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UNUSED MEDICATION COLLECTION:

An Emerging Service-Learning Experience for Pharmacy Students

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STUDENT AND FACULTY AUTHOR BIO SKETCHES

Anne E. Packard, Purdue College of Pharmacy, completed a summer internship with the Illinois-Indiana Sea Grant in conjunction with Purdue College of Pharmacy, where her research focused on the effects of pharmaceuticals in the environment and the collection of unwanted medication. In conjunction with fellow Purdue College of Pharmacy graduates and coauthors, **Maryam Noureldin**, **Carmine Colavecchia**, and **Jennifer Colavecchia**, and her Purdue College of Pharmacy faculty advisor, **Patricia Darbishire**, she describes the impact of her research findings on our communities and reflects on her experiences. Anne is currently completing her pharmacy training as a postgraduate ambulatory care resident at Kaiser Permanente–Colorado in Denver, in order to specialize in ambulatory care pharmacy.

INTRODUCTION AND BACKGROUND

While the U.S. makes up around 5% of the world's population, we consume approximately 75% of the world's prescription drugs—well over 4 billion prescriptions per year (Kaiser Family Foundation, 2018; National Institutes of Health, 2011; World Health Organization, 2003). Approximately one third of those are never used, creating an array of public health challenges (Take Meds Seriously, 2014). These challenges include land and water pollution (Boxall et al., 2012; Glassmeyer, Koplin, Furlong, & Focazio, 2008; Grason, 2009; Kidd et al., 2007; Nash et al., 2004; Tipp of the Mitt Watershed Council, 2019; U.S. Environmental Protection Agency, 2016); unintentional inappropriate use and unintentional human, pet, and wildlife poisonings (ASPCA, 2015; Atreja, Bellam, & Levy, 2005; Centers for Disease Control and Prevention, 2017a; Mowry, Spyker, Brooks, McMillan, & Schauben, 2015; National Institute on Drug Abuse, 2019; Rudd, 2016); and intentional drug abuse and diversion. Misuse of prescription drugs now exceeds that of all illegal drugs combined (Center for

Health Policy, 2016; Centers for Disease Control and Prevention, 2010; Department of Health and Human Services, 2012; National Institutes of Health, 2011; Poison Control National Capital Poison Center, 2017; U.S. Department of Health and Human Services, 2012, 2014; Tanabe, Paice, Stancati, & Fleming, 2012; Volk, 2019). Reducing the number of medications prescribed is of primary importance, as well as collecting unnecessary medications from households and disposing of them through environmentally friendly methods. There are a variety of medication collection methods, including public take-back events, permanent drop boxes at pharmacies, collection by police departments, as well as prepaid mailers available from some pharmacies and the Internet. When bulk medication is collected at take-back events or by police departments, it is generally quantified as “pounds collected,” with no determination of specific medications collected, quantities of prescribed medications left unused, or length of household storage beyond the expiration date. Pharmacy students are uniquely positioned to explore these unknowns and develop solutions with their high level of drug expertise. This research

study combined with community service events involved the collaboration of pharmacy students with environmentalists, community volunteers, and law enforcement officers to collect and analyze unwanted medications, as well as explore factors pertinent to this public hazard.

The goals for this student service project were to remove unused medications from households, dispose of them in an environmentally friendly method, and educate the public on both the risks of storage and appropriate disposal methods. Research objectives were to identify (1) which medications are commonly stored in households, as well as the quantities and length of time retained, (2) the public's current disposal practices, and (3) the public's understanding of and willingness to participate in safe disposal of medications. At the conclusion of this project, approximately 50 pharmacy students had collected 4,961 containers of unwanted medications from homes of approximately 700 participants. Over half of participants voluntarily completed the students' survey, which enhanced students' knowledge on the public's attitudes and practices regarding disposal of medications and better prepared them to provide education in their future practices.

METHODS

Under the guidance of a pharmacy faculty advisor and the Illinois-Indiana SeaGrant organization, and in conjunction with members of the Purdue University Student National Pharmaceutical Association, a team of

pharmacy students addressed the issue of unwanted medication in their community by organizing and hosting a series of 20 community medication take-back events and conducting survey research on returned medications, current disposal practices, and public perceptions.

