

Curbing Pharmaceuticals in Wastewater Streams: Assessing the Environmental Benefits of a Drug Recycling Program in Santa Barbara.

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Problem Statement

Common classes of pharmaceuticals include antibiotics, hormones, analgesics, antidepressants, antipyretics, and antipsychotics (FDA 2006). In any given community, all of these classes of pharmaceuticals are prescribed, sold, ingested, excreted, and disposed of. Drugs are intended to cure disease and relieve complex physiological symptoms, and as such, have powerful biochemical influences that may include cytotoxicity or antimicrobial properties. For these reasons, the manufacture and distribution of drugs is tightly regulated by government agencies. Paradoxically, the uncontrolled release of drugs and their metabolites into the environment is not regulated and is, in fact, weakly understood. This proposal regards pharmaceuticals in the environment: the probability of their release by individual users, the quantities released, laws that could help constrain their release, and practices that could reduce their uncontrolled release into the environment.

Specifically, this proposal regards pharmaceuticals that enter the environment by being flushed through household plumbing. The main disposal method for un-used or expired household pharmaceuticals is flushing them down the toilet or pouring them down the drain. Pharmaceuticals are then conveyed to a waste treatment system. However, they are not typically transformed or degraded in conventional secondary biological wastewater treatment systems (Huang and Sedlak 2001; Daughton 2003a). Reverse osmosis treatment systems are able to remove more contaminants, but these systems are expensive and few municipal wastewater treatment facilities employ them (Daughton 2003b). Alternatively, pharmaceuticals disposed of in the trash are landfilled and can enter the environment through their dissolution into landfill leachate. Thus, unused pharmaceuticals have at least one route of entry into the external environment.

The presence of household pharmaceuticals in wastewater has been discovered in part because of analytical advances that now make it possible to detect low concentrations of drugs and drug metabolites in aquatic samples. Drugs enter wastewater from excretion of un-metabolized materials and by disposal of unused drugs. But little is known regarding the amount of each contribution and the possibility for reducing them. Recent research has demonstrated that toxicological effects on aquatic organisms are manifested at very low concentrations of pharmaceuticals (Ingerslev et al. 2003). Further, many pharmaceuticals are unchanged during the course of wastewater treatment. Thus, any practices that could be implemented to reduce drug delivery to waste disposal systems would potentially benefit the environment. This proposed research would assess the feasibility and effectiveness of implementing a pharmaceutical recycling program in Santa Barbara County. While conducted in this region, the research and program parameters would have implications for similar concerns in nearly any community.

Background

Multiple research groups have discovered trace amounts of chemicals from pharmaceuticals in wastewater effluents (Huang and Sedlak 2001; Kolpin et al. 2002); and the LA Times recently published a list of pharmaceuticals that have been detected in Southern California groundwater (Cone 2006). While it is unclear how these low levels might affect human health, the release of these compounds into the environment can have negative impacts on aquatic organisms. For example, 17 β -estradiol, a common compound in birth control and hormone replacement drugs, has been shown to inhibit testicular growth in trout at concentrations as low as 2 ng/L (Jobling et al. 1998). Further, antibiotic compounds could have implications in the proliferation of antibiotic resistant bacteria (Rooklidge 2004).

Despite the potential environmental implications, pharmaceutical waste disposal practices in municipalities are mostly uncontrolled. As this waste stream gets more recognition, some counties, such as King County in Washington State, are implementing pharmaceutical waste management plans (IRAC 2006). An alternative waste diversion plan is drug recycling, where unused/unopened pharmaceuticals are collected and redistributed to low-income community members.

In 2005, California legislators passed a bill (California Senate Bill 798) that allows counties to implement drug-recycling programs. Four California counties, including Santa Clara County, are in the process of starting drug-recycling programs. Narinder Singh, the Santa Clara pharmacy director, expects that the program will save the county about \$100,000 over the next year (Benson 2005) in drug costs for low-income patients. Recycling is potentially an important vehicle for diverting excess pharmaceuticals away from the environment and providing health benefits for the disadvantaged.

