

Inside Maine's Medicine Cabinet: Findings From the Drug Enforcement Administration's Medication Take-Back Events

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The use and misuse of prescription medications continue to rise in the United States. According to the most recent US National Health and Nutrition Examination Survey, the percentage of people who took at least 1 prescription drug in the past month increased from 44% in 1999 to 2000 to 48% in 2007 to 2008.¹ The percentage of people who used 5 or more prescription drugs increased from 6% to 11% in the same period.¹ In 2013, the National Drug Threat Assessment reported that nonmedical use of medications had higher prevalence rates than use of all other illicit substances (except marijuana), with pain relievers being most commonly misused.² Admissions for treatment arising from nonmedical use have increased 68% from 2007 to 2010; emergency department visits also increased 91.4% from 2006 to 2010.²

According to 1307 state and local law enforcement agencies, nonmedical use of medications represented the greatest drug threat, an increase of 9.8% since 2009.² Regional data suggest that New England (where 41.1% of prescription medication use is nonmedical), New York–New Jersey (47.1%), the Southeast (38%), and Florida–Caribbean (60.4%) suffer disproportionately in comparison with the rest of the United States (28.1%). Law enforcement agencies also report an increase in the availability of controlled medications without a valid prescription from 40.7% in 2007 to 75.4% in 2013.²

In 2012, the National Survey on Drug Use and Health estimated that 2.9 million people aged 12 years and older used an illicit substance within the past 12 months.³ Nonmedical use of prescription medications (defined as “use without a prescription or simply for the experience or feeling the medication caused”^{3(p27)}) accounted for 26% of those. Of the people taking prescription medications nonmedically, 54% reported obtaining the medication from a friend or relative for free, 10.9% bought the

medication from a friend or relative, and 4% stole the medication from a friend or relative.³ With an estimated 6.8 million people (2.6% of the US population) using prescription medications for nonmedical purposes and 68.9% of those obtaining these medications from community homes, our own medicine cabinets may be the primary source for abuse, misuse, and overdose deaths.

In 2011, the Drug Abuse Warning Network estimated that of approximately 2.5 million drug-related emergency department visits, 1.24 million (51%) were related to nonmedical use of medications (prescription, over-the-counter, and dietary supplements).⁴ Long-term trends (2004–2011) reveal a 132% increase in nonmedical use, and short-term trends (2009–2011) reveal a 15% increase. Among emergency department visits related to alcohol, 56% were also found to involve nonmedical use of medications. By contrast, emergency department visits whose main cause was

medication involved alcohol only 25% of the time. Almost all 200 000 medication-related suicide attempts involved either prescription or over-the-counter medications, which represents a long-term increase of 41% from 2004 to 2011.⁴

The availability of prescription medications has contributed significantly to the rate of accidental poisonings and overdoses. Among children aged 5 years or younger, accidental poisoning involving medications accounted for 318 visits per 100 000 children (67.8% of all accidental poisoning visits in 2011).⁴ Drug overdose deaths among adults increased for the 11th consecutive year in 2010, according to the National Center for Health Statistics.⁵ From 1999 to 2010, the number of US drug overdose deaths involving prescription opioid analgesics more than quadrupled, from 4030 to 16 651.⁵ In 2009, US drug overdose deaths surpassed motor vehicle accident deaths, with prescription opioid pain

Objectives. We evaluated the quantity and type of medications obtained in unused-medications return programs and the proportion of medication waste.

Methods. We analyzed data collected in 11 Maine cities in 2011 to 2013 during 6 Drug Enforcement Administration (DEA) national medication take-back events. Pharmacy doctoral student volunteers collected data under the supervision of law enforcement, independent of the DEA. Data entry into the Pharmaceutical Collection Monitoring System, through its interface with Micromedex, allowed for analysis of medication classification, controlled substance category, therapeutic class, and percentage of medication waste (units returned/units dispensed).

Results. Medication take-back events resulted in return of 13 599 individual medications from 1049 participants. We cataloged 553 019 units (capsules, tablets, milliliters, patches, or grams), representing 69.7% medication waste. Noncontrolled prescription medications accounted for 56.4% of returns, followed by over-the-counter medications (31.4%) and controlled prescription medications (9.1%).