Illinois-Indiana Sea Grant, a community partner, provides education, research, and funding to help strengthen and preserve the ecosystems and communities. They were a contributing partner to this service project and research by providing an internship opportunity to the primary author (Packard), as well as guidance and materials. The student team followed the procedures outlined in the publication "Collecting Unwanted Medications," developed by the Indiana Unwanted Medicines Task Force. (Illinois-Indiana Sea Grant, 2019). Donations of time and materials were provided by multiple community partners, including the Drug Free Coalition of Tippecanoe County and the Lafayette Police Department, among others. The events were advertised on local radio and television, campus newspaper ads, flyers, posters, and prescription bags stuffers at local pharmacies. The take-back events took place at multiple venues, including the Purdue campus, local community pharmacies, assisted living facilities, police departments, and churches. Events were conducted under the direct supervision of a pharmacist, police officer, and community partner host. Events were generally three to four hours in length, and the number of pharmacy students present at events averaged 8 to 16. Approximately 50 pharmacy students participated over a three-year time span.



Figure 1. Pharmacy students categorized and counted unused medications collected at an assisted living facility under the supervision of a pharmacist.



Figure 2. Members of the Student National Pharmaceutical Association at the Lafayette Police Training Academy with boxes of unused medications ready for transport to an environmentally friendly incinerator in Indianapolis.

Pre-pharmacy students welcomed participants to the events and requested participation in the survey research. Advanced, professional program students organized and analyzed the medications collected, recorded medication and survey data on spreadsheets, answered participants' questions, and provided education on proper disposal.

The students' first research objective was to identify which medications are commonly stored in households, as well as the quantities and length of time retained. Therefore, human and veterinary products, over-the-counter (OTC) and behind-the-counter (BTC) medications, as well as personal care products were collected at the events. Pharmacy students identified the medications and estimated quantities as they were returned. Students recorded the medication name, dosage form, prescription status (e.g., veterinary medications, controlled substances, OTC), quantity prescribed or total quantity of bottle/package size purchased, quantity remaining in container when collected, and product expiration date when known. Medications were further classified into 10 categories created before the study. Prescription labels were removed or marked out prior to placing products in large cardboard boxes. The boxes were then sealed and placed in the custody of the police officer and transported to a high-temperature incinerator for destruction—recommended as best practice (Illinois-Indiana Sea Grant, 2009; U.S. Department of Justice, 2019).

In order to meet the research objectives, the students and their faculty advisor developed a voluntary questionnaire



Figure 3. Old medications collected by students at a take-back event.

to provide to participants attending medication collection events. To this end, they performed literature searches using key words: medication disposal, medication collection, medication safety, environmental safety, and drug abuse. Students and their faculty advisor then developed a new questionnaire using foundational knowledge from published literature and adding questions that targeted unknowns. The questionnaire was reviewed by two additional faculty members and two community partners, and their feedback was incorporated. The questionnaire was deemed exempt by the Purdue Institutional Review Board and administered at the collection events to a convenience sample of participants 18 years of age and older. It consisted of 15 items

and took approximately 3 minutes to complete. Participant responses were linked to their returned medications through an assigned number. No personal identifiers were collected. The survey is available upon request of the faculty advisor/author.

Descriptive statistics were performed on questionnaire responses, as well as the medication data. Responses to partially completed surveys were included in data analysis, and missing data was not replaced. Post-hoc analysis was performed after matching the questionnaire data and medication data. Statistical tests included student's t-test, Mann-Whitney U test, chi-square test, and ANOVA with Tukey's test to compare participants' answers to survey questions and their relationship to the number of medications returned. A p-value of less than 0.05 was considered statistically significant. Statistical analyses were performed using Microsoft Excel and SAS 9.3 (Excel, Microsoft Corp, Redmond, WA; Winks SDA 7.0.5, TexaSoft, Cedar Hill, TX, and SAS 9.3, SAS Institute, Cary, NC).

