to greater uniformity in how localities manage their pharmaceutical load. Other possible action steps:

- More attention to research. The Association of Metropolitan Water Agencies (AMWA), among others, has urged the EPA and the Food and Drug Administration (FDA) to study the short-term and long-term effects of trace pharmaceuticals on human health and the environment. The AMWA has also called on the EPA to make research into treatment technologies a high priority.[22]

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- More public education to encourage consumers and health care providers to dispose of medications properly. A partnership has been formed among the U.S. Fish and Wildlife Services, the American Pharmacists Association, and the Pharmaceutical Research and Manufacturers of America to publicize appropriate disposal measures.[23] "Take-back" programs, already instituted at some pharmacies, allow customers to return unused and out-of-date pharmaceuticals for safe disposal.
- Changes in the way the FDA requires pharmaceutical companies to assess the environmental impact of their drugs, as recommended by the Environmental Working Group, an advocacy organization.[24]
- Altering agricultural practices that release antibiotics and steroids into the water supply, as recommended by the AMWA. The association has also asked that the agricultural industry abandon its efforts to seek liability exemptions from federal hazardous waste laws.[22]
- An emphasis on controlling the discharge of contaminated water at the source, rather than treatment at the point of use. This would be safer for the environment, while reducing the burden on downstream drinking water treatment plants.[25]
- A close look at regulatory approaches in the European Union, where there have been more aggressive efforts to control contamination in waterways.[26]
- Greater public investment in drinking and wastewater infrastructure. Rather than taking a contaminant-by-contaminant approach, upgrading technology offers an opportunity to address water quality issues, and ecological stressors, systematically.[27]

Amidst uncertainty a few facts are clear. Trace pharmaceuticals survive the steps in place to treat both wastewater, before it is discharged back into the environment, and drinking water, before it reaches the tap. While the threat to human health and the ecosystem are not well-established, Christian Zwiener, a German researcher from the University of Karlsruhe, offers this perspective:

"Irrespective of any risks, the precautionary principle should apply and micropollutants from wastewater should not be present in drinking water. There is also a question of public acceptance of, and confidence in, good drinking water quality."[15]

Endnotes

1. See, for example, Donn J, Mendoza M, Pritchard J., "AP Probe Finds Drugs in Drinking Water." *The Washington Post*, March 10, 1998.

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3. Hemminger P. "Damming the Flow of Drugs into Drinking Water." *Environmental Health Perspective* 2005 October;113 (10);A678–81.

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6. Gros M, Petrovic M, Barcelo D. "Wastewater Treatment Plants as a Pathway for Aquatic Contamination by Pharmaceuticals in the Ebro River Basin (Northeast Spain)." *Environmental Toxicology and Chemistry* 2007 August;26 (80):1553–62. Another European study of interest is Vieno NM, Harkki H, Tuhkanen T, Kronberg L. "Occurrence of Pharmaceuticals in River Water and their Elimination in a Pilot-Scale Drinking Water Treatment Plant." *Environmental Science & Technology* 2007 July 15;41 (14):5077–84.

7. Mendoza M. "Providers, Researchers Keeping Secrets." Associated Press, March 10, 2008.

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21. DC Water and Sewer Authority, "FY: 2005–14 Capital Improvement Plan: Wastewater Treatment Service Area." WASA Web site. Accessed April 6, 2008.

22. Association of Metropolitan Water Agencies. "AMWA Discusses Pharmaceuticals in Water Supplies," News release, March 11, 2008.

23. The partnerships' public awareness campaign, called SmartRx Disposal, is described on its Web site.

24. Environmental Working Group. "Utilities, Consumers Ask FDA, EPA to Study Effect of Drugs in Water." March 13, 2008.

25. See the "Source Water Protection" Web site of the U.S. Environmental Protection Agency for more on this issue.

26. Knacker T, Duis K, Ternes T, Fenner K, et al. "The EU-project ERAPharm. Incentives for the Further Development of Guidance Documents?" *Environmental Science & Pollution Research* 2005;12 (2);62–5. See also the Environmental Risk Assessment of Pharmaceuticals Web site for an extensive array of European peer-reviewed publications and material from the International Conference on Pharmaceutcals, held in September 2007 in the United Kingdom.

27. Among the many sources that have assessed the nation's water infrastructure needs and recommended increased investment are the U.S. Environmental Protection Agency, "Drinking Water Infrastructure Needs Survey and Assessment: Third Report to Congress." June 2005 and the Water Infrastructure Network, *Water Infrastructure Now: Recommendations for Clean and Safe Water*, February 2001. The Water Quality Investment Act of 2007 (H.R. 569) and the Water Quality Financing Act of 2007 (H.R. 720) have been passed by the U.S. House of Representatives and referred to Senate committees.