Bay Area Medication Disposal Study 2009

An Inventory of Household Pharmaceutical Waste

Final Report
Version 2.1

PREPARED BY

Dr. Joel Kreisberg, DC, MA
Dr. Ilene Ruhoy, MD, PhD
Connie Zheng, BS

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TELEOSIS INSTITUTE

863 Arlington Avenue
Berkeley, CA 94707
510.558.7285 Fax 510.527.1682
www.teleosis.org

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EXECUTIVE SUMMARY

This research report evaluates the quantity and types of unused pharmaceuticals returned in the San Francisco Bay Area in 2009, as well as the types and distribution of take-back programs for consumers.

In 2009, 126 pharmaceutical take-back sites collected 60,365 pounds of unused pharmaceuticals. Based on the inventoried samples, this quantity is composed of 85.6% pharmacological ingredient and 15.4% packaging material. The total cost of disposal for pharmaceuticals was $119,133.00 with an average cost of $1.99 per pound.

In order to identify the medications returned, two one-month samples from three sites in the nine counties of the SF Bay Area were manually inventoried by hand. Full bins of unused pharmaceuticals were opened and counted pill by pill, bottle by bottle. This study used the DAWN classification systems to categorize the medications by therapeutic class. The top four most common classes of medications returned were respiratory agents (19.9%), central nervous system agents (16.6%), topical agents (11.2%), and psychotherapeutic agents (9.9%). In addition, this study inventoried samples collected by generic name. We found the most common generic medications returned were albuterol (6.4%), acetaminophen (5.5%), and ipratropium (5.2%).

The research also looked at other key characteristics of the medications returned. Results showed that 57.2% of the medications were pills, capsules, or tablets, while 26.5% were liquids. In addition, 64.6% of the medications were prescription, 25.4% were over-the-counter, and 10% were nutritional supplements. Out of the medications returned, the average percent packaging by volume was 52.2%. Interestingly, only 20.6% of medications returned were not expired.

This study identified 126 permanent take-back sites operated by 20 agencies in seven of the nine SF Bay Area counties. The other two counties, Napa and Solano, did not operate permanent take-back sites, only take back events. Out of the 126 permanent sites, the two most common locations for take-back sites were pharmacies (49%) and law enforcement agencies (21.4%).

But regardless of the actual sites of operation, most of the agencies responsible for these sites belong to municipal waste water agencies, environmental health services, or waste management agencies. There is notable absence of participation from healthcare industries.

FOREWORD

While unused medications have steadily accumulated in our environment, their risks are only now beginning to be evaluated. Over the past several years, public and environmental health organizations such as the US Environmental Protection Agency, as well as other non-governmental organizations, have voiced concerns about current methods of disposal for unused household pharmaceuticals. Household pharmaceutical take-back programs began to operate as early as 2000 in the San Francisco Bay Area. Within the past three years, over 100 take-back sites have opened for operation. An evaluation of the quantities and types of unused or expired medications returned at these sites is essential to understand what constitutes commonly disposed pharmaceuticals by consumer.

This research seeks to address the following questions about household take-back programs. 1) What quantity of unused pharmaceuticals is returned by consumers for disposal at the take-back sites? 2) What are the most common types of medications returned? 3) How many take-back sites are in operation in the SF Bay Area? 4) Where are these sites and how are they organized? 5) What can we learn from a comprehensive examination of these systems used to take-back unwanted consumer medications?

With legislation entering several statehouses across the United States, we need to understand how these take-back programs operate. This comprehensive study evaluates not only the types of take-back programs, but also seeks to quantify the types of pharmaceuticals disposed of in the San Francisco Bay Area, an area that represents over 7 million people. The lessons for the pharmaceutical industry, government agencies, policy makers, public health systems, and most importantly health providers will emerge only after a closer examination of these programs. From there, we can move forward to facilitate a cross-sector dialogue and reach a consensus on the best way to handle our pharmaceutical waste.

INTRODUCTION

In 2009, the Teleosis Institute in Berkeley, CA initiated a two phased study of the unused pharmaceuticals returned to all take-back programs operating in the nine county San Francisco Bay Area region. The primary goal of this study is to provide a comprehensive documentation of the efforts of regional stakeholders that collect unused and unwanted pharmaceuticals. In addition, this research seeks to deepen our understanding of the types and quantities of medications returned to these programs.

This evaluation was done by sampling the actual types of pharmaceuticals disposed. The modeling system utilized involved manual inventories of unused pharmaceuticals collected at three different take-back sites. We identified the types and quantities of pharmaceuticals routinely disposed during two different one-month periods. Using these manual medicine counts, each sample was itemized for individual medication type, quantity, percent unused in original container, and percent packaging. These inventories offered an estimate of the total types and quantities of medications disposed in the Bay Area in 2009.

BACKGROUND

To date, there has been limited investigation into the actual nature of unused medications returned for disposal at household pharmaceutical take-back programs. Typically, quantities of collected pharmaceuticals are measured by pounds returned, with little information about the classes of medications returned or the amount of packaging discarded.

A recent study conducted by Lenard Kaye, Jennifer Crittenden, and Stevan Gressitt[i], partially funded by the United States Environmental Protection Agency demonstrated the effectiveness of the Safe Medicine Disposal for Maine (SMDME), a statewide model program for unused pharmaceutical waste disposal through a mail-back envelope system. Over a two-year period, the program successfully collected 2373 pounds of medication from approximately 150 participating health and human services agencies throughout Maine. The mail-back program allowed the SMDME to educate the public about proper pharmaceutical waste disposal and empower consumers to make informed decisions about environmental health. While the study served as a model for future mail-back systems, it did not detail the feasibility of other drug disposal options.

A report authored by Ilene Ruhoy and Christian Daughton of the US EPA[ii] assessed the types of unused medication collected by coroner records over a 13-month period in an effort to quantify medications that would be disposed into the environment by decedents. This study not only offered valuable insight as to the potential health impacts of unused pharmaceutical waste, but also provided crucial information regarding medication waste from patient non-compliance. While the research offered significant data to the spectrum of unused medication from decedents, the information collected is not representative of the overall consumer population. The decedent population may be biased in terms of age and health, thus it is necessary to broaden the scope of the study to obtain a sample population that is representative of the public.

i. Gressitt, S Kaye, I,& Crittenden, J, Reducing Prescription Drug misuse through the use of citizen mal-back program in Maine. 2010.

ii Ruhoy IS and Daughton CG “Types and Quantities of Leftover Drugs Entering the Environment via Disposal to Sewage - Revealed by Coroner Records,” Sci. Total Environ. , 2007, 388(1-3):137-148;

Two separate investigations conducted by Langley et al.[iii] and Thomas Morgan[iv] provide important information in regards to the therapeutic classes of pharmaceutical waste in community settings. The Langley et al. research collected 114 pound of medication in eight community pharmacies and General Practitioner surgeries, over a four-week period. The most common therapeutic classes collected were cardiovascular, CNS, and respiratory agents. Through 73 in-home pharmacy survey evaluations, the Morgan research found antibiotics, benzodiazepines, and antihypertensive to be the most commonly wasted medication and the cost of medication waste to be over $1 billion per year among patients 65 years and older. Although both studies presented vital information regarding the impacts of pharmaceutical waste, they are limited by the small sample size collected in the pilot studies. These studies need to be expanded to acquire a larger sample of medication collected and survey returned.

Our current research, the Bay Area Medication Disposal Study 2009, attempts to bridge these gaps in knowledge by examining multiple disposal methods. We want to broaden our population sample and expand our sample sizes in order to present a comprehensive overview of pharmaceutical waste returned to take-back sites in the San Francisco Bay Area. In effect, we hope to engage healthcare professionals and the public to reduce unused pharmaceuticals becoming waste and entering the environment.

METHODOLOGY

Program information was collected using an online questionnaire system hosted by SurveyMethods.com. The questionnaire included twenty questions as to the types of take-back programs operated, the number of sites in each program, the cost of disposing collected unused pharmaceuticals, and the methods of collection and disposal. Follow-up phone calls confirmed the results from the survey.

To understand the different types of medications that are commonly returned to household take-back sites in the SF Bay Area, sample manual counts were performed for medications returned. In this study, six samples from three different sites were calculated. Two samples were taken from each site to represent the amount pharmaceuticals returned within a one-month period. These samples are assumed to be representative of the average samples returned for the total inventory of medications. There were three different locations evaluated in this study: 1) a central collection center Palo Alto Regional Water Quality Control Plant which oversees all three take-back sites in the Palo Alto program 2) a single take-back site at Leiter's Pharmacy and 3) a central collection site for the Contra Costa Sanitary District which collects unused pharmaceuticals from seven other operating sites in their program.

iii Langley CA, Marriott JF, Mackridge A, Daniszewsi R, An investigation of returned medicines in primary care, Pharm World Sci., 2005, Vol. 27, 10

iv Morgan, TM The economic impact of Wasted Perscription Medication in an outpatient Population of Older Adults The Journal of Family Practice, 2001, Vol. 50 No. 9, 6

RESULTS

I) TAKE-BACK FACILITIES

Take-back Facilities in Operation

In 2009, 126 permanent pharmaceutical take-back sites were reported in the nine SF Bay Area Counties. Table 1 shows the number of take back sites, the population, and the population density per take-back site of each county. We expected counties with larger population sizes to have more take-back sites in operation and vice versa for counties with smaller population sizes, so that the population density at each site would be similar across the Bay Area. But interestingly, there is no clear relationship between the number of take-back sites and the population size of each county. For example, Sonoma County, Marin County, and Santa Clara County have the most take-back facilities in the Bay Area (28, 26, and 25, respectively). Because the three counties have similar numbers of take-back site, it is plausible to assume that they also have similar population numbers per county, thus similar population densities per take-back site. However, Table 1 shows that Sonoma County has population 472,102, with a population density of 16,862 people per site; Marin County has population 250,750, with a population density of 9,644 people per site; and Santa Clara County has population 1,784,642, with a population density of 71,386 people per site. Therefore, our results show that while these three counties have similar number of take-back sites, the population density per site among the counties are not the same.