Conclusions. The significant quantities of medications, including controlled substances, returned and high degree of medication waste emphasize the need for medication collection programs to further public health research and improve health in our communities. (*Am J Public Health.* 2015;105:e65–e71. doi:10.2105/AJPH.2014.302207)

relievers accounting for more deaths than cocaine and heroin combined.⁶

A case-control study in Tennessee conducted from 2007 to 2011 found that of the 932 opioid-related deaths, 340 (36.5%) of the decedents did not have a prescription for the opioid that resulted in their death.⁶ This may indicate that family members and friends are a significant source for obtaining prescription medications. A prospective cohort study in the Midwest published in 2012 found that emergency department patients with unused pain medications gave their medications to a friend (18.2%); were unable to locate the extra medication in their home, indicating the possibility of theft (18.2%); were keeping the medication “just in case” (66.7%); or disposed of their medications improperly (9.1%).⁷ In addition, none of the participants stored the medication safely.⁷

Maine has been disproportionately affected by this problem.⁸ The rate of increase in overdose deaths in Maine (210%) from 1999 to 2004 was the third highest in the nation, behind only Oklahoma and West Virginia.⁹ In 2009, the number of prescription overdose deaths in Maine exceeded motor vehicle deaths (165 vs 159) and has remained higher than all other causes of accidental deaths in the state since that time.¹⁰ A Centers for Disease Control and Prevention report found that in 2012, Maine ranked above all other states in prescribing rate per 100 persons of high-dose opioid pain relievers.¹¹

To address Maine's growing prescription drug problem, the legislature enacted 2 statutes that enabled the creation of the Maine Prescription Monitoring Program and the Safe Medicine Disposal for ME mail-back program (Title 22 Chapter 1603 and Title 22 Chapter 679, respectively).^{12,13} The monitoring program database serves as a tracking and monitoring system for controlled substance prescribing and distribution. However, only approximately 50% of prescribers in Maine were registered to use the program during the time of our study. Forty-eight of 50 states have implemented prescription-monitoring programs similar to Maine's. The Safe Medicine Disposal for ME program, which was a unique service provided by the Maine Drug Enforcement Administration (DEA), allowed community members to anonymously use the US Postal Service to easily

return controlled and noncontrolled medication, free of charge, for proper incineration.^{12,13} This program ran parallel to the DEA national medication take-back events until 2013.

The current prescription drug abuse epidemic is affected by several factors, ranging from improper prescribing or dispensing habits to illegal drug sources.¹⁴ Nonmedical use of prescription medication is a growing public health crisis, with subsequent high annual medical costs related to morbidity, mortality, and addiction.¹⁵ The lack of sustainable medication return programs has left households with unused and often expired medications that are easily accessible to abusers and may be accidentally ingested by children and pets or mistakenly taken by older adults.

Despite the growing national epidemic of prescription medication misuse and abuse, little is known about prescription medication waste in our communities. We evaluated data regarding unused medications collected in 11 Maine cities from 2011 to 2013 during 6 DEA national medication take-back events. One goal was to inform health care providers and public health policy officials about the amount and types of prescription medication waste. A second aim was to elevate awareness of medication waste in our communities and its

contribution to increased poisonings and abuse, misuse, and diversion of prescription medications.

METHODS

We recruited 11 medication collection sites independently via the Pharmaceutical Collection Monitoring System (PCMS) coordinator in collaboration with Generation Rx, a subset of the American Pharmacists Association's Academy of Student Pharmacists' chapter at the University of New England. We entered all sites into a use contract with the PCMS tool designers. The PCMS tool (Computer Automation Systems Inc, Aurora, CO) allowed for consistency in all data sets through the use of its interface with Micromedex, a comprehensive drug database by Truven Health Analytics (Greenwood Village, CO) that provides full drug information with American Association of Poison Control Centers coding.¹⁶

Doctor of pharmacy student volunteers collected all data under the direct supervision of licensed pharmacists, independent of the DEA, with direct oversight from local law enforcement. Student pharmacists attended a required 1-hour training session prior to any event. The training session provided information on how to accurately complete the logging

TABLE 1—Medication Returns by Number of Units and Percentage Waste for Each Medication Category: Drug Enforcement Administration Medication Take-Back Events, Maine, 2011–2013

Medication Category ^a	Original Units, ^b No.	Returned Units, ^c No.	Waste, ^d %
Noncontrolled Rx	393 640	311 670	79.2
Over-the-counter	248 867	173 452	69.7
Schedule II Rx	25 196	18 337	72.8
Schedule III Rx	20 023	14 371	71.8
Schedule IV Rx	15 373	12 441	80.9
Nonmedication item	13 110	11 950	91.2
Unknown	1420	5413	...
Schedule V Rx	7369	5386	73.1
Total combined units	724 997	553 019	69.7

Note. Rx = prescription medication.