RESULTS

Approximately 700 participants attended 20 medication collection events held between the years 2012 and 2015, and 478 completed questionnaires were collected. Approximately 222 participants did not complete the questionnaire, and their medications were not included in the analysis. Data on medication owner demographics is described in Table 1. Over two thirds of survey participants were first-time collection event attendees.

Products returned by survey participants (n = 4961 containers) were analyzed and placed into one of 10 therapeutic classifications (Table 2). Almost 60% (n = 2873) of medications were prescription products for human use, 40% (n = 2003) were OTC, BTC, or personal care products and 2% (n = 89) were prescribed for animals. Participants returned an average of 10 different types of products per consumer, with those participating in a medication collection event for the first time returning significantly more products than past participants. (Mean number of products returned: 11.5 ± 11.4 versus 7.7 ± 5.4, respectively, p = <0.001).

In this study, there was no significant difference in the number of medications returned based on household size, education level, participation in mail-order pharmacy, or participation in a pharmacy auto-refill program. Analgesics and related products were the most commonly returned medications (26%), followed

Table 1. Medication owner demographics as reported by survey participants.

Demographic	No. (%)*
Medication owner (n = 478)	
Survey participant	362 (75.7)
Family member	300 (62.8)
Friend	22 (4.6)
Animal	43 (9.0)
Other	15 (3.1)
Gender (n = 434)	
Male	104 (24.0)
Female	206 (47.5)
Unknown or other	0
Survey participant brought in medication for more than one gender.	124 (28.6)
Education level (n = 468)	
High school graduate or less	101 (21.6)
Some college or associate's degree	108 (23.1)
Bachelor's degree	112 (23.9)
Postgraduate degree	147 (31.4)
Age (n = 457)	
0–10	22 (4.8)
11–20	35 (7.7)
21–40	80 (17.5)
41–64	219 (48.0)
≥65	185 (40.5)
Number of people in household (n = 460)	
1	118 (25.7)
2	193 (42.0)
3	64 (13.9)
4	60 (13.0)
5	17 (3.7)
≥ 6	8 (1.7)

* Participants were allowed to select multiple options, therefore not all percentages add to 100.

by cough/cold, allergy, and asthma products (16%), and antimicrobials (11%). Over two thirds (70%) of product remained in nonprescription product containers when collected, whereas 63% of product remained in prescription containers. Antimicrobial medications were turned into the events with an average of 58% of the drug remaining in the original container. Table 3 lists the top 10 medications returned based on number of containers returned, as well as quantity of product (pills) returned. Hydrocodone-acetaminophen

Table 2. Product quantities returned by therapeutic classification

Ten therapeutic classifications		Number of containers returned* (n = 4,961) (%)
1	Analgesics, anti-inflammatory, and muscle relaxants	1,299 (26.2)
2	Cough/cold, allergy, and asthma	783 (15.8)
3	Antimicrobials	545 (11.0)
4	Cardiovascular	531 (10.7)
5	Gastrointestinal and urinary tract	513 (10.3)
6	Vitamins, herbals, and homeopathic	502 (10.1)
7	Psychiatric, neuroleptics, and hypnotics	401 (8.1)
8	Miscellaneous	270 (5.4)
9	Diabetes	75 (1.5)
10	Contraception	42 (0.8)
	Unknown	31 (0.6)

*Only products associated with completed questionnaires were included in results.

Table 3. Top ten medications returned.

Top ten medications ranked by number of containers		Top ten medications ranked by product (pill) quantity
1	Hydrocodone/acetaminophen	Potassium
2	Ibuprofen	Acetaminophen
3	Acetaminophen	Aspirin
4	Diphenhydramine	Ibuprofen
5	Vitamins	Hydrocodone/acetaminophen
6	Naproxen	Calcium
7	Guaifenesin	Diphenhydramine
8	Aspirin	Naproxen
9	Levothyroxine	Levothyroxine
10	Tramadol	Tramadol

combination products were the most commonly returned medication, and six of the top 10 medications returned were analgesics.

The average number of years a product was left in a household following its expiration date (prior to collection at this event) was almost 5 years (4.8 ± 4.1).