The inconsistency between the number of take-back sites and population size is further highlighted as we look at San Francisco County, which has only three take-back sites, the lowest number in the Bay Area. However, San Francisco County has a relatively high population size of 815,358 people and a population density of 271,786 people per site. Napa County and Solano County have the lowest population sizes in the Bay Area. Neither counties have a permanent take-back site, although both offered take-back events at least once during 2009.

TABLE 1. Population Density per Take-back Site by County

County	Sites	Population by County	Population Density per Site
San Francisco	3	815,358	271,786
Contra Costa	10	1,041,274	103,127
Alameda	18	1,474,368	81,909
Santa Clara	25	1,784,642	71,386
San Mateo	16	718,989	44,937
Sonoma	28	472,102	16,862
Marin	26	250,750	9,644
Solano	0*	407,234	0
Napa	0*	134,650	0
Bay Area Total	**126**	**7,100,000**	**56,349 (Average)**

* Solano and Napa hosts take-back events, but do not have permanent take-back sites

Types of Take-Back Facilities

Table 2 organizes the take-back sites into nine categories of location. The most common permanent take-back facilities in the SF Bay Area are commercial pharmacies, which consist of 49.2% (62) of the total 126 Bay Area sites. The second most common take-back facilities are hosted by law enforcement agencies (public safety offices, sheriff stations and police departments) operate 21.4% (27) of total sites. The combined categories of medical facilities, which include hospitals, clinics, and dental offices, only make up 11.1% (14) of the take-back facilities. The remaining 17.3% (23) of sites are distributed across household hazardous waste facilities (9), fire stations (7), and government offices (7).

TABLE 2. Categories of Take-back Sites

Category of Take-back Sites	Sites	% of Total
Pharmacies	62	49.2%
Law Enforcement Agencies	27	21.4%
Household Hazardous Waste	9	7.1%
Medical Clinics	7	5.5%
Fire Stations*	7	5.5%
Government Offices	7	4.7%
Hospitals	3	2.4%
Other Medical Facilities	2	1.6%
Dental Offices	2	1.6%
Total Take-back Sites	**126**	

* Fire stations have programs under the supervision of law enforcement

Take Back Events

Take back events are common throughout the SF Bay Area. The two counties without permanent take-back sites, Napa and Solano offered at least one take-back event in the year 2009. All other counties, except San Mateo, offered take-back events in addition to their permanent take-back sites.

Program Oversight, Agency Responsible and Funding Mechanisms

The 126 permanent sites and the two single take-back events in this report are operated by 23 individual fiscal agencies. The 126 permanent sites are operated by 20 of these fiscal agencies. Of the 20 fiscal agencies, 18 returned our survey (90% response rate), which represents 122 take-back sites. The events-only sites are overseen by the three other fiscal agencies. Although all three agencies returned our survey, information from the events-only sites are not included in much of the data presented because this research focus specifically on the permanent take-back sites. Table 3 provides a summary of the types of agencies responsible for pharmaceutical take-back sites throughout the Bay Area.

Agency Oversight

The predominant agencies involved in returning household pharmaceutical wastes are water utility/waste water and environmental health service agencies. Because of regional differences in the organization of municipal services, these two agencies, as well as waste management agencies, overlap in their service jurisdiction. For example, while some utility districts oversee only drinking water, only wastewater, or only household hazardous waste, other programs oversee both wastewater and hazardous waste as part of environmental health services. Table 3 shows that 90.2% (110) of the pharmaceutical take-back sites in the SF Bay Area are operated by water, waste and environmental health services under the jurisdiction of city or county governments. If law enforcement (public safety) agencies are included, then the total local and regional government agencies operate 95.1% (116) of all on-going take-back sites. Three programs, a non-profit organization, a hospital, and a private pharmacy operate the remaining 4.9% (6) of the sites.

TABLE 3. Agency Oversight of Take-back Programs and Sites

Agency Oversight of Take-back Programs and Sites	# of Programs	% of Programs	# of Sites	% of Sites
Water Utility/Waste Water Agencies	8	44.4%	49	40.2%
Environmental Health Dept/Services	4	22.2%	59	48.4%
Waste Management	2	11.1%	2	1.6%
Public Safety Agency	1	5.6%	6	4.9%
Non-profit	1	5.6%	4	3.3%
Pharmacies	1	5.6%	1	0.08%
Hospital	1	5.6%	1	0.08%

Funding

Most programs cover the costs of disposal as part of their overall operating budget of the agency responsible for the site. Take-back sites situated at household hazardous waste facilities (which could be overseen by water/waste waster agency or public waste management agencies) may collect fees for drop off. For the most part, these fees are not specific to pharmaceutical waste, but are set for general or specific hazardous waste materials. All private organizations operating take-back facilities pay for the costs of disposal without an external funding mechanism, but consider take-backs programs as part of overall operating expenses. Currently, all programs operate at no cost to participants. Actual cost of disposal is presented on Table 10 of this report.

Date organizations began take-back programs

Table 4 indicates that majority of the programs in the SF Bay Area were established over the last three years. Out of the 20 reporting agencies, which include take-back events and sites, 70% (14) of the programs were initiated between 2007 and 2009. The newness of these programs reflects the recent trend to mandate the collection of unused pharmaceuticals. Older programs, such as Palo Alto Wastewater Facility and East Bay Municipal Utility District originated in 2003, while Marin's program operated by Marin County Environmental Health Services started in 2000. It is unclear whether the recent development of take-back programs will continue to rise or stabilize at these levels.

TABLE 4. Year of Program Establishment

Year	Number of Programs
2009	6
2008	4
2007	4
2005	2
2003	3
2000	1

Style of Collection System Used

The style of collections systems have evolved over the years and they often vary among different sites of operation. Table 5 organizes the take-back programs and take-back sites according to the type of collection system used. The earliest collection system used is the open bin, which is most convenient for consumers to return medications. The 26 sites in Marin County, which represent 20.6% of the overall sites, continue to operate this simple design. The open bin container, secured from public access behind a counter, is common in pharmacy take-back sites, and is used in 25.4% (32) of the total sites. The front loading single key lock has become common as law enforcement/public safety agencies and municipal water agencies began to operate take-back sites. These relatively easy-to-use permanent take-back systems make up 44.4% (56) of the sites. In 2009, CalRecycle developed a "model program" in conjunction

with the California Board of Pharmacy, which recommended a dual key lock system that required the waste hauler to have a separate key from the operator of each take-back location. This recent style is uncommon in the Bay Area and is found in only 3.2% (4) of the take back sites. The mailer system is operated by 1.6% (2) of sites. The mail-back system has several advantages consumers can either come to the take-back location to pick up the mailer or can have the mailers sent directly to consumers offering the advantage of reaching consumers unable to travel to take-back facilities.

TABLE 5. Style of Collection System Used

Style of Collection System	# of Programs	% of Programs	# of Sites	% of Sites
Front loading single key lock box	6	33.3%	56	44.4%
Open bin behind counter (no public access)	5	27.8%	32	25.4%
Other	3	16.7%	6	4%
Front loading dual key lock box	2	11.1%	4	3.2%
Open bin (with direct pubic access)	1	5.6%	26	20.6%
Mailer	1	5.6%	2	1.6%
Total	**18**		**126**	

Transportation Used for Disposal of Medication

Most programs employ a licensed medical waste transporter to pick-up full bins of pharmaceutical wastes and return them to a regional transfer stations for further consolidation. Once regional transfer stations accumulate significant quantities of unused pharmaceuticals, these wastes are transported by truck to incinerators, most commonly located in Utah. 93.4% (114) of all sites in the San Francisco Bay Area uses a licensed medical waste hauler.

Six of the 114 sites that ship pharmaceuticals with trucks utilize a household hazardous waste designation. All of these sites co-mingle household hazardous waste with pharmaceuticals. This does not necessarily mean that pharmaceuticals collected are not kept separate. Rather, the pharmaceutical wastes are treated as household hazardous waste and are disposed in a hazardous waste incinerator. Two sites use the direct mailer system which allows for consumers to drop unwanted pharmaceutical directly into a United States Postal Service box to be returned to a medical waste incinerator. The incinerator used in the mail-back system is located in Texas.

TABLE 6. System Used to Transport Medications for Permanent Disposal

Type of Transport	# of Programs	% of Programs	# of Sites	% of Sites
Licensed Medical Waste Hauler	13	72.2%	114	93.4%
Shipped as Hazardous Waste	4	22.2%	6	4.9%
Direct Mailer System	1	5.5%	2	1.6%
Total	**18**		**122**	

Disposal of Controlled Substances

While 80.3% (98) of the take-back sites are not allowed to collect medications regulated by the Control Substances Act, most of them do not provide proper instructions for consumers who need to dispose of their controlled substances. Only 24 of the 27 sites operated by law enforcement agencies, which make up 19.7% of overall sites, accept controlled substances for disposal in compliance with the Federal Controlled Substance Act. Consumers are not directed to sort their unused medicines, all prescription and OTC medications are returned for incineration using a locked-box system for handling unused pharmaceuticals safely. All 24 sites that accept controlled substances have a minimum of single key take-back boxes open directly to the public in facilities that have continuous law enforcement supervision.

Programs with Take-Back Events

Of the 18 programs in this study, 52.2% (12) of programs participate or offer take-back events throughout the year. Within these twelve programs, 13% (3) programs are exclusively take-back event programs and they are located in Solano, Napa and San Francisco County and have been offering annual take-back events for the past several years.

Programs Offering Mailers

Only the program operated by SF Environment utilizes mailers exclusively for the return of unwanted pharmaceuticals. Two other programs, Contra Costa and Santa Clara, use mailers in addition to their permanent take-back sites. Therefore, a total of 13% (3) of the programs in this study offer a mailer option for returning pharmaceuticals.

II) QUANTITIES OF PHARMACEUTICALS DISPOSED

The survey reported that 60,365 pounds of pharmaceuticals were collected for incineration in the SF Bay Area in 2009. This figure includes the weight of the bins, the mailers and the packaging due to the fact that weights are taken after collection.

