

Figure 3: WTP for a disposal surcharge per prescription
Model: $Pr[\text{Yes}] = f(\text{bid}, \text{gender}, \text{age}, \text{democrat}, \text{Hispanic}, \text{awareness})$

Hispanic respondents placing a higher value on a disposal program. Surprisingly, we found that awareness negatively influences WTP. One possible explanation for this observation is that awareness is correlated with education level, and educated respondents may also be aware of other social and environmental issues. Their “no” response may indicate that they do not feel a disposal program is a priority problem or that they do not feel financially responsible for the disposal program.

Overall, the average WTP is a \$1.55 per prescription. Using the average WTP, the 2005 Census population for Santa Barbara County, and the national prescription rate of 11.8, the value of a pharmaceutical disposal program in Santa Barbara County is \$ 7,329,937. To avoid burdening the elderly and infirm residents with disposal costs, a policy could be devised where the surcharge is paid on only the first prescription of the year; under this assumption, the value of the program is \$621,181 per year. These estimates indicate the range of benefits that might arise from implementing a disposal program.

CONCLUSIONS

The survey results were used to evaluate different disposal programs and policy options. Our primary findings and recommendations for Santa Barbara County are the following:

1. A drug recycling program is not recommended at this time, as we did not find evidence for a reliable and consistent supply of usable medicines.
2. A campaign to educate residents is necessary: the drain and trash are the most common disposal habits among the public, which are not best-practice disposal routes.

3. A permanent collection program is recommended to ensure that residents have an effective and legal way to properly dispose of their medications.

Because the successful implementation of a permanent disposal program is constrained by regulatory and institutional barriers, we have outlined a range of end-user disposal program options. The options presented below are ordered from the most recommended and ideal option, but also the most difficult to implement program, to the option that is least ideal, but still fulfills the objective of implementing a permanent disposal program.

Option A. Apply for a DEA exemption for drop-off box collection at pharmacies. This program option would allow for permanent drop-off box collection of both controlled and non-controlled medications. The boxes would be located at pharmacies and serviced by a reverse distributor.

Option B. Collection at police stations. Another solution for a permanent collection program that includes controlled substances is collection at police stations; police are allowed to take-back controlled substances from end-users, and no DEA exemption would be required. We recommend that the County of Santa Barbara approach law enforcement officials to gauge their willingness to participate in a drug collection program.

Option C. Collection of non-controlled medication at hazardous waste facilities. Although hazardous waste facilities are not authorized to collect controlled substances, they can collect non-controlled medications for hazardous waste incineration. This service should be prominently advertised within the community.

Option D. Special collection events. If none of the other options can be implemented, Santa Barbara County should hold special collection events at a minimum. Although less than ideal because they are not as convenient as a permanent disposal program, collection events would allow residents to get rid of their unwanted medications and have the added benefit of educating consumers about the environmental and safety issues associated with pharmaceutical disposal.

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DONALD BREN SCHOOL OF ENVIRONMENTAL SCIENCE AND MANAGEMENT
 UNIVERSITY OF CALIFORNIA, SANTA BARBARA

GROUP PROJECT BRIEF

Pharmaceuticals in wastewater streams: Disposal practices and policy options in Santa Barbara

ON THE WEB AT [HTTP://WWW.BREN.UCSB.EDU](http://www.bren.ucsb.edu)

SPRING 2007

Project Members: James Kallaos, Kaleena Wheeler,
 Crispin Wong, Margaret Zahller

Project Advisor: Matthew Kotchen

INTRODUCTION

Recent advances in analytical technology have led researchers to discover trace amounts of pharmaceuticals in wastewater effluents, rivers, lakes, and ground water (Kolpin et al. 2002; Brun et al. 2006; Kummerer et al. 2004). Pharmaceuticals have also been detected in soil samples and fish tissues. Based on the wealth of published occurrence data, it seems probable that most, if not all, urban wastewater is contaminated with pharmaceutical compounds, differing only in the type and abundance of the substances present (Daughton 2003).