^aBased on Micromedex American Association of Poison Control Centers coding and the Controlled Substance Act of 1974.^{16,17}

^bCapsules, tablets, milliliters, patches, or grams, obtained from returned-bottle label.

^cDetermined by manual counting.

^dCalculated by units returned divided by original units dispensed. If original units were missing, medication was excluded from the total percentage waste calculation.

TABLE 2—Medication Returns by Number of units and Percentage Waste for Each Controlled Substance Category: Drug Enforcement Administration Medication Take-Back Events, Maine, 2011–2013

Controlled Substance Classification ^a	Original Units ^b	Returned Units ^c	Waste, ^d %
Schedule III APAP and hydrocodone	14 380	10 679	74.3
Schedule II opioid (oxycodone)	12 057	8379	69.5
Schedule IV benzodiazepam	9776	7824	80
Schedule V opioid (codeine)	4310	2826	65.6
Schedule II opioid (morphine)	3623	2742	75.7
Schedule V other ^e	3059	2520	82.4
Schedule II APAP and oxycodone	2766	2317	83.8
Schedule III APAP and codeine	3277	2285	69.7
Schedule II stimulant (methamphetamine)	3007	2196	73
Schedule IV APAP and propoxyphene	2637	2174	82.4
Schedule IV sedative/hypnotic	1623	1523	93.8
Schedule II opioid (hydromorphone)	1721	1188	69
Schedule III other ^f	1789	1118	62.5
Schedule IV other ^g	1319	944	71.6
Schedule II stimulant (amphetamine)	833	667	80.1
Schedule II opioid (methadone)	522	419	80.3
Schedule II opioid (fentanyl)	414	328	79.2
Schedule III cannabinoid	490	205	41.8
Schedule III opioid	155	117	75.2
Schedule II opioid (meperidine)	120	61	50.8
Schedule II opioid (codeine)	130	37	28.5
Schedule II barbiturate	3	3	100
Total controlled substance units	68 011	50 549	74.3

Note. APAP = acetaminophen.

^aBased on Controlled Substance Act of 1974.¹⁷

^bCapsules, tablets, milliliters, patches, or grams, obtained from returned-bottle label.

^cDetermined by manual counting.

^dCalculated by units returned divided by original units dispensed. Percentage waste $\pm 16.2\%$ because of some missing original units.

^eLyrica, Potiga, Vimpat, promethazine and codeine, Lomotil/Lonox.

^fAspirin, codeine and butalbital, androgens, antihistamin/decongestant without phenylpropanolamine, ibuprofen and hydrocodone.

^gABHR suppositories, armodafinil, butorphanol, carisoprodol, codeine and guaifenesin, Modafinil, phenobarbital.

sheets and enter the data into PCMS, the process of participant number assignments and removal of patient information from medication containers, and all law enforcement requirements for handling the medications. Each volunteer signed Health Insurance Portability and Accountability Act and Zero Tolerance Diversion sheets prior to handling any medication.

Volunteers assigned each participant a number according to the order of arrival at the site. For all returned items, volunteers removed or obscured patient information, placed

medications in bags, and labeled them with the participant number prior to logging the information on a log sheet to be entered into PCMS. Information logged comprised classification (prescription, over-the-counter, or controlled prescription), name of medication or product, strength (including units), formulation, original quantity dispensed, quantity returned (manually counted), manufacturer, original fill date, expiration date, and whether the medication was a sample, factory sealed, or mail order. Volunteers compiled full medication information, including controlled substance category

(Schedule II–V), with the PCMS tool. We generated Excel (Microsoft Corp, Redmond, WA) reports for each of the data points entered.