Participants’ primary reasons for bringing in medications included medication expired (71%), medication changed (43%), and medical condition resolved (34%). When participants were asked about their previous method of disposal, common responses were “Threw medication in the trash” (32%) and “Flushed the medication down the toilet” (25%). About 28% had never disposed of

any medication before. Table 4 reports the participants’ disposal practices.

Approximately 95% of participants claimed to know reasons to properly dispose of medications, and 98% indicated that improper disposal is harmful to the environment. However, over one third (37%) of participants reported that prior to this event, they were unsure of how to properly dispose of medications. Less than half (47%) were willing to pay for a disposal service to which they could return an unlimited number of medications, regardless of age. Over 65% of participants were unsure or negative toward the idea of government intervention in appropriate disposal. Table 5 contains participants’ responses related to their disposal knowledge and perceptions.

Table 4. Survey participant disposal practices.

Practice	No. (%)*
Origin of medication (n = 477)	
Local pharmacy	414 (83.3)
Locally over-the-counter	154 (32.3)
Mail-order pharmacy	121 (25.4)
Doctor's office sample	43 (9.0)
Other	29 (6.1)
Veteran's Administration	23 (4.8)
Don't know	21 (4.4)
Internet	4 (0.8)
Pharmacy auto-refill utilization (n = 432)	
Yes	144 (33.3)
No	284 (65.7)
First time event attendee (n = 465)	
Yes	320 (68.8)
No	145 (31.2)
Reason for disposal (n = 477)	
Medication expired	336 (70.6)
Medication changed	204 (42.8)
Medical condition resolved	160 (33.5)
Reaction/side effect	87 (18.2)
Patient deceased	73 (15.3)
Forgot to finish it	35 (7.3)
Other	31 (6.5)
Abuse/theft concern	7 (1.5)
Previous methods of disposal (n = 474)	
Placed in trash	153 (32.3)
Never disposed of medications	132 (27.8)
Flushed in toilet	118 (24.9)
Medication collection event	107 (22.6)
Police station	58 (12.2)
Took to pharmacy or HC provider	56 (11.8)
Other	13 (2.7)
Gave to a friend or relative	12 (2.5)

* Participants were allowed to select multiple options, therefore not all percentages add to 100.

DISCUSSION

Almost 5,000 containers of unwanted medications were removed from households that could have ended up in land and water supplies and/or posed consumption hazards. Additionally, students educated hundreds of individuals about the dangers of retaining expired and/

Table 5. Survey participant knowledge and perceptions regarding medication disposal.

Knowledge or perception	No. (%)
Perceives improper disposal harms environment (n = 460)	
Yes	449 (97.6)
No	1 (0.2)
Unsure	10 (2.2)
Claims to know reasons for safe disposal (n = 466)	
Yes	441 (94.6)
No	7 (1.5)
Unsure	18 (3.9)
Believes he/she knows where to dispose of medications (n = 457)	
Yes	288 (63.0)
No	80 (17.5)
Unsure	89 (19.5)
Willing to pay for disposal service (n = 447)	
Nothing	243 (54.4)
\$1.00-\$5.99	152 (34.0)
\$6.00-\$10.99	32 (7.2)
\$11.00-\$15.00	9 (2.0)
>\$15.00	11 (2.5)
Approves of government intervention in disposal (n = 458)	
Yes	160 (34.9)
No	134 (29.3)
Unsure	164 (35.8)

or unnecessary medications in the household, as well as proper disposal methods. These future pharmacists also gained knowledge and experience through their interactions with participants, better preparing them to positively impact their communities in the future.

Most medication owners in the study were elderly and resided in one or two person households, which aligns with national data (Kaiser Family Foundation, 2018). In contrast, nearly 80% of our participants were college educated, compared to the US national average of 59%. In fact, one third had completed a postgraduate degree, in contrast to the 12% national average (U.S. Census Bureau, 2016). Therefore, the educational level of this sample was higher than would be expected in the general public. This is not surprising when using a convenience sample of participants located near a top 10 university.