Pounds Collected Per County

The average pounds of medications collected in the Bay Area, excluding the Solano and Napa take-back events, is 8,516 pounds. We expected the counties with higher number of take-back sites to collect larger amounts of medication, and vise versa for counties with lower numbers of take-back sites. However, Table 7 reveals that Santa Clara, Sonoma, and Marin, counties with the highest number of take-back sites (25, 28, and 26, respectively), collected varied amounts of medication. Santa Clara County collected 18,746 pounds of medication, more than twice the average collected in the Bay Area. Sonoma County collected 5,377 pounds of medication, relatively closer to the average pounds collected. Marin County collected 2,941 pounds of medication, which is much lower than the Bay Area average. These three counties illustrated that the pounds of medication collected is not necessarily correlated to the number of take-back sites in the county.

However, a distinct correlation is revealed when we compare the pounds of medication collected in Table 7 to the county population size in Table 1. Santa Clara County, the largest county by population (1,784,642 people), collected the highest pounds of medication. Sonoma County, a county with a modest population size of 472,102 people, collected close to the average pounds of medication. Marin County, the smallest county by population (250,750 people) with permanent take-back sites, collected the lowest pounds of medication.

TABLE 7. Pounds Collected by Sites

County	# of Sites	Pounds Collected	% of Total
Santa Clara	25	18,746	31%
San Mateo	16	17,778	29.5%
Contra Costa	10	8,813	14.6%
Sonoma	28	5,377	8.9%
Alameda	18	3,991	6.6%
Marin	26	2,941	14.6%
San Francisco	3	1,967	3.3%
Solano	0	671*	1.1%
Napa	0	80*	0.1%
Total Collected 2009		60,364	
Composite Average Per Site		8,516**	

* Total pounds collected from event

** Composite average excludes pounds collected from Solano and Napa events

When considering the total weight of pharmaceuticals collected, it is important to recognize that pharmaceuticals are most commonly returned in packaging, which includes both plastics and paper. As part of the inventory process, one of the samples from Palo Alto was separated into medication, plastics and paper. Table 8 presents the weight of the separated wastes, which consists of 85.6% pharmacological ingredients and 15.4% packaging (13.3% plastic and 2.1% paper). The total weight of medications returned in the SF Bay Area is 51,672 lbs when this sample is used to adjust for calculation.

TABLE 8. Percent of Medications by Weight for Palo Alto Sample

	Weight (lbs)	% Packaging by Weight
Medication weight (lbs)	571	85.6%
Plastics lbs	90	13.3%
Paper by lbs	14.5	2.1%
Total Weight	**675**	**100%**

Pounds Collected Per Site

Table 9 shows unwanted medications collected by sites within each county. San Mateo averaged 1,111 pounds per site, Contra Costa averaged 881 pounds per site and Santa Clara averaged 750 pounds per site. San Francisco, with only three sites, two of which offer a mail back distribution system, averaged 656 pounds per site. Interestingly, although Sonoma and Marin counties have high numbers of operating take-back sites, they only collected 192 and 113 pounds per site, respectively. Alameda, one of most populous counties in the Bay Area, only collected 3,991 pounds for its large population size of 1,474,368 people. These numbers include the weight of the bin, mailer and packaging.

TABLE 9. Pounds of Medication Collected per Site

County	Number of Sites	Pounds Collected	Pounds per Site
San Mateo	16	17,778	1,111
Contra Costa	10	8,813	881
Santa Clara	25	18,746	750
San Francisco	3	1,967	656
Alameda	18	3,991	222
Sonoma	28	5,377	192
Marin	26	2,941	113

III) COSTS OF DISPOSAL

The total cost of disposal for the collected household pharmaceutical waste in the SF Bay Area for 2009 was $119,133.00, as reported by the 22 of 24 programs responding to this inquiry. An accurate cost per pound ratio includes disposal costs calculated for respondents who provided the weight of pharmaceuticals collected and the costs of disposal for that weight. However, household hazarous waste facilities were not consistent in their reports of cost per pound. They commonly reported either weight without costs of disposal or weights with cost of disposal that reflected the costs of disposal as hazardous waste, which occurs at a significantly lower rate than medical waste. The cost of disposal for the 2,136 pounds of medication collected by the 10 household hazardous waste collection sites is not included in the total cost for disposal calculation because of inconsistent data.

Excluding the costs from household hazardous waste facilities, our survey found that the costs of disposal for pharmaceuticals collected in on-going take-back sites in the SF Bay Area to be $ 115,707.00 for a total 58,228 pounds of pharmaceuticals collected and disposed (again, including bins and packaging). This represents the total pounds and costs for 116 non-household hazardous waste sites.

The composite cost per pound for disposal for the 58,228 lbs is $1.99 per pound. Table 10 shows the costs per pound by county. The range of the cost per pound begins at a low of $1.13 per pound in Santa Clara to a high of $5.65 in San Francisco. Santa Clara and San Mateo County combined are responsible for collecting 63% of the total pounds of pharmaceuticals although their average cost for disposal is less than $1.99 per pound.

Several factors effect cost per pound. The most significant is that waste haulers often charge for pick up by volume, rather than by pound. For example, an 18-gallon container could cost any where from $90 to $140. Since the charge is for volume, the weight of each pick up varies greatly. More packaging and partially empty pill containers fill up a bin more quickly, leading to a lower weight. Another factor that affects costs is the overall sizes of the containers. Both San Mateo and Santa Clara, with their older and more established programs, collects significantly higher quantities of unused pharmaceuticals. Larger volumes are often charged at a lower rate than smaller volumes. Sonoma's program is distributed over many pharmacies and has a high cost of disposal, which may be a result of the smaller quantities returned distributed over more facilities. Likewise, Marin's program, which serves a county with low population size, may also have bin volumes that are smaller per pick-up.

The costs of $5.65 in San Francisco reflect the limitations of the mailer system. Consumers use mailers that are limited to an average of 8 ounces per prepaid mailing envelop. The cost of the mailer is predetermined, similar to the costs of the bins. There is no mechanism to require participants to completely fill the mailers, thus the weight and volume varies greatly based on use by consumer. Another issue effecting costs is that there is no guarantee that mailers will be used by consumers. The actual costs of the mailers equals the money spent on prepaid mailers divided by the actual pounds returned. Currently, the return rate for mailers is only 40%. Perhaps over time, prepaid mailers will be returned to the incinerator, reducing the overall average cost per pound.

From the data, it is clear that the cost per pound of disposal is lower when larger quantities of pharmaceuticals are collected and disposed. This may be less a factor of number of sites collecting unused pharmaceuticals and more a factor of the overall volume of collected pharmaceutical waste and the scale of fees associated with handling larger volumes of waste. Larger volumes are often handled more cheaply by medical waste haulers.

TABLE 10. Costs of Disposal per Pound

County	Cost per Pound	Pounds Collected (58,228 lbs total*)	% of Total Pounds
San Francisco	$5.65	1,667 lbs	2.9%
Marin	$4.76	2,941 lbs	5%
Sonoma	$3.91	5,337 lbs	9.2%
Contra Costa	$2.65	8,168 lbs	14.0%
Alameda	$1.75	3,591 lbs	6.2%
San Mateo	$1.25	17,778 lbs	30.6%
Santa Clara	$1.13	18,746 lbs	32.2%
Solano	NA	Event	NA
Napa	NA	Event	NA
Composite Cost Per Pound	**$1.99**		

* Total pounds excludes 2136 pounds of medication that were inconsistently reported

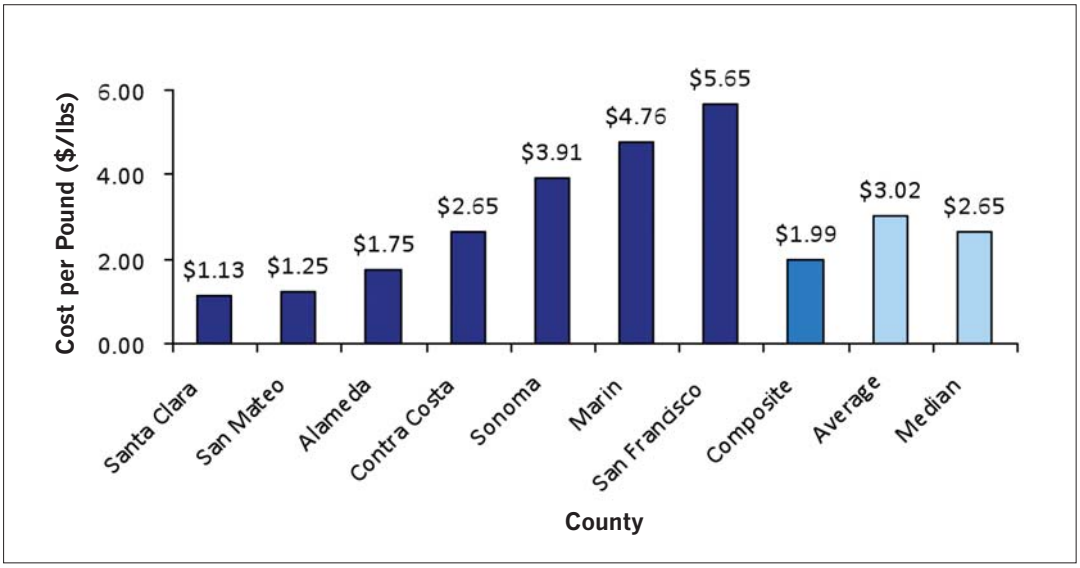


FIGURE 1. **Cost per Pound of Medication Disposal**

IV) TYPES OF MEDICATIONS RETURN

The Types of Pharmaceuticals Returned

In an effort to reveal the true nature of pharmaceuticals returned as unwanted or unused, the collected data is presented in several ways. The first method utilizes the comprehensive Drug Abuse Warning Network Drug Reference Vocabulary (DAWN DRV) to present the percentage of medications returned by therapeutic class (www.dawninfo.samhsa.gov). DAWN DRV is a resource managed by the US Department of Health and Human Services to record, code, and classify medication by information such as brand name, generic name, chemical name, and metabolites of both legal and illegal substances. The second method presents the top 11 generic medications found in the total composite of the six samples identified. The third method breaks down the medications collected according to formulary types- pills, liquids, injectables, ointments, powders, inhalers, suppositories, and patches.

