Presence of Pharmaceuticals in Treated Wastewater Effluent and Surface Water Supply Systems, Metropolitan Atlanta, Georgia, July–September 1999

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Abstract

Human and veterinary pharmaceutical compounds are a source of increasing environmental concern because the compounds are used in large quantities and the physical and chemical properties of the compounds make them likely to be transported into hydrologic systems. Effects on human health and aquatic ecosystems from the presence of small concentrations of pharmaceuticals in streams and rivers are generally unknown. Several pharmaceuticals have recently been detected in the US and Europe in surface waters that receive sewage effluent. Because Federal and state agencies do not routinely monitor these compounds, almost no data exist on the occurrence and distribution in US water supplies.

The Centers for Disease Control and Prevention (CDC) and the U.S. Geological Survey (USGS) initiated a study in 1999 to determine the occurrence of pharmaceuticals in treated effluent discharged from water pollution control plants (WPCPs), and in raw and finished drinking water at three drinking-water treatment plants in the Chattahoochee River watershed in Metropolitan Atlanta. Grab samples of water were collected at five effluent discharge points, and raw and finished water samples were collected at three drinking-water treatment plants downstream of the effluent discharges. Samples were collected once per month during low-flow conditions from July through September 1999. Two research analytical methods recently developed by the USGS Toxics Hydrology Program were used to quantify prescription and nonprescription pharmaceuticals, including antibiotics, at parts per billion (ppb) concentrations in filtered water samples.

Sixteen pharmaceuticals were detected in wastewater samples, 10 were detected in raw drinking-water samples, and three were detected in finished drinking-water samples. The prescription pharmaceuticals detected included diltiazem and dehydronifedipine (cardiac medications), metformin (anti-diabetic medication), and gemfibrozil (cholesterol-lowering agent). The nonprescription pharmaceuticals detected included caffeine (stimulant), 1,7-dimethyl xanthine (caffeine metabolite), cotinine (nicotine metabolite), cimetidine (gastrointestinal and ulcer medication), and acetominophen (analgesic). The antibiotics detected represent four groups including sulfonamides (trimethoprim, sulfamethazine, sulfamethoxazole, and sulfadimethoxine), macrolides (erythromycin-H_2O and roxithromycin), lincosamides (lincomycin), and fluoroquinolones (enrofloxacin). An additional seven prescription and nonprescription pharmaceuticals and fourteen antibiotics that were analyzed for were not detected.

One to three prescription pharmaceuticals were detected in 13 of 15 treated WPCP effluent samples. Concentrations ranged from low parts per trillion (ppt) to low ppb. Diltiazem was the only prescription pharmaceutical detected in raw drinking-water samples–detected at low ppt concentrations. No prescription pharmaceuticals were detected in finished drinking-water samples (minimum reporting levels (MRLs) ranged from 0.007–0.028 ppb). One to four nonprescription pharmaceuticals were detected in 11 of 15 treated WPCP effluent samples at low ppt to low ppb levels. Detection of nonprescription pharmaceuticals in the nine raw drinking-water samples ranged from no detections for cimetidine to nine detections for caffeine. The only three pharmaceuticals detected in finished drinking-water samples—caffeine, cotinine, and acetominophen—are widely used nonprescription pharmaceuticals. These compounds were detected in low ppb concentrations in two to eight of the nine finished drinking-water samples. One to five antibiotics were detected in 14 of 15 treated WPCP effluent samples at low ppt to low ppb levels, and in seven of 15 raw drinking-water samples at low ppb levels. No antibiotics were detected in finished drinking-water samples (MRLs ranged from 0.03-0.10 ppb).
Detection of antibiotics in raw drinking water is of particular concern because the presence of these chemicals in the environment may lead to the development of resistant bacterial strains, thus diminishing the therapeutic effectiveness of antibiotics. Detection of numerous prescription and nonprescription pharmaceutical compounds in treated WPCP effluent, and raw and finished drinking water; together with the absence of pharmaceutical

manufacturing facilities in the study area, suggests that human use of pharmaceuticals is one source of these compounds in water resources within the upper Chattahoochee River watershed.

Biographical Sketches

Deborah M. Moll, Ph.D., has worked as an Environmental Health Scientist in the Health Studies Branch of CDC's National Center for Environmental Health since 1998, focusing on exposure to contaminants through drinking water. She received her PhD from the Department of Civil and Environmental Engineering, University of Cincinnati in 1998 with a focus in drinking water quality and treatment. She is a member of the American Water Works Association and the International Water Association.

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