The majority of survey participants claimed to understand that improper disposal of medications harms the environment, but significant numbers also reported regularly disposing of medication in the trash or the toilet. Therefore, even highly educated segments of the population either do not view this issue as a public priority (supported by findings that the majority of participants were unwilling to pay any amount for disposal of an unlimited number of medications) or may not be as informed as they claim to be regarding the ramifications of medication waste. Other studies demonstrated similar findings in the public's actions and attitudes regarding medication disposal (Delano, 2016; Kotchen, Kallaos, Wheeler, Wong, & Zahller, 2009; Thach, Brown, & Pope, 2013).

Even highly educated segments of the population continue to store multiple, outdated products, as evidenced by the return of an average of 10 different types of products expired for 5 years. Almost one third indicated they had never before disposed of any medication. Many attendees anecdotally expressed keeping certain types of nonprescription items, such as eye or ear drops, vitamins/herbals, cough/cold, pain, and personal care products due to a belief that they may need the product in the future and/or that nonprescription and personal care products pose few safety hazards. Participants seemed generally unaware how frequently nonprescription and personal care products lead to unintentional poisonings, drug abuse, and environmental contamination (Mowry, Spyker, Cantilena Jr, McMillan, & Ford, 2014). With over two thirds (70%) of product remaining in nonprescription product containers, pharmacists could make a positive impact by promoting purchase of smaller quantities when recommending OTC products.

Patients also expressed an intention to retain certain prescribed medications, such as anti-infectives and analgesics, with reasons cited as future potential need, difficulty in obtaining from a prescriber when needed, and costs incurred with a doctor's visit and additional prescriptions. Several prescription products collected at events dated back to the 1970s.

In regard to the most common types of drug collected, analgesics (pain medications) were the primary group of prescription medications collected, with six of the top 10 medications collected in this therapeutic class. Hydrocodone/acetaminophen, specifically, was the most common drug collected at events. Of primary concern here are the quantities prescribed and left unused, as well as the length of time narcotics, such as hydrocodone, are retained in households. Retention time increases

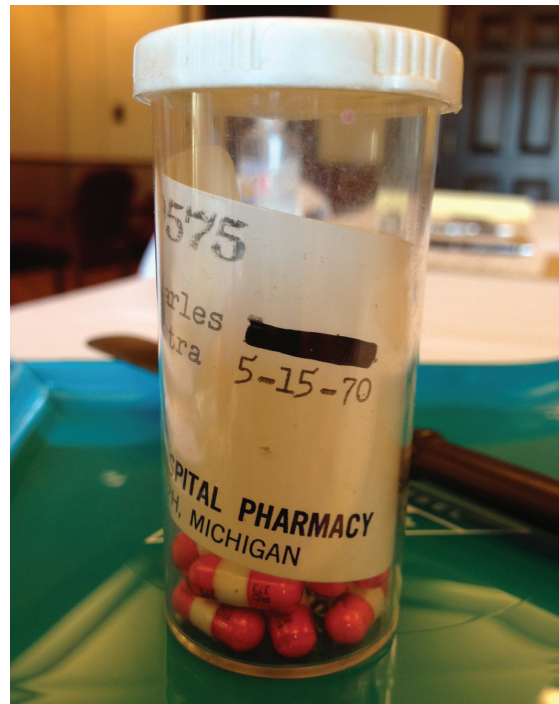


Figure 4. Vial of medication turned in at a collection event dating back to 1970.

the window of opportunity for abuse, theft, and diversion. The Substance Abuse and Mental Health Services Administration reported that 70% of abused narcotics come from friends and relatives' medicine cabinets (Volk, 2019). Likewise, Teen Drug Rehabs reported that 64% of teens say they have taken prescription painkillers from friends or family members (Teen Drug Rehabs, 2015). Cough/cold and asthma products are also often implicated in misuse and abuse, and were the second most commonly collected classes of medications.

Anti-infective agents were the third most commonly returned class of medications. On average, 63% of therapy remained in the container at the time of collection. Failure to finish a prescribed course of anti-infective therapy is commonplace, and may result in ineffective treatment, delay in appropriate therapy, and/or antibiotic resistance (Centers for Disease Control and Prevention, 2018a, 2018b; Marion County Public Health Department, 2019). Pharmacists can make a positive impact by ensuring their patients understand the importance of finishing the prescribed course of therapy.