RESULTS

Medication take-back events collected a total of 13 599 individual medications (controlled prescription, noncontrolled prescription, and over-the-counter) from 1049 participants. Of the medications returned, we catalogued 553 019 units (capsules, tablets, milliliters, patches, or grams). Upon comparison with dispensed amounts, the collection represented a total of 76.3% medication waste (units returned/original units dispensed). Upon exclusion for missing original counts (if the original units were missing, we excluded the medication from the total percentage waste calculation), the total medication waste was 69.7%. To clarify, if 100 tablets of a medication were dispensed and 69.7 tablets were turned in at the take-back event, medication waste was 69.7%. The full breakdown of returns is shown in Table 1.

Controlled substances accounted for 50 549 of the total units collected (9.1%). The therapeutic category breakdown and corresponding percentage waste for controlled substances are shown in Table 2. Of those returns, Schedule II medications accounted for 36.3%, Schedule III medications for 28.4%, Schedule IV medications for 24.6%, and Schedule V medications for 10.7%. The most commonly returned controlled medications were acetaminophen with hydrocodone (10 679 units), oxycodone IR (7474 units), lorazepam (3530 units), and guaifenesin with codeine (2826 units).

Noncontrolled prescription medications totaled 311 670 (56.4%) of all units collected. A full breakdown of the therapeutic categories with corresponding percentage waste is shown in Table 3. The most common noncontrolled medications received were lactulose (14 148 units), metoprolol (9003 units), gabapentin (8598 units), levothyroxine (6933 units), lisinopril (6785 units), warfarin (6672 units), albuterol (6389 units), hydrochlorothiazide (5406 units), simvastatin (5306 units), and fluticasone (4726 units). Overall, cardiovascular medications were the largest single category

TABLE 3—Medication Returns by Number of Units and Percentage Waste for Noncontrolled Prescriptions by Therapeutic Class: Drug Enforcement Administration Medication Take-Back Events, Maine, 2011–2013

Therapeutic Class ^a	Original Units ^b	Returned Units ^c	Waste, % ^d
Cardiovascular medication	87 208	72 839	83.5
Miscellaneous ^e	36 501	31 746	87
Gastrointestinal medication	28 306	25 645	90.6
Hormone	34 296	22 640	66
Antidepressant	24 984	21 912	87.7
Anticonvulsant	18 195	14 939	82.1
Antibiotic	20 238	13 571	67.1
Asthma	17 238	13 553	78.6
NSAID	12 763	10 367	81.2
Diuretic	14 956	10 069	67.3
Antihistamine	12 993	9409	72.4
Hypoglycemic medication	12 017	9335	77.7
Anticoagulant	11 652	8558	73.4
Topical steroid	10 951	7471	68.2
Sedative/hypnotic/antipsychotic	7022	6232	88.7
Antacid	6679	5371	80.4
Muscle relaxant	6008	4620	76.9
Opioid (noncontrolled)	5172	4333	83.8
Electrolyte/mineral	6315	3988	63.2
Antispasmodic medication	3501	2745	78.4
Antineoplastic medication	3126	2378	76.1
Antifungal medication	3687	2372	64.3
Anticholinergic medication	2485	2151	86.5
Antiparasitic medication	2249	1487	66.1
Lithium	900	782	86.9
Analgesic	693	706	...
Nasal medication	909	649	71.4
Antiviral medication	623	611	98.1
Topical anesthetic	912	594	65
Ophthalmic medication	759	469	61.7
Otic medication	200	125	62.6
Total noncontrolled units	393 540	311 664	79.2

Note. NSAID = nonsteroidal anti-inflammatory drug.

^aBased on Micromedex American Association of Poison Control Centers coding.

^bCapsules, tablets, milliliters, patches, or grams, obtained from returned-bottle label.

^cDetermined by manual counting.

^dCalculated by units returned divided by original units dispensed. Percentage waste \pm 15.3% because of some missing original units.

^eAll other noncontrolled therapeutic categories.

of returns (23.4%), followed by gastrointestinal agents (8.2%), hormones (7.3%), and antidepressants (7%).

Over-the-counter medications accounted for 31.4% of all returns (173 452 units). Dietary supplements were the largest category collected (30.4%), followed by gastrointestinal

agents (9.5%), nonsteroidal anti-inflammatory drugs (8.9%), aspirin (8.6%), and acetaminophen (6.3%). A complete breakdown of therapeutic categories with corresponding percentage waste is shown in Table 4. The most commonly returned dietary supplements were multivitamins (14 469 units), vitamin B

(10 692 units), calcium plus vitamin D (8730 units), magnesium (5788 units), vitamin D (5512 units), vitamin C (5027 units), vitamin E (4924 units), iron (4455 units), and glucosamine and chondroitin (4231 units).

