Environmental stewardship practices of veterinary professionals and educators related to use and disposal of pharmaceuticals and personal care products

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OBJECTIVE
To document the environmental stewardship practices (decisions and actions regarding use and disposal) of pet and human pharmaceuticals and personal care products (PPCPs) among pet-owning veterinary-care professionals (practicing veterinarians, veterinary students, and veterinary technicians and trainees) and environmental educators.

DESIGN
Internet-based cross-sectional survey.

SAMPLE
191 pet owners (103 veterinary-care professionals and 88 environmental educators).

PROCEDURES
Study participants were recruited by means of a 2-part internet survey distributed to veterinary-care professional and environmental educator networks of individuals residing in Washington state, Oregon, and southern California. Survey questions addressed motivators for environmental stewardship practices (ie, decisions and actions regarding use and disposal of pet and human PPCPs).

RESULTS
Data were collected from 191 respondents; the response rate for individuals who self-selected to opt in was 78% (191/246). Of the 191 respondents, 42 (22%) stored pet pharmaceuticals indefinitely. The most common disposal method was the garbage (88/191 [46%]). Veterinary-care professionals counseled clients infrequently regarding environmental stewardship practices for PPCPs. Fifty-five percent (105/191) of all respondents preferred more environmentally friendly and clinically effective PPCPs.

CONCLUSIONS AND CLINICAL RELEVANCE
Results of the present survey emphasized the urgent need for improved educational resources to minimize environmental contamination from improper disposal of PPCPs. Environmental and economic motivations among pet owners in the veterinary-care and education professions indicate further opportunities for outreach and institutional support. (J Am Vet Med Assoc 2018;252:596–604)

Pharmaceuticals and personal care products are emerging as contaminants of growing concern in watersheds and drinking water. Examples of PPCPs include prescription and over-the-counter drugs manufactured for human or animal use, cosmetics, hygiene products, and fragrances. Studies indicate that the average annual per-capita consumption of pharmaceuticals in developed countries is 50 to 100 g, or 3 to 10 times the worldwide average. Specifically for pets in the US, spending on veterinary care (routine visits and prescription medications) increased 3.4% from 2015 to 2016, from $15.42 billion to $15.95 billion. In addition, spending on pet supplies and over-the-counter pet medications increased 3% to $14.71 billion. Despite the increased manufacturing volume and use of pet PPCPs, there is comparatively little research on environmental stewardship practices (ie, decisions and actions of consumers [pet owners] regarding use and disposal of these products and the resultant environmental impact).

Pharmaceuticals and personal care products are an essential element of care for the 68% of US households owning at least 1 pet. Veterinary-care professionals (practicing veterinarians, veterinary students, and veterinary technicians and trainees) are trusted for their expertise and clinical services and thus would typically be expected to serve as role models and educators of pet owners regarding environmental stewardship practices for PPCPs. One pathway by which PPCPs could become environmental contami-

ABBREVIATIONS
MOU Memorandum of understanding
NOAA National Oceanic and Atmospheric Administration
PPCP Pharmaceuticals and personal care products
nants is via the improper, human-mediated disposal of unwanted or expired PPCPs. High concentrations of PPCPs in the environment can result in adverse effects ranging from poor water quality to negative effects on aquatic organisms. These problems, in turn, may potentially impact human health and aspects of the environment that pet owners value. As of 2017, only limited programs are available for diverting the entry of unwanted PPCPs into watersheds. Most current PPCP waste-diversion programs are directed toward outreach to discourage flushing of unused medication, support for voluntary take-back collection events and similar activities, placement of collection drop-off boxes at law enforcement stations, and distribution of mail-in envelopes, which hold only a limited number of products. Mandatory take-back programs for PPCPs that have been initiated in limited local jurisdictions have increased collection of unwanted prescription drugs from residents by nearly 10-fold. Although this is a positive step, these programs tend to emphasize human versus pet PPCPs.

Stewardship actions that deal with reducing PPCP accumulation in pet-owning households can help reduce the risk of accidental poisonings, abuse, and unused products entering the environment. Storing PPCPs indefinitely in the household poses a growing concern, as the PPCPs ultimately may either be disposed of or accidentally ingested or misused. There is, however, limited research on what motivates people, including pet owners, to decide on and engage in stewardship practices related to PPCP disposal. Unless