This presents a problem to the aquatic environment because pharmaceutical compounds are specifically designed to affect biological organisms. While environmental concentrations are below acutely toxic levels, the main concern is the chronic and/or synergistic effects of the pharmaceutical “cocktail” humans have created in the water. Endocrine disruption is the most widespread and documented effect that pharmaceuticals have on aquatic organisms. The presence of synthetic estrogens, among other known endocrine disruptors, has contributed to the feminization of male fish in waters receiving treated wastewater effluents (Jobling et al. 1998). Also of concern is the development of antibiotic resistant bacteria populations. A number of studies have shown a decrease in antibiotic effectiveness due to their widespread presence in the environment.

Pharmaceuticals reach the environment via two main pathways: excretion and disposal. This study focuses on

PROJECT OBJECTIVES

- Determine household and institutional disposal behaviors and disposal practices related to pharmaceuticals in Santa Barbara County.
- Recommend policy options that will improve pharmaceutical disposal practices in Santa Barbara County.

OVERVIEW

- Pharmaceuticals have been found in treated wastewater and surface water and can have a negative impact on aquatic communities.
- Improper disposal of medications, through the plumbing or trash, is one source of pharmaceuticals in the environment.
- Surveys were conducted to determine the disposal practices of institutions and end-users in Santa Barbara County. The survey results were used to recommend end-user disposal programs to ensure that Santa Barbara County residents have a safe and legal way to dispose of their unused medications.
- We recommend a permanent disposal program in combination with an educational campaign.

the disposal of pharmaceuticals, examines regional disposal practices, and evaluates the different ways that Santa Barbara County can divert this waste from its water.

There are no laws that regulate how end-users (patients) dispose of their drugs. The Drug Enforcement Agency (DEA) and other government agencies recommend the trash or drain as disposal methods; however, both disposal routes can lead to water contamination through landfill leachate and wastewater treatment or septic systems, which are not equipped to remove these compounds. A better way to dispose of pharmaceuticals is through hazardous waste incineration, but this requires a centralized disposal program. While some counties and municipalities across the country have begun to implement disposal programs, one noted barrier to implementation is DEA regulations that prohibit the take-back of controlled substances. DEA regulations make implementing disposal programs difficult, as most programs must get DEA approval or exclude controlled substances (and most people do not know which medications are classified as “controlled”). This study looks at the barriers to implementation and recommends a range of disposal program options for Santa Barbara County.

Disposal programs that are currently being considered by the research and decision-making community include:

- permanent collection boxes at pharmacies or police stations,
- mail-back programs,
- periodic collection events.

Another option is a drug recycling program. California law authorizes counties to collect unused, unexpired pharmaceuticals from nursing homes, wholesalers, and manufacturers and redistribute them to low-income residents.

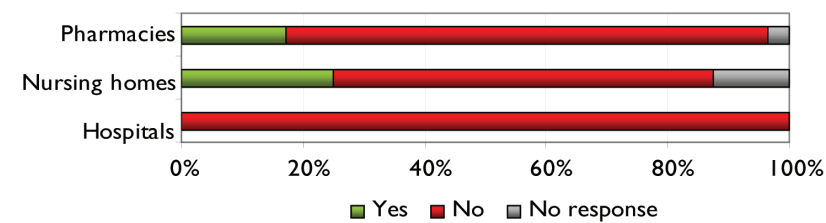
METHODOLOGY

Two surveys were conducted to determine disposal practices of institutions and end-users in Santa Barbara County. For the institutions, a 15-question telephone survey was conducted by the authors. Institutions included in this study were pharmacies, hospitals, nursing homes, and hospices in Santa Barbara County. These institutions were surveyed because they handle a large volume of pharmaceuticals and may be a major source of pharmaceuticals in the environment. In addition, institutions are a source of information and education to the public, and it is important to gauge the extent of this contact. Survey questions were both open-ended and categorical and covered the following topics:

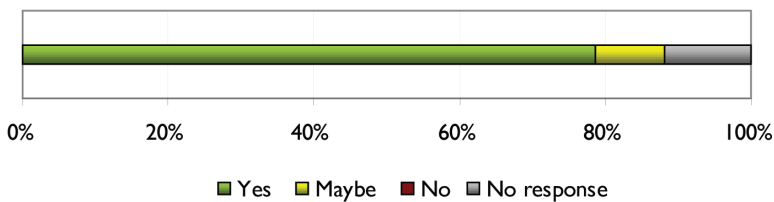
- current disposal practices,
- contact with the public,
- likelihood to supply/support a recycling program,
- likelihood to support a disposal program for the public.

A five-question end-user survey was conducted to gain insight into residents' medicine use, disposal habits, awareness of pharmaceuticals in surface water, and willingness to participate in a disposal program. A contingent valuation (CV) question was also included to determine the value of a disposal program through people's willingness-to-pay (WTP). The questions were part of the Central Coast Survey, an annual survey of Ventura and Santa Barbara County residents conducted by the UCSB Social Science Survey Center. The CV question was a referendum format and asked whether the respondent would be willing to pay a surcharge per prescription to fund a disposal program. A surcharge amount was randomly drawn for each respondent, and amounts ranged from \$0.05 to \$2.50.

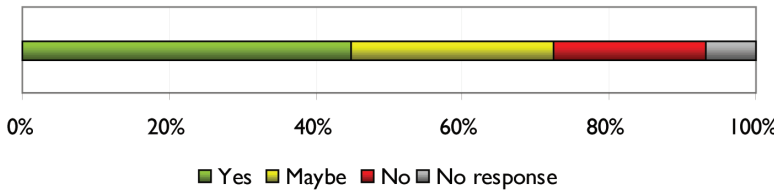
Does your facility have unexpired, unopened drugs for donation?



Is this issue an environmental concern?



Are pharmacies willing to house a drop-off box?



Who should take responsibility for disposal?

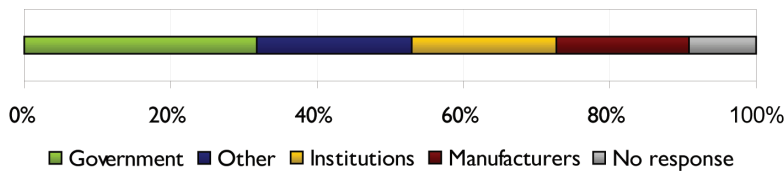


Figure 1: Selected results from the institutional survey

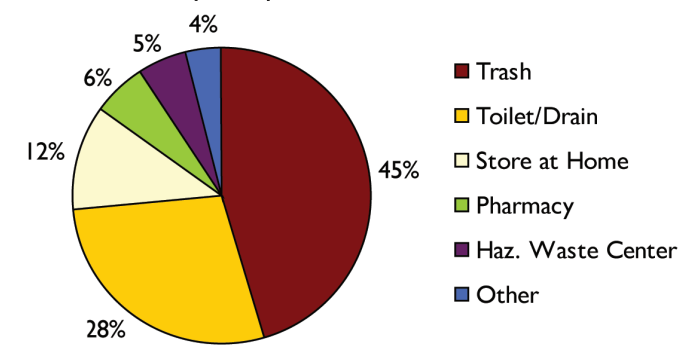
INSTITUTIONAL SURVEY

In total, 116 facilities were contacted, 87 of which were usable for our study; 42 responses were obtained for a total response rate of 48 percent. Most of the responses were from pharmacies (29 out of 42); thus, the data primarily represent the pharmacies.

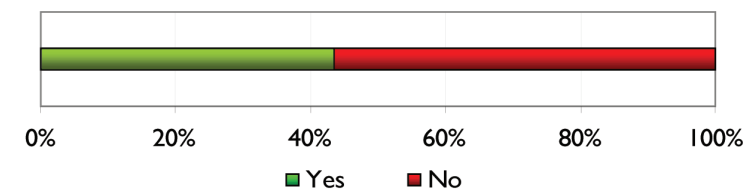
The majority of institutions contract with reverse distributors to dispose of unused medications. A reverse distributor is a service that arranges for the return of unwanted pharmaceuticals to manufacturers for credit or for the destruction or disposal of non-creditable products. Few institutions use the trash or drain as disposal methods. This indicates that institutions probably do not contribute pharmaceuticals to the environment via disposal.