Total Sample Size

Table 11 shows that six samples totaled to 1,418 lbs of unwanted pharmaceuticals. As samples of three distinct programs, these 1,418 lbs represent 10.4% of total unwanted pharmaceuticals returned in 2009 for the three sites combined (total returned for three sites was 13,686 lbs). This sample size also represents 5.1% of the total pounds collected in the two counties Santa Clara and Contra Costa combined (27,559 lbs), and 2.4% of the total pound (60,365 lbs) collected in the nine Bay Area counties in 2009.

TABLE 11. Comparative Sample Size

	Total Pounds	% of Total
Total Sample Size by Weight	1,418	
Total Weight 2009 of Three Sample Sites	13,686	10.40%
Total Weight 2009 of Two Counties	27,559	5.10%
Total Weight 2009 SF Bay Area	60,365	2.35%

The three sample sites refer to Palo Alto, Leiters, and Contra Costa.
The two counties refer to Santa Clara County and Contra Costa County

* Four of the six sample collections represented medications returned in Santa Clara County, a county that is close to average size population per site ratio, offering a respectively large percentage of total pounds collected by county (31%) for the SF Bay Area. The pounds per site collected represent the middle of the range of pounds collected per site. The Contra Costa County sample represents 14% of the total pharmaceutical collected by weight, with significantly lower number of population per site. The Contra Costa sites offer a representation of an above average pounds per site collected for the Bay Area. (For a complete presentation of the data from each of the three sample sites see Appendices).

Total Items Inventoried

The 1,418 pounds of pharmaceuticals identified generated 8,982 separate identified items of unused medication. One potential way of converting data is to calculate the number of items per pound.

TABLE 12. Total Items Inventoried

	Inventory
Total Pounds Collected	1,418 lbs
Total Items Identified	8,982 items

Identification of Returned Medications by Therapeutic Class

Table 13 presents the full list of therapeutic classes identified for the 1,418 lbs of the combined six samples in this study. The sum total of all items identified was 91% due to the fact that 9% of the items in the samples had been separated from the identifying container rendering identification beyond the scope of this paper or were identified as items other than pharmaceuticals such as glucose test strips, lancets, and contact lens cases. The most common therapeutic class of medication returned as unwanted was respiratory agents 19.9% (1,623). Central nervous system agents was second most common at 16.6% (1,358), and topical agents third 11.2%. Psychotherapeutic medications were disposed of at a rate of 9.9% (809). Appendix D offers a graphical representation of the distribution range for each therapeutic class across all six individual samples.

TABLE 13. Top Therapeutic Class

	Items	%	
Total Items Returned	8,982		
Unknown	808*	9%	
Total Therapeutics Identified	8,174	91%	
Therapeutic Class	**Items**	**%**	**Continuous % Composite**
Respiratory Agents	1,623	19.9%	19.9%
CNS Agents	1,358	16.6%	36.5%
Topical Agents	923	11.2%	47.7%
Psychotherapeutic Agents	809	9.9%	57.6%
Gastrointestinal Agents	607	7.4%	65.0%
Nutritional Products	592	7.2%	72.2%
Cardiovascular Agents	537	6.6%	78.8%
Anti-Infectives	536	6.6%	85.4%
Hormones	330	4.0%	89.4%
Metabolic Agents	288	3.5%	92.9%
Alternative Medicines	221	2.7%	95.6%
Miscellaneous Agents	137	1.7%	97.3%
Coagulation Modifiers	79	1%	98.3%
Anti-Neoplastics	32	0.4%	98.7%
Immunologic Agents	28	0.3%	99.0%
Radiologic Agents	2	0%	—
Non-Alcohol Illicits	2	0%	—

*58 items of the unknown were identified as non-pharmaceutical products.
Of these items, 10 were glucose test strips, 8 were lancets, and 4 were contact lens cases.

TABLE 14. Breakdown of Top Four Therapeutic Classes

Respiratory Agents	Items	%
Bronchodilators	1,012	62.4%
Antihistamines	217	14.4%
Respiratory agents NTA	168	10.3%
Upper respiratory combinations	90	5.5%
Expectorants	50	3.1%
Upper respiratory agents	47	2.9%
Decongestants	39	2.4%
Total Respiratory Agents	**1358**	

CNS Agents	Items	%
Analgesics	1,013	74.6%
Anti-convulsants	135	9.9%
Anti-emetic Agents	72	5.3%
Miscellaneous CNS agents	57	4.2%
Muscle relaxants	42	3.1%
Anti-parkinson agents	35	2.6%
Anorexiants	4	0.3%
Total CNS Agents	**1358**	

Topical Agents	Items	%
Dermatological agents	440	47.7%
Nasal preparations	192	20.8%
Ophthalmic preparations	160	17.3%
Otic preparations	35	3.8%
Vaginal preparations	34	3.7%
Mouth and throat products	33	3.6%
Antiseptic and germicides	22	2.4%
Anorectal preparations	7	0.7%
Total Topical Agents	**923**	

Psychotherapeutics Agents	Items	%
Antipsychotics	314	38.8%
Anxiolytics and sedatives	290	35.8%
Antidepressants	173	21.4%
CNS stimulants	32	4%
Total Psychotherapeutics	**809**	

Most Common Medications Return by Name

Table 15 presents the 11 most common medications identified by generic names in the composite sample. Due to the separation of packaging, 11.3% of the items were unidentifiable. Albuterol a bronchodilator, was the most common medication identified in our study with 6.4% (512) of our sample. The other significant pharmaceutical identified were acetaminophen, 5.5% (440) an analgesic or pain reliever that targets the central nervous system. The third most common medication returned was Ipratropium, 5.2% (417), an anticholinergic medication classified as a respiratory agent.

The concentrations of the next eight most common medications identified were significantly lower than the top three with highs of 1.9% (151) for ibuprofen and 1.5% (119) for aspirin, both non-steroidal anti-inflammatory medicines classified as central nervous system agents. The concentrations of identified generic medications drops off considerably after the 11th most common medication potassium chloride at 1% (78), a common nutritional product used to replenish electrolytes.

Interestingly six of the eleven most common medicines identified were prescription medications. Fluticasone 1.2% (95), a steroid creme is the only topical agent identified in the top 11 generic medications identified. Three over-the-counter medications, acetaminophen 5.5% (440), ibuprofen 1.9% (151), and aspirin 1.5% (119), and two nutritional products, multivitamins 1.4% (112) and potassium chloride 1% (27), were identified.

TABLE 15. Most Common Medications Returned

	Items	%	
Total Items Returned	8,982		
Unknown	1,019	11.3%	
Total Generic Medication Identified	7,962	88.6%	
Top 11 Generics	**Items**	**Est. %**	**Therapeutic Class**
Albuterol	512	6.4%	Respiratory Agents
Acetaminophen	440	5.5%	CNS Agents
Ipratropium	417	5.2%	Respiratory Agents
Ibuprofen	151	1.9%	CNS Agents
Aspirin	119	1.5%	CNS Agents
Multi-vitamin*	113	1.4%	Nutritional Products
Naproxen	109	1.4%	CNS Agents
Fluticasone	95	1.2%	Topical Agents
Diphenhydramine	94	1.2%	Psychotherapeutic Agents
Olanzapine	88	1.1%	Psychotherapeutic Agents
Potassium Chloride*	78	1%	Nutritional Products

* Not technically medications

Returned Medicines Identified by Dosage Form: Pills, Liquids, Injectables, Ointments, Powders, Inhalers, Suppositories, Patches

Identifying unused pharmaceutical by delivery type offers an interesting variation as to the nature of returned unused pharmaceuticals. Table 12 shows that the most common medication type returned in our samples was pills, such as capsules or tablets, which made up 57.2% (5,137) of the medications collected. The second most common type of type of medication returned were liquids, which made up of 26.5% (2,382) of the medications collected.

TABLE 16. Pharmaceuticals by Dosage Form

Type	Items	%	Continuous % Composite
Pills	5,137	57.2%	57.2%
Liquids	2,382	26.5%	83.7%
Ointments	534	5.9%	89.6%
Injectables	358	4%	93.6%
Powders	278	3.1%	96.1%
Inhalers	166	1.9%	98.6%
Suppositories	76	0.8%	99.4%
Patch	51	0.6%	100%
Total Items	**8,982**		

Percentage Prescription, Over-the-counter, or Supplement

An essential method for identifying types of pharmaceuticals is by categorizing the medication into prescription, over the counter or nutritional supplement. Table 17 shows that samples identified consisted of 64.6% (5,530) prescription medications, 25% (2,174) over the counter pharmaceuticals, and 10% (852) nutritional supplements.

TABLE 17. Prescription, OTC, and Supplements

	Items	%
Total Items Returned	8,982	
Total Items Identified as RX/OTC/Supp	8,554	95.2%
Prescription Medication	5,530	64.6%
Over-the-counter Medication	2,172	25.4%
Nutritional Supplement	852	10%

Percentage Expired

Because pharmaceutical disposal systems are design to collect unwanted medicines, the percentage of the medications identified as expired provides valuable information about the amount of household medication that goes unused. Table 18 shows that our samples identified 79.4% (6,488) of the medications collected as expired.

TABLE 18. Expired Medication

	Items	%
Total Items Returned	8,982	
Total Therapeutic Identified	8,174	91%
Items Expired	6,488	79.4%
Items Not Expired	1,686	20.6%

Percentage of Product Samples Returned

Product samples are medications given in smaller quantities by the prescribing party directly to patients at no cost. Product samples are commonly considered a large source of pharmaceutical waste and Table 19 shows that they compose of 11% of the total medications collected.

TABLE 19. Product Samples

	Items	%
Total Items Returned	8,982	
Unknown	808	9%
Total Product Samples Returned	986	11%

Percentage Packaging

Much of the pharmaceutical waste collected is measured by volume. As part of the identification researches estimated the percentage of packaging. This calculation was made by volume. Given the variation of pharmaceutical types, the study itemized the packaging by different medication type. Table 20 shows that the overall average percent packaging in the samples was 52.2%. An examination of the packaging by type shows that liquids have the lowest percentage of packaging 39.3% and inhalers have the highest percentage of packaging 76.9%.