DISCUSSION

We collected unused medication data because previous medication take-back events did not routinely report an inventory of types or quantities of returned medications. Out of deference to the request of law enforcement, we were unable to survey participants about their past experiences with unused medications or why they were returning excess medication. The DEA's take-back events were among the first simultaneous medication return programs in the United States, resulting in removal of more than 1400 tons of unused medications from communities across the country.² Maine has continuously had the highest amount of returns per capita (range = 589–1676 lb/100 000 population), according to the Maine DEA.

According to data from the 3-year collection period (2011–2013), cardiovascular medications consistently accounted for the largest proportion of returns (13.2%). In 2011, a medication take-back event in Hawaii also found that cardiovascular medications were returned at higher proportions than other noncontrolled prescriptions.¹⁸ These findings are not surprising because cardiovascular disease is a silent (i.e., lacking disabling physical characteristics), chronic condition and often requires several dosage adjustments, leading to excess medication. Studies have shown that patients base medication use priorities on perceived benefit and disease severity, which could also lead to unused medication.^{19–22}

Gray and Hagemeyer recently reported that controlled medication returns in rural Appalachia totaled 9.3% of their collection,²³ which closely resembled returns in Maine (9.1%). However, Maine received a total of 50 549 units; the study area in Northeast Tennessee–Southwest Virginia generated 11 406 returned units. This could be a result of Maine's larger aging population: the median age in the state is 42.7 years and in the country, 37.2 years.²⁴ In the Appalachia and Maine studies, hydrocodone combinations represented the largest

TABLE 4—Medication Returns by Number of Units and Percentage Waste for Over-the-Counter Medications by Therapeutic Class: Drug Enforcement Administration Medication Take-Back Events, Maine, 2011–2013

Therapeutic Class ^a	Original Units ^b	Returned Units ^c	Waste, % ^d
Dietary supplement	74 717	52 795	70.7
Gastrointestinal medication	20 482	16 392	80
NSAID	24 774	15 511	62.6
Aspirin	20 981	14 881	70.9
APAP alone	16 372	10 867	66.4
Antihistamine	11 949	9644	80.7
Miscellaneous ^e	12 176	9040	74.2
Botanical	8850	6276	70.9
Cold and cough	8633	5141	59.6
Antacid	6355	5043	79.4
Other topical medication ^f	7483	4977	66.5
APAP combination	5139	3890	75.7
Antihistamine/decongestant without PPA	5799	3739	64.5
APAP/antihistamine/decongestant without PPA	6095	3394	55.7
Hormone	3076	2153	70
Antidiarrheal medication	4459	2148	48.2
Amino acid	3018	2028	67.2
Homeopathic medication	1574	1278	81.2
Nasal preparation	1248	923	74
Ophthalmic medication	1213	795	65.5
Topical anesthetic	1018	763	74.9
Throat medication	902	638	70.7
Topical antibiotic	1019	349	34.3
Topical antifungal medication	788	333	42.2
Otic medication	386	263	68.1
Analgesic	362	195	53.9
Total over-the-counter units	248 867	173 452	69.7

Note. APAP = acetaminophen; NSAID = nonsteroidal anti-inflammatory drug; PPA = phenylpropanolamine.

^aBased on Micromedex American Association of Poison Control Centers coding.

^bCapsules, tablets, milliliters, patches, or grams, obtained from returned-bottle label.

^cDetermined by manual counting.

^dCalculated by units returned divided by original units dispensed. Percentage waste \pm 13.7% because of some missing original units.

^eAll other over-the-counter therapeutic categories.