Institutions were asked whether patients have asked them how to dispose of unwanted pharmaceuticals. Ninety percent

End-user disposal practices



End-users' awareness of issue



End-users' likeliness to return medicines to a pharmacy

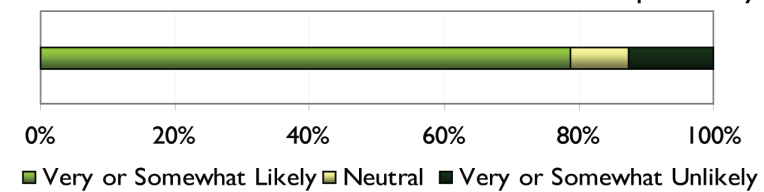


Figure 2: Selected results from the end-user survey

of pharmacies said "yes"; lower percentages were found for nursing homes and hospitals. This result indicates that if a disposal program is implemented in the future, institutions, particularly pharmacies, should be properly educated about current best disposal practices to provide accurate information to the public.

As mentioned previously, one of the potential policy options is a drug recycling program. However, this study found that most institutions in Santa Barbara County would not have unused, unexpired medications to donate to a drug recycling program. When asked if the facility would have medications that could be donated, 33 of 40 institutions (82.5 percent) answered "no." Most institutions dispose of less than 5 percent of their stock, and the majority of the medications they dispose of are expired, which are unsuitable for a recycling program. This implies that there is not likely to be a consistent supply of usable medications to support a drug recycling program.

Responses reveal that the majority of institutions are genuinely concerned about pharmaceutical contamination, which is manifested in a shared sentiment of cooperation among the respondents. This finding is encouraging and signals that if the County government were to implement a disposal pro-

gram for the public, the institutions would support the move. Respondents were asked whether they would house a drop-off box for an end-user disposal program. Many of the pharmacies said they would; conversely, only one hospital would consider installing a drop-off box. "Maybe" was the second most-common answer among pharmacies; many said they would have to ask their corporate headquarters. Pharmacies may be the best location to collect unwanted medications from end-users.

When asked which entity should take responsibility to address the pharmaceutical disposal issue, many respondents said that a collective effort is needed, and "government" was the most common response. This finding suggests the local government will likely need to instigate the movement toward establishing policy solutions.

END-USER SURVEY

In total, 1,005 responses were obtained from residents in Santa Barbara and Ventura Counties. There is no significant difference between the data from each county, so the data were combined for this analysis.

The most common responses for typical pharmaceutical disposal practices are trash (45 percent), toilet/drain (28 percent), and store at home (12 percent). These results are the opposite of the disposal practices of institutions, which rarely use the trash,

toilet, or drain as disposal methods.

A majority of the respondents (54 percent) are not aware that medicinal compounds have been found in treated wastewater and surface waters, indicating that education on the issue, with recommended alternative disposal methods, may be beneficial. An education or advertising campaign may help move people's disposal habits away from the trash, toilet, and sink. Respondents also show a strong willingness to participate in a drug disposal program, with 79 percent of respondents indicating that they would be very likely or somewhat likely to return their medicines to their pharmacy.

The CV data were used to estimate a logit model that predicts the probability of a "yes" response based on the surcharge amount and other predictive variables. Consistent with economic theory, we find that demand decreases as the given bid amount increases. Figure 3 shows this result, as the probability of a "yes" response decreases with an increase in surcharge amount. The WTP for a disposal program is also influenced significantly by age. The effect is in the expected direction, with older respondents, who tend to buy more prescriptions, having a lower WTP. Gender, political party, and ethnicity also influence WTP, with women, democrats, and