Although the student researchers found no significant difference in the number of medications returned based on participation in mail-order pharmacy or pharmacy auto-refill programs, this is an area for further study. Many insurance plans promote the use of mail-order pharmacy through copay incentives, home delivery, and

eligibility for larger quantities of medication. Additionally, prescribers may provide “just in case” prescriptions and neglect suggesting nonpharmacological treatments when appropriate. The CDC reports that approximately 50% of antibiotic prescriptions written in the outpatient setting may be inappropriate (CDC, 2017b). Pharmacists should be vigilant in monitoring quantities prescribed and filled, and intervene when appropriate.

Likewise, both local and mail-order pharmacies commonly encourage patrons to enroll in a free, automatic prescription refill program whereby chronic medications are automatically refilled based on prescription directions, rather than actual need. Medications are then delivered directly to the patient’s home or made ready for pickup. This practice may facilitate the purchase of excessive medications, as research demonstrates that only about 50% of medications are actually taken as directed (Dimatteo, Giordani, Lepper, & Croghan, 2002; Iuga, 2014). Medication samples from doctor’s offices, verbal changes in the prescription directions from the prescriber directly to the patient, or instruction to discontinue using the medication may result in incorrect directions on a prescription. When situations like these occur, use of an auto-refill program results in unnecessary medications shipped to households or unwary caregivers picking up unneeded medications from local pharmacies. Survey results revealed that one third (33%) of medication owners utilized an auto-refill program.

There are many other factors that contribute to medication waste in the U.S., including aggressive marketing campaigns by drug manufacturers and the US public’s expectation and demand for quick fixes.

STUDENT CHALLENGES AND IMPACT

The Secure and Responsible Drug Disposal Act of 2010, an amendment to the Controlled Substances Act, permits collection of both noncontrolled and controlled substances by law enforcement, pharmacies, and police-supervised community collection events. Community pharmacists are perfectly poised to assist in the collection of unwanted medications due to their knowledge and accessibility. Unfortunately, there are barriers to collection, which include financial incentives, time, supplies and resources, personnel, and uncertainty of state and federal laws governing medication collection. These barriers can be addressed through a variety of means, with a first step being education in the pharmacy curricula, as well as the provision of professional service opportunities to students. Pharmacy faculty and student organizations have the unique ability to rally student assistance and

provide experiences in applying professional knowledge and skills. With more than two thirds of survey participants having never before attended a collection event and over one third reporting they had no idea where to take medications, it is evident that communities are in need of this service and education. Community service grants are available for materials/resources, and faculty can utilize connections in their local communities to assist students in finding venues. Therefore, it is our recommendation that pharmacy schools commit to engaging faculty and students in this important public issue.

Through this project, students applied their knowledge and skills to address a real-world problem. They removed thousands of unwanted medications from households, properly disposed of them, and provided public education. They produced new knowledge from research on medications commonly stored in households, and examined public attitudes and reasons for their findings. Medication take-back events provide an opportunity for pharmacy students to positively impact their communities and profession.

STUDY LIMITATIONS

This study had several limitations. The research was conducted in one state, with most events held in proximity to a large research-based university. Additionally, the person who turned in medication at the event was not necessarily the medication owner. This may have confounded interpretation of responses to some questions. Many (n = 222) patrons brought medications to events but did not fill out the questionnaire. In most cases, this was due to student personnel constraints, coupled with large numbers of participants. For the same reasons, not all products associated with surveys were recorded and analyzed. At some busy events, less than 10% of medications were recorded for analysis.

CONCLUSION

The public continues to store and improperly dispose of medications despite an awareness of misuse, abuse, diversion, and environmental harm. Entities with a stake in unused medication collection, including environmental agencies such as the Illinois-Indiana Sea Grant, health care professionals such as the Student National Pharmaceutical Association, and local police continue to collaborate to collect and properly dispose of unused medications through reciprocal interests. Community-based medication take-back events provide opportunities for pharmacy students to learn about and contribute toward safer communities.

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