^fAll other over-the-counter topical therapeutic categories.

proportion of returns (32% and 21.2%, respectively), followed by oxycodone and oxycodone combinations (11% and 21.2%, respectively).²³ It is important to note that Maine had more individual participants (1049 vs 752); however, Maine had fewer individual medications returned (13 599 vs 16 956).²³ Controlled substance returns from Hawaii, Maine, and Northeast Tennessee–Southwest Virginia were similar (10%, 9.1%, and 9.3%, respectively); the most common returns were hydrocodone

combinations, oxycodone, and oxycodone combinations.^{18,23}

In addition to disposal programs, medication education is an essential component of the overall solution. In a survey completed by Ma et al., 32% of participants reported keeping unused medications in their home, and 67% kept those medications for longer than a year.¹⁸ Another recent study, on the medication storage and retention habits of 191 veterans, revealed that 65.4% kept medication, and 34%

reported diverting or sharing medication or obtaining medication from a friend or family member.²⁵ Of the 65.4% who reported keeping the medication, 44% admitted to holding onto it “just in case” they needed it later.²⁵ Tanabe et al. had similar findings in a population of emergency department patients, with two thirds reporting they were keeping the medication for “the next time” so they could possibly avoid future emergency department visits.⁷ Because the Maine DEA did not allow us complete a survey, we were unable to compare Maine participants’ responses with other reported survey results.

We catalogued more than half a million pharmaceutical dosages, highlighting the concerns that medication storage in the home represent for health care providers. First, the medications can easily be acquired by children. These medications also serve as a ready source for teen and young adult abuse or experimentation. Excessive medications in the home can also lead to patient confusion and inadvertent overdoses. Furthermore, if patients use the stored medication, without a physician’s or pharmacist’s knowledge, medication interactions or adverse events can occur, with unknown consequences. Finally, medication storage can increase the risk of home invasions. All of these represent legitimate concerns that need to be properly relayed to patients.

Limitations

We did not assess the exact reasons behind the abundance of medication waste. A survey would have allowed us to better understand participants’ past experiences with unused medications and why they were returning excess medication. Several reasons may exist: overprescribing, lack of adherence, allergic reactions, or adverse drug events, or the medication simply didn’t work for that individual. Understanding the reasons participants have unused medication is key to understanding how to prevent medication waste.

Manually counting every unit returned can lead to unintentionally missing units. To minimize this limitation, we implemented a protocol to keep noise levels at a minimum to allow for proper concentration. Each volunteer had a paper log at hand to use as a counting sheet, which helped keep track of larger counts.

Some participants returned medications outside of their original containers or took the labels off the containers. Volunteers had to manually identify each of those medications from such details as their imprint code, color, and shape. This altered the total percentage waste calculation, because we were unable to determine the dispensed quantity, leading to the variations and exclusions presented. Some medications either could not be identified by their imprint code, didn't have an imprint code, or were liquid substances without labels. This made identification impossible and removed a proportion of medications from our counts (5413 units). Finally, returned medications came from the homes of people who did not take all of their medications for one reason or another. This affected the external validity of the study, because we cannot say that all medications dispensed are wasted 69.7% of the time.

Conclusions

We identified key areas that require additional research. First, demographic information about people who return unused medications and their reasons should be assessed. This would allow the health care sector and community organizations to understand the magnitude of this public health problem and begin to address the accumulation of medications in our communities. Second, retail and institutional market costs reached \$325.9 billion for prescription medications in 2012,²⁶ and are expected to increase,²⁷ so efforts to reduce medication waste could help control overall medical costs incurred by the public and private sectors.

Maine residents returned significant quantities of medications, including controlled substances, at each event over the 3-year study period, which confirms that these drugs are prevalent in our homes and communities. Medication waste was high in all collected therapeutic categories. These observations emphasize the need for sustainable medication collection programs, not only to further research to inform public health policy, but also to improve the health of our communities by removing dangerous and potentially addictive medications from residential areas in an environmentally safe manner. An immediate need exists for educational campaigns targeting

patients, health care providers, and community leaders to raise awareness about the risks associated with the accumulation of medications that contribute to poisonings, abuse, misuse, and diversion. Together, collection and education programs will provide Maine residents with opportunities for safe disposal of unused medications, which will decrease waste and overall medical costs and improve the health of our communities. ■

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Contributors

H. Stewart collected and analyzed all data, completed the background search, drafted the article, and incorporated revisions from all authors into the final version. A. Malinowski collected and analyzed the data. L. Ochs completed the background search. J. Jaramillo analyzed the data. K. McCall III compiled reviewer responses and completed revisions. M. Sullivan completed revisions.

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Human Participant Protection

The UNE institutional review board exempted the study because no human participant information was collected.

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