However, a full accounting of the volume of diversion, and the costs, benefits, and broad justification for pharmaceutical recycling programs is lacking. This project would use Santa Barbara County as a case study for the feasibility and effectiveness of a pharmaceutical recycling program. Interested parties include the Community Environmental Council, who is seeking funds to support this project, and the County of Santa Barbara, who would administer the program.

Project Objectives

- I. Develop baseline information on pharmaceutical distribution and disposal in Santa Barbara County to assess the size of the problem. Include the following information:
 - a. Volume of pharmaceuticals distributed in Santa Barbara County.
 - b. An estimated amount of different drug types (e.g. hormone, antibiotic, etc.) sold to consumers, and the amount potentially entering the environment.
 - c. Current disposal methods for un-used pharmaceuticals.
 - i. What is recommended by pharmacies to clients?
 - ii. What are the actual practices by consumers?
 - d. Proportion of unwanted drugs that are unopened/un-tampered with.

- II. Assess the environmental benefits and feasibility of implementing an unused drug collection and recycling program in Santa Barbara County.
 - a. Determine the impact on the current pharmaceutical waste stream (i.e. how much pharmaceutical waste would be diverted from wastewater treatment facilities or landfills).
 - b. Research legislation and review drug-recycling programs in other California counties.
 - c. Determine types of drugs eligible for reuse.
 - d. Recommend a drug collection and recycling program design for Santa Barbara and draft guidance documents on the implementation of the program.
 - e. Estimate public participation in a drug-recycling program.

Project Significance

The scientific literature and the U.S. EPA's website on the disposal of pharmaceuticals (<http://www.epa.gov/esd/chemistry/pharma/about.htm>) strongly suggest that the uncontrolled release of unused and/or un-metabolized pharmaceuticals in the environment is detrimental to aquatic life and thus to ecosystems, particularly downstream of wastewater treatment facilities. Community by community, this type of waste can be diverted from the environment, and diversion is best addressed through local policies. While pharmaceuticals reach the environment by the actions of individual citizens, the chemicals can impact broad geographic areas as they migrate through the environment away from their point of release. Thus, while this project is of local significance, the biogeochemical outcomes of a pharmaceutical collection and recycling program would be at least regional. Further, a program in Santa Barbara could be model for other similar programs to be developed elsewhere in the U.S. and beyond. Finally, a collection and recycling program would help divert a small portion of this waste into a socially beneficial program.

Stakeholders

County of Santa Barbara Public Health and Resource Recovery & Waste Management Division
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Possible Approach and Available Data

- Design and conduct surveys (either web-based, paper-based or in combination with interviews) to determine:
 - *How much and what types of drugs are in Santa Barbara County.* This survey will be performed directly with pharmacies throughout Santa Barbara County to determine the volume of different classes of pharmaceuticals that are being distributed.
 - *Pharmaceutical disposal advice given by pharmacies to consumers.* This will be used to qualitatively understand the types of disposal behaviors in the area.
 - *Actual use and disposal practices by consumers.* Actual practices may differ from the advice but, in any event, this survey will provide a quantitative basis for predicting amounts of pharmaceuticals that enter the environment in various ways (e.g. through landfills, wastewater, etc.).
 - *The volume of unopened pharmaceuticals that would qualify for a recycling program.* This would also be discovered through surveying consumers.
 - *Willingness of pharmacies and consumers to participate in a drug recycling program.*

The information from the above surveys would be used to determine the benefit to the environment and the feasibility of implementing a drug recycling program. In collaboration with the CEC and the County, a program would be designed and the costs estimated. The environmental and societal benefits would be weighed against the costs to make a final recommendation to the County regarding implementing a new program. Additional research will be needed in the following areas:

- Examine other counties that have established a drug-recycling program in California and identify potential problems.
- Research the laws to determine exactly what is allowed in terms of collection, recycling, and disposal.

Deliverables

Report of findings and draft guidance documents for drug collection and recycling program Santa Barbara County.

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