TABLE 20. Percent Packaging

	Items	%
Total Items Returned	8,982	
Items with Packaging Identified	8,441	93.8%
Total Percentage Packaging by Volume		52.2%

Medication Type	Items	Average % Packaging
Inhalers	166	76.9%
Suppositories	74	66.1%
Injectables	328	65.3%
Pills	4,703	56.9%
Ointments	528	56.2%
Patch	35	55.1%
Powders	247	40.6%
Liquids	2,360	39.3%
Product Samples	986	75%

Product samples often have significant portions of packaging. Our inventory was able to calculate the percentage of package for samples that were disposed. We found that product samples average 75% packaging, which is well above the average percentage of packaging of 52.2% and very close the largest percent of packaging for any category of product delivery.

Percentage of Returned Items Unused Compared to Original Container Size

One of the more misleading figures when considering the nature of unused pharmaceutical returned for disposal at household take-back sites is the percentage of unused medications returned. In an effort to understand what portion goes unused of medications returned to household take-back systems, our inventory counted the number of pills that were left unused in each container of pills and compared that with the total amount as identified on the bottle. For much of the other types of medication, this calculation was done by a visual estimation. Overall with the average percentage of medications returned unused as compared to the original containers was 73.1%. It must be noted that this does not imply that 73.1% of all medication purchased or prescribed go unused. Rather, when medications are unwanted or unused, only 22.9% of the original dosage had been consumed leaving 73.1% remaining.

TABLE 21. Amount Unused in Container

	Items	%
Total Items Returned	8,982	
Items Identified as Unused	8,583	95.60%

Medication Type	Items	Average % Unused
Pills	4,757	67.3%
Liquids	2,369	78.2%
Injectables	358	80.8%
Ointments	533	81.6%
Powders	277	63.9%
Suppositories	75	86.6%
Inhalers	161	74.1%
Patch	53	95.6%
Average percentage remaining		**73.1%**

DISCUSSION

This discussion section analyzes different aspects of the inventory data including cost of disposal, funding mechanisms, drivers of take-back programs, participation of various healthcare sectors in take-back programs, age of establishment of the programs, types of medications and therapeutic classes returned, as well as overall lessons learned.

Costs

Our data shows that the cost of disposal is greatly reduced if the pharmaceuticals are collected in larger volumes. The counties of Santa Clara and San Mateo, which collected the largest quantities of pharmaceutical, paid $1.25 and $1.13 per pound for disposal, respectively. Their cost of disposal is significantly lower than the cost paid by other counties. Although there are several contributing factors for the low cost, the most obvious reason is the rate of medical waste transporter fees, which is less for larger quantities of pharmaceutical waste carried per trip. If all the unused medication were disposed of at the lowest rate of $1.13 per pound, the total cost of the 58,228 lbs of unwanted pharmaceuticals collected in 2009 would have been $65,798.00, a cost savings of $49,910.00, a 43% reduction.

As a theoretical exercise, a simple extrapolation may provide a reasonable estimate of the potential costs of pharmaceutical disposal in the United States. Assuming that the SF Bay Area is representative of the US (which it may or may not), the Bay Area population reflects 2.3% of the US population. Based on our data, the annual cost of disposal for pharmaceuticals is an estimated $5 million to $10 million. Keep in mind that these numbers would fluctuate significantly due to regional cost variations of disposal programs. Given the cost variations in the Bay Area alone, which ranged from $1.13 to $5.65, our estimate could be five times as high. In addition, this estimate does not include the costs of program operation, which were not calculated in this research study. However, our report does suggest that the removal of packaging could reduce the cost of disposal by at least 15%.

Drivers of Take-Back Programs

Our study shows that current systems of pharmaceutical take-backs are initiated and funded by government, public health, and law enforcement agencies. In other words, citizens are paying for the cost of disposal through public financing from money allocated for environmental quality assurance and public safety. Given our current difficult economy, this may not be the best use of public money. Certainly other stakeholders such as manufacturers, pharmacies, and health providers must also participate to alleviate the cost of pharmaceutical disposal.

Our study indicates that our current healthcare system has only marginally participated in consumer pharmaceutical waste disposal practices. While it is not the purpose of this study or the role of the researchers to make recommendations, we cannot ignore the need for active participation from the healthcare industry. In order to effectively reduce the burden of pharmaceutical waste in our environment, a cross-sector dialogue is required to understand the overall cost of disposal and the consequences of waste.

Age of Establishment of Take-back Programs

Most of the pharmaceutical waste disposal programs in this study have recently come into operation within the past three years. While long-term patterns of establishment are not evaluated, evidence suggests that initiation of new programs will continue in the future.

Types of Medications Returned

Because nearly two-thirds or the medicines returned in our study are prescription medications, these unused medications cannot be classified as traditional consumer goods. To some extent, they may reflect prescribing patterns, limiting our analysis. In order to effectively reduce waste, it is essential for all prescribing healthcare professionals, insurance providers, and healthcare system executives to be aware of their individual contributions to waste and to actively partake in practices to reduce unwanted pharmaceuticals.

Our study shows that the most common class of medication returned is respiratory agents, which accounts for nearly 20% of the collected medication. Several reasons for the prevalence of respiratory agents can be considered. Has the recent rise in acute and chronic respiratory diseases led to over-prescription and accumulation of respiratory agents? In turn, perhaps the accumulation of respiratory medications reflects a worsening of air quality in our environment?

Our research shows that the most common generic medication is albutoral. It may be appropriate to consider the effectiveness of albutoral, as well as other commonly returned medications. Are these products becoming less effective? Do these prescriptions naturally lead to stronger follow-up medicines, generating more waste? Even though our current research does not address these questions, further research is required to evaluate the issues.

Sample Medications

Interestingly, product samples only made up of 11% of the collected pharmaceutical wastes. Thus, reducing the amount of sample medications would lower the amount of unused medications, but it would only minimally reduce the overall waste.

Potential Comparison with Drug Sales

To further analyze our data, it would be useful to compare the quantity and type of drugs collected to the quantity and type sold in this region. Does the amount of unused medication collected reflect the amount sold over the period of our study? Are respiratory agents the most common medications prescribed? Do prescription medications make up two-thirds of all drug sales? What percentage of medications dispensed are sample medications? Are there strategies to reduce the amount of packaging to decrease the amount of solid waste?

Potential Quantities Returned Based on Density of Take-back Sites

Because a majority of the take-back programs have only been established in the past three years, we need to understand how the increase or decrease of take-back sites would affect amount of pharmaceuticals returned. Our data shows that an increase in take-back sites may not necessarily lead to an increase in pharmaceuticals returned. Perhaps there may be an ideal number of sites per population which results in the most cost-efficient programs. Since pharmaceuticals accumulate over time, once additional programs are established, perhaps the amount of pharmaceuticals disposed may reach a steady state. If this point is reached, then reduction of unused pharmaceuticals requires minimizing the overall number of pharmaceuticals prescribed, purchased, or unused rather than the additional establishment of take-back sites.

Sources and Overall Unused Pharmaceutical Accumulations

Our data does not identify the sources of unused pharmaceuticals. Even so, the continued growth in prescription drugs sales may lead to accumulation pharmaceutical wastes, which could overwhelm current take-back programs. Only long-term studies of trends in pharmaceuticals waste and monitoring of take-back programs will reveal the effectiveness of these take-back programs to properly manage wastes.

CONCLUSION

This report provides a snapshot of the cost, types, and quantities of medications disposed of in the Bay Area over the 2009 calendar year. 126 pharmaceutical take-back sites, primarily driven by government and public health agencies, collected over 60,000 pounds of unused pharmaceuticals. The estimated cost of waste incineration was roughly $120,000.00. By sampling 1,418 lbs or 2.3% of the total collected unused pharmaceutical, this research has provided a comprehensive analysis of common items returned in household take-back programs.

The most common classes of the medication collected include respiratory agents, non-steroidal anti-inflammatories, analgesics, central nervous systems agents, topical medications psychotherapeutic agents, which represented nearly 60% of the overall inventory. The most common specific medications returned are albuterol, acetaminophen and ipratropium. We have also identified the composition of pharmaceuticals by delivery type. For example, 57% returned are pills, capsules or tablets, while 26.5% are liquids. In addition, we have found that 64.4% are prescription medications, while 25.4% are over-the-counter medications. On average, items are made up of 52.2% packaging by volume.

What can we learn from this comprehensive research study? For one, the SF Bay Area, which includes over 7 million people, has successfully established multiple regional take-back programs for pharmaceutical waste. In 2009, these programs collected 60,000 pounds of unused medications for disposal by incineration, thus diverted these wastes from our waste water systems and landfills. Furthermore, these programs have increased consumer awareness for medication waste disposal and consumer participation in waste reduction.

This report also shows the variations in the cost of medication, as well as current methods of cost management. We found that the majority of these programs are funded by public financing systems, which means that citizens are ultimately shouldering the cost for disposal. Because the cost of disposal and incineration varies from $1.13 per point to $5.39, free market dynamics do play a role in driving costs. For example, current waste collection service fees often vary among different agencies depending on volume and weight of regular pick ups.

In many ways, our study cannot measure the full impact of collection programs. Accidental poisoning of children and the elderly, teenage drug abuse, household burglaries, and toxicant pollution in our regional water supply are all important issues that are affected by the accumulation pharmaceuticals in our homes. The current span of our research does not provide solid evidence that take-back programs lead to the reduction of these problems. But the fact is, in 2009, the programs did divert 60,000 pounds of medications from accidental poisoning, abuse, resale on the street, and environmental pollution. Thus, our research study does provides a clear picture of the potential problems, as well as offers safe solutions to the accumulation of medications in our homes.

From this study, we found that environmental safety and quality professionals play an important role in raising awareness for the potential risks of pharmaceutical in the environment. Yet this research also shows that healthcare industry, particularly prescribing health professionals, is not actively involved with the ultimate fate of unused pharmaceuticals once accumulated in the home. Because the prescribing professionals are directly involved in patient interactions, they potentially have the most influence in raising consumer awareness for pharmaceutical waste disposal.

Although our study provided valuable insight about current take-back programs, our findings may be limited by the one-year time frame of our research. Because most programs are less than three-years old, long term assessment is necessary to provide a clearer picture about patterns of program establishment. Still, this research does provide detailed analysis of pharmaceutical waste in a metropolitan region over one year's time. The quantities collected are large enough to suggest that it is prudent to call for the reduction of pharmaceutical waste accumulation in households across the United States. Because we do not know the full impact of these accumulated medications in our society and the environment, we need to take precautionary action against any potential harm.

Through a close examination of the nature of these collected wastes, we can take the necessary steps to reduce these wastes, lowering the risks and improving health for people and the environment. Because of the significant therapeutic values of these discarded medications, their active ingredients may continue to have an impact not properly disposed. Essential work lies ahead for us to improve our healthcare system and reduce the impacts of its waste. Archeologists learn a about people by looking into their trash. What become waste and why is a yet unexamined aspect of healthcare. Learning to use our medicines wisely by considering what goes unused has the potential for creating innovative approaches to improve healthcare outcomes for people with the added benefit of reducing the burden on the environment. Increasingly we find ourselves understanding more deeply our interrelationship with other beings on this planet. This report adds another piece to the growing data about a complex and emerging concern—how to support health for the people and the living planet while managing an overflow of our own unintended health care products.

APPENDICES

A) Composite Data for Palo Alto Regional Water Quality Control Plant

APPENDIX A1. Palo Alto Comparative Sample Size

	Pounds	%
Total Pounds Collected in Palo Alto Sample	946 lbs	
Total Pounds Collected in Palo Alto in 2009	5,486 lbs	17.20%
Total Pounds Collected in County	23,466 lbs	4%
Total Pounds Collected in Bay Area	65,676 lbs	1.4%

APPENDIX A2. Top Therapeutic Class

	Items	%
Total Items Returned	5,439	
Unknown	366	6.7%
Total Therapeutics Identified	5,073	93.3%

Therapeutic Class	Items	%
Respiratory Agents	1,055	20.7%
CNS Agents	915	18%
Topical Agents	604	11.9%
Nutritional Products	402	7.9%
Anti-Infectives	381	7.5%
Gastrointestinal Agents	347	6.8%
Cardiovascular Agents	337	6.6%
Psychotherapeutic Agents	317	6.2%
Hormones	210	4.1%
Alternative Medicines	171	3.4%
Metabolic Agents	167	3.3%
Miscellaneous Agents	82	1.6%
Coagulation Modifiers	63	1.2%
Antineoplastics	18	0.4%
Immunologic Agents	4	0.1%

APPENDIX A3. Most Common Generic Medication Returned

	Items	%
Total Items Returned	5,439	
Unknown	504	9.3%
Total Generics Medication Identified	4,935	90.7%

Top 15 Generics	Therapeutic Class	Items	%
Albuterol	Respiratory Agents	358	7.2%
Acetaminophen	CNS Agents	310	6.3%
Ipratropium	Respiratory Agents	295	6%
Ibuprofen	CNS Agents	127	2.6%
Aspirin	CNS Agents	104	2.1%
Multivitamin	Nutritional Products	98	2%
Naproxen	CNS Agents	82	1.7%
Methylcellulose	Gastrointestinal Agents	74	1.5%
Levothyroxine	Hormones	59	1.2%
Diphenhydramine	Psychotherapeutic Agents	57	1.2%
Ciprofloxacin	Topical Agents	56	1.1%
Amoxicillin	Anti-Infectives	51	1%
Colistimethate	Anti-Infectives	49	1%
Insulin	Metabolic Agents	48	1%
Docusate	Gastrointestinal Agents	46	0.9%

APPENDIX A4. Items by Dosage Form

Dosage Form	Items	%
Pills	3,208	59%
Liquids	1,630	30%
Injectables	228	4.2%
Ointments	194	3.5%
Powders	85	1.6%
Suppositories	37	0.7%
Inhalers	57	1%
Patch	0	0%
Total Items	5,439	

APPENDIX A5. Amount Unused in Container

	Items	%
Total Items Returned	5,439	
Items Identified as Unused	5,221	96%
Total Sample Unused		70.9%

Medication Type	Items	Average % Unused
Pills	3,000	62.9%
Liquids	1,620	81%
Injectables	272	90%
Ointments	150	77.7%
Powders	85	74.5%
Suppositories	37	74.6%
Inhalers	57	100%
Patch	0	0%

APPENDIX A6. Percent Packaging by Item

	Items	%
Total Items Returned	5,439	
Items with Packaging Identified	5,120	94.1%
Total % Packaging by Volume		46%

Medication Type	Items	Average % Packaging
Pills	2,933	52.1%
Liquids	1,617	28.6%
Injectables	228	66.9%
Ointments	191	62.1%
Powders	57	26.5%
Suppositories	37	74.6%
Inhalers	57	86.7%
Patch	0	0%

APPENDIX A7. Prescription, OTC, and Supplement

	Items	%
Total Items Returned	5,439	
Total Items Identified as RX/OTC/Supp	5,204	95.6%

	Items	%
Prescription Medication	3,236	62.2%
OTC Medication	1,475	28.3%
Nutritional Supplement	493	9.5%

APPENDIX A8. Expired Medications

Total Items Returned	5,439
Total Items Expired	4,076
% of Total Items Expired	74.9%

APPENDIX A9. Product Samples

Total Items Returned	5,439
Total Sample Items	366
% Sample by Item	6.7%

B) Composite Data for Leiters Pharmacy

APPENDIX B1. Leiters Comparative Sample Size

	Pounds	%
Total Pounds Collected in Sample	304 lbs	
Total Pounds Collected in Leiters in 2009	3,500 lbs	8.69%
Total Pounds Collected in County	23,466 lbs	1.3%
Total Pounds Collected in Bay Area	65,676 lbs	0.5%

APPENDIX B2. Top Therapeutic Class

	Items	%
Total Items Returned	1,618	
Unknown	177	10.9%
Total Therapeutics Identified	1,441	89%

Therapeutic Class	Items	%
Psychotherapeutic Agents	410	28.5%
CNS Agents	208	14.4%
Gastrointestinal Agents	177	12.3%
Topical Agents	166	11.5%
Respiratory Agents	102	7.1%
Cardiovascular Agents	77	5.3%
Nutritional Products	76	5.3%
Hormones	63	4.4%
Anti-Infectives	51	3.5%
Miscellaneous Agents	46	3.2%
Metabolic Agents	36	2.5%
Alternative Medicines	11	0.8%
Coagulation Modifiers	7	0.5%
Antineoplastics	6	0.4%
Immunologic Agents	3	0.2%
Non-Alcohol Illicits	2	0.1%

APPENDIX B3. Most Common Generic Medications Returned

	Items	%
Total Items Returned	1,618	
Unknown	212	13.1%
Total Generics Identified	1,407	87%

Top Generics	Therapeutic Class	Items	%
Olanzapine	Psychotherapeutic Agents	85	6%
Ziprasidone	Psychotherapeutic Agents	74	5.3%
Eszopiclone	Psychotherapeutic Agents	68	4.8%
Quetiapine	Psychotherapeutic Agents	62	4.4%
Acetaminophen	CNS Agents	59	4.2%
Metoclopramide	Gastrointestinal Agents	56	4%
Folate	Nutritional Products	47	3.3%
Divalproex Sodium	CNS Agents	35	2.5%
Memantine	CNS Agents	29	2.1%
Bacitracin/neomycin/polymyxin B	Topical Agents	26	1.8%
Atomoxetine	Psychotherapeutic Agents	17	1.2%

APPENDIX B4. Items by Dosage Form

Dosage Form	Items	%
Pills	1,101	68%
Liquids	176	10.9%
Injectables	44	2.7%
Ointments	183	11.3%
Powders	45	2.8%
Suppositories	28	1.8%
Inhalers	36	2.2%
Patch	5	0.3%
Total Items	1,618	

APPENDIX B5. Amount Unused in Container

	Items	%
Total Items Returned	1,618	
Items Identified as Unused	1,552	95.9%
Total Sample Unused		71.1%

Medication Type	Items	Average % Unused
Pills	1,039	72.5%
Liquids	174	50%
Injectables	44	58%
Ointments	183	86%
Powders	44	65.2%
Suppositories	27	93.3%
Inhalers	34	64.7%
Patch	7	66.6%

APPENDIX B6. Percent Packaging by Item

	Items	%
Total Items Returned	1,618	
Items with Packaging Identified	1,557	96.2%
Total % Packaging by Volume		64.8%

Medication Type	Items	Average % Packaging
Pills	1,052	75%
Liquids	168	38.4%
Injectables	44	48%
Ointments	181	43.8%
Powders	44	13.8%
Suppositories	27	68.7%
Inhalers	36	77.5%
Patch	5	62%

APPENDIX B7. Prescription, OTC, and Supplement

	Items	%
Total Items Returned in Sample	1,618	
Total Items Identified as RX/OTC/Supp	1,533	94.7%

	Items	%
Prescription Medication	1,103	72.7%
OTC Medication	266	17.5%
Nutritional Supplement	164	10.8%

APPENDIX B8. Expired Medications

Total Items Returned	1,618
Total Items Identified as Expired	991
% Expired	61.2%

APPENDIX B9. Product Samples

Total Items Returned	1,618
Total Sample Items	554
% Sample	34.2%

C) Composite Data for Contra Costa Municipal

APPENDIX C1. Contra Costa Comparative Sample Size

	Pounds	%
Total Pounds Collected in Sample	168 lbs	
Total Pounds Collected in Contra Costa in 2009	4,700 lbs	3.60%
Total Pounds Collected in County	8,811 lbs	1.90%
Total Pounds Collected in Bay Area	65,676 lbs	0.3%

APPENDIX C2. Top Therapeutic Class

	Items	%
Total Items Returned	1,925	
Unknown	265	13.8%
Total Therapeutics Identified	1,660	86.2%

Therapeutic Class	Items	%
Respiratory Agents	466	28.1%
CNS Agents	235	14.2%
Topical Agents	223	13.4%
Cardiovascular Agents	123	7.4%
Nutritional Products	114	6.9%
Anti-Infectives	104	6.3%
Metabolic Agents	85	5.1%
Gastrointestinal Agents	83	5%
Psychotherapeutic Agents	82	4.9%
Hormones	57	3.4%
Alternative Medicines	39	2.3%
Immunologic Agents	21	1.3%
Coagulation Modifiers	9	0.5%
Miscellaneous Agents	9	0.5%
Antineoplastics	8	0.5%
Radiologic Agents	2	0.1%

APPENDIX C3. Most Common Generic Medications Returned

	Items	%
Total Items Returned	1,925	
Unknown	305	15.8%
Total Generics Identified	1,620	84.2%

Top 12 Generics	Therapeutic Class	Items	%
Albuterol	Respiratory Agents	148	9.1%
Ipratropium	Respiratory Agents	113	7%
Acetaminophen	CNA Agents	71	4.4%
Fluticasone	Topical Agents	53	3.3%
Potassium Chloride	Nutritional Products	46	2.8%
Amphotericin B	Anti-Infectives	30	1.9%
Cholestyramine	Metabolic Agents	28	1.7%
Ibuprofen	CNS Agents	27	1.7%
Oral Nutritional Supplement	Nutritional Products	27	1.7%
Saline	Topical Agents	27	1.7%
Diphenhydramine	Psychotherapeutic Agents	26	1.6%

APPENDIX C4. Items by Dosage Form

Dosage Form	Items	%
Pills	828	43%
Liquids	576	29.9%
Injectables	86	4.5%
Ointments	157	8.1%
Powders	148	7.7%
Suppositories	11	0.6%
Inhalers	73	3.8%
Patch	46	2.4%
Total Items	**1,925**	

APPENDIX C5. Amount Unused in Container

	Items	%
Total Items Returned	1,925	
Items Identified as Unused	1,810	94%
Total Sample Unused		94%

Medication Type	Items	Average % Unused
Pills	718	74.4%
Liquids	575	78.8%
Injectables	86	64.4%
Ointments	156	81.3%
Powders	148	57.1%
Suppositories	11	100%
Inhalers	70	90.7%
Patch	46	100%

APPENDIX C6. Percent Packaging by Item

	Items	%
Total Items Returned	1,925	
Items with Packaging Identified	1,770	91.9%
Total % Packaging by Volume		59.2%

Medication Type	Items	Average % Packaging
Pills	718	50%
Liquids	575	69.8%
Injectables	56	72.7%
Ointments	156	63.4%
Powders	146	54.2%
Suppositories	10	27.8%
Inhalers	73	68.9%
Patch	30	54%

APPENDIX C7. Prescription, OTC, and Supplement

	Items	%
Total Items Returned	1,925	
Total Items Identified as RX/OTC/Supp	1,765	91.8%

	Items	%
Prescription Medication	1,181	66.9%
OTC Medication	476	27%
Nutritional Supplement	108	6.1%

APPENDIX C8. Expired Medications

Total Items Returned	1,925
Total Items Expired	1,421
% Expired by Item	73.8%

APPENDIX C9. Product Samples

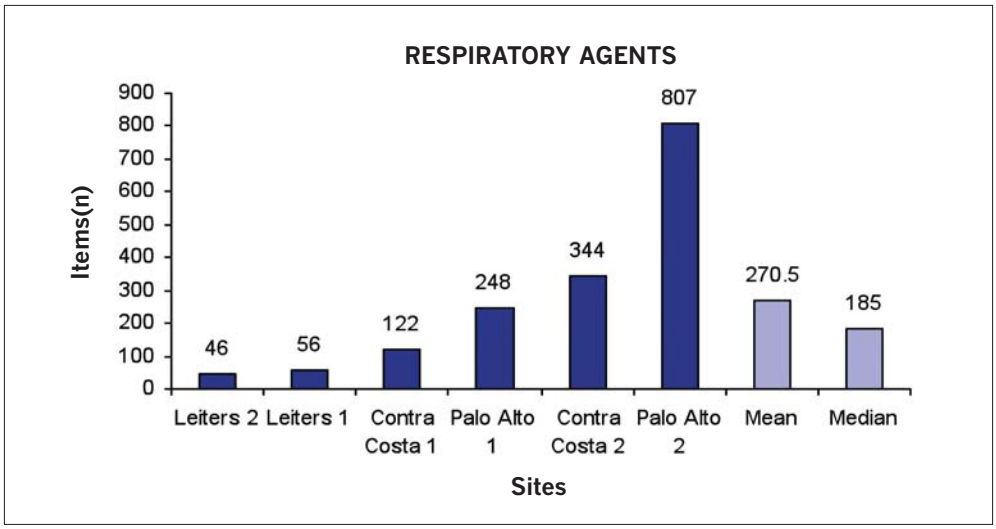
Total Items Returned	1,925
Total Sample Items	66
% Sample by Item	3.4%

D) Range of Therapeutic Classes for Six Samples

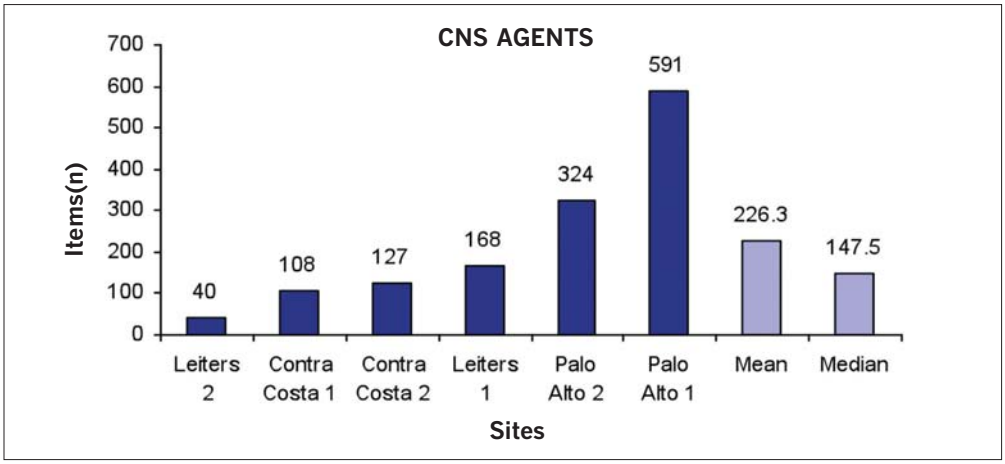
APPENDIX D1. Top Therapeutic Classes

	Items	%
Total Items Returned	8,982	
Unknown	808	9%
Total Therapeutic Identified	8,174	91%

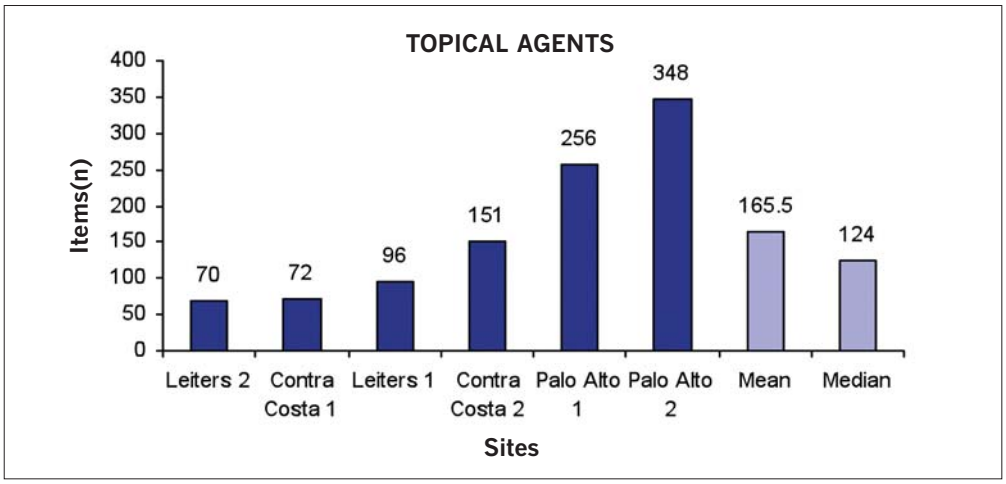
Therapeutic Class by Item	Items	%
Respiratory Agents	1,623	19.9%
CNS Agents	1,358	16.6%
Topical Agents	993	12.2%
Psychotherapeutic Agents	809	9.9%
Gastrointestinal Agents	607	7.4%
Nutritional Products	592	7.2%
Cardiovascular Agents	537	6.6%
Anti-Infectives	536	6.6%
Hormones	330	4%
Metabolic Agents	288	3.5%



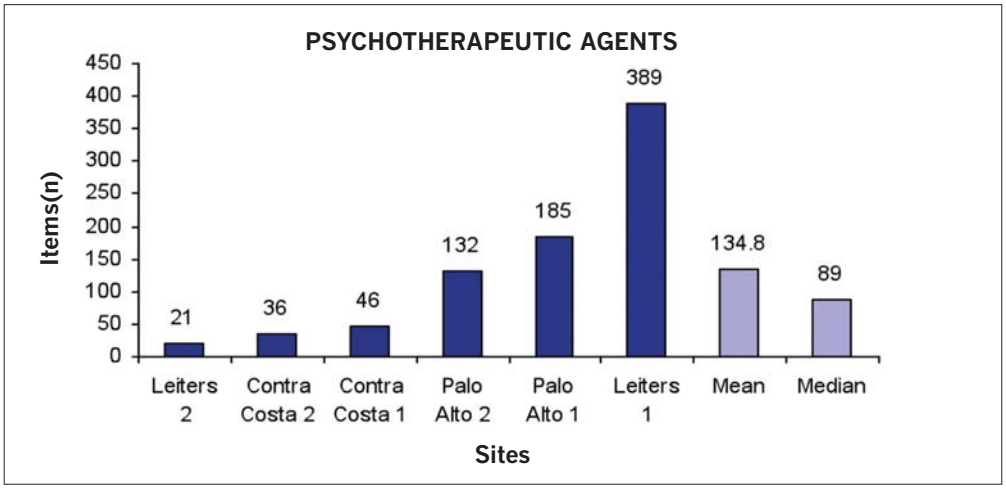
APPENDIX D2. Respiratory Agents by County



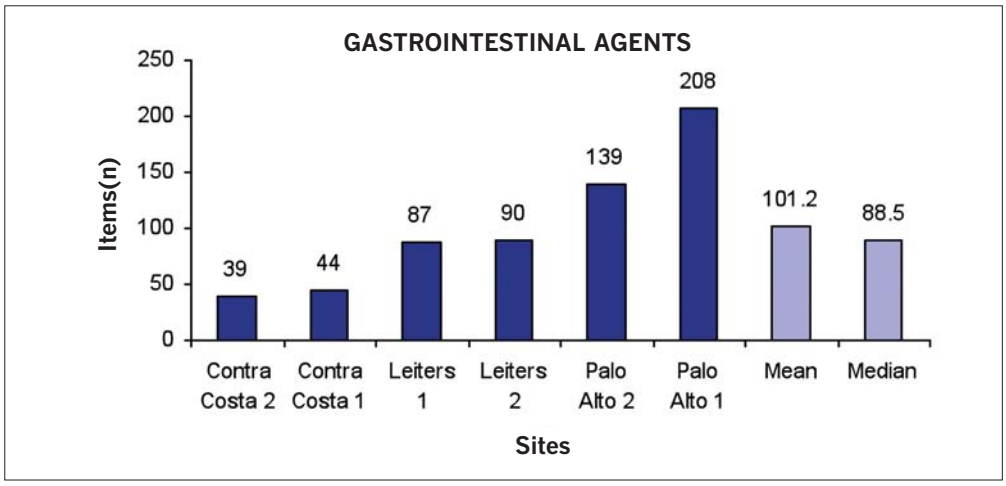
APPENDIX D3. CNS Agents by County



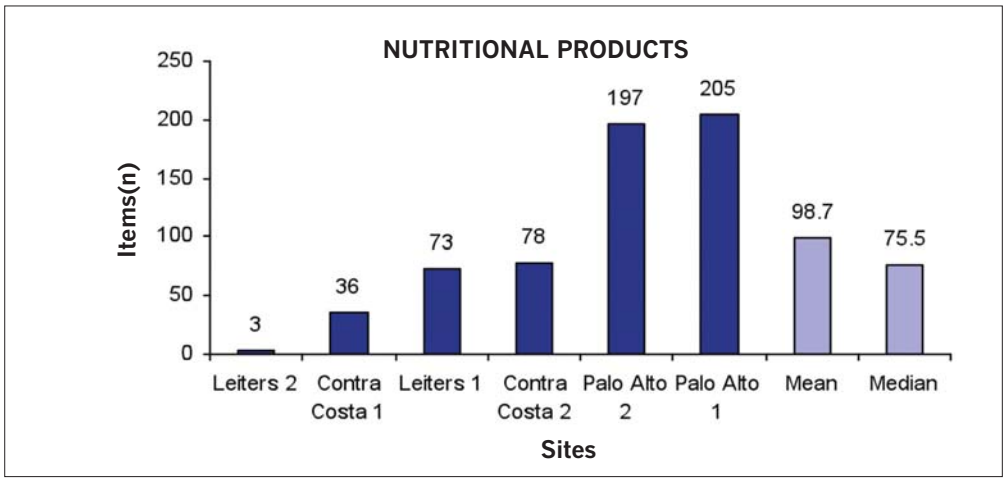
APPENDIX D4. Topical Agents by County



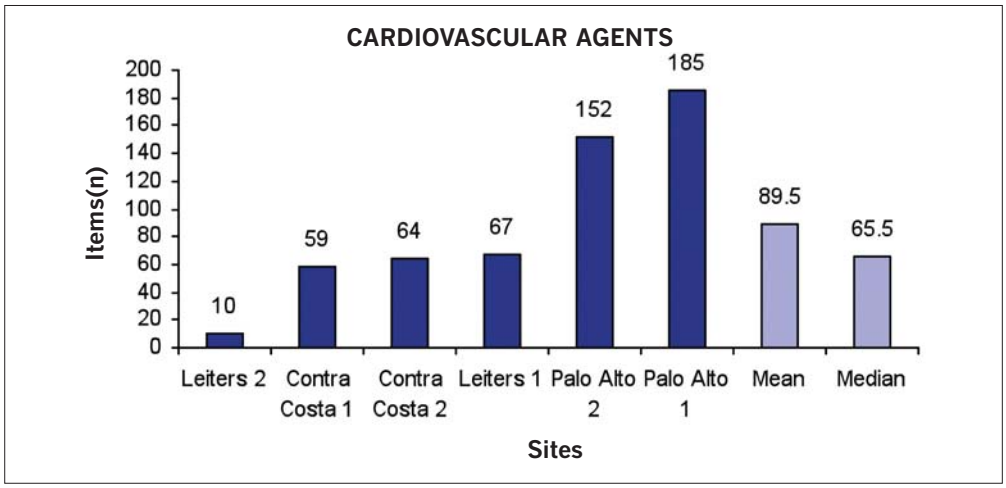
APPENDIX D5. Psychotherapeutic Agents by County



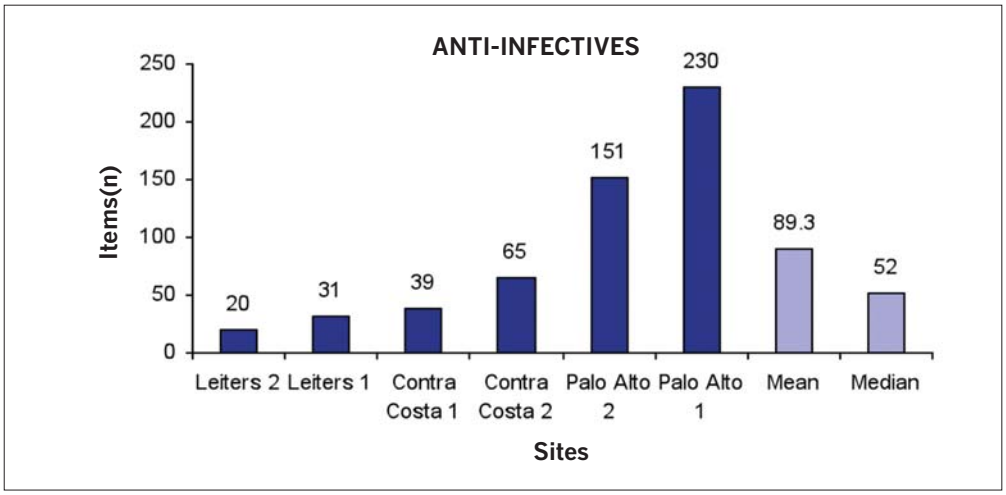
APPENDIX D6. Gastrointestinal Agents by County



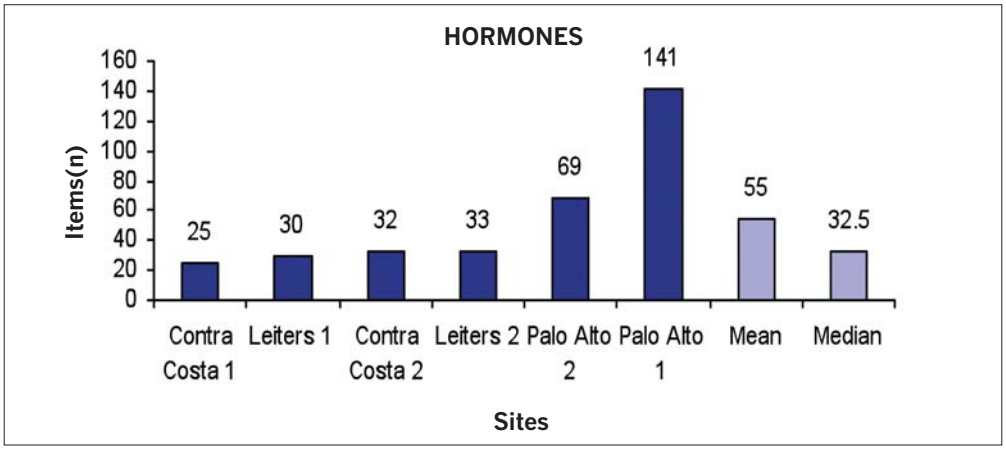
APPENDIX D7. Nutritional Products by County



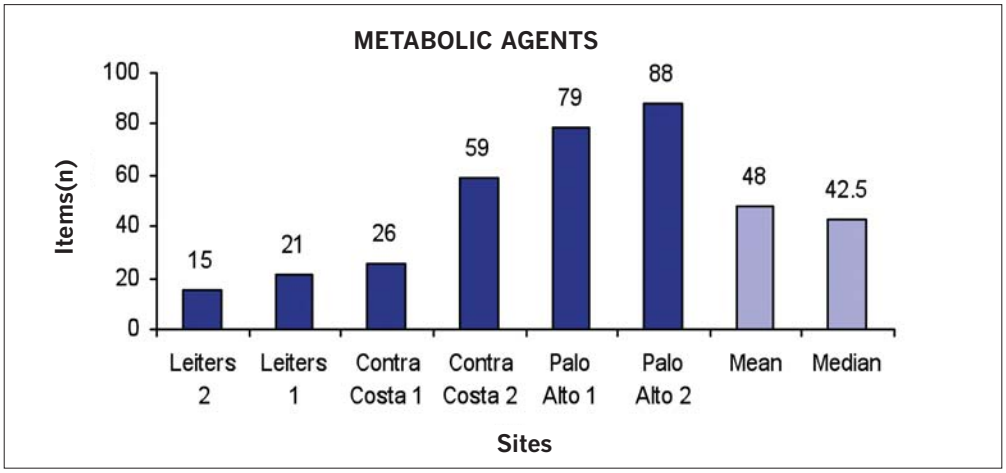
APPENDIX D8. Cardiovascular Agents by County



APPENDIX D9. Anti-Infectives by County



APPENDIX D10. Hormones by County



APPENDIX D11. Metabolic Agents by County

TELEOSIS INSTITUTE

863 Arlington Avenue
Berkeley, CA 94707
510.558.7285 Fax 510.527.1682
www.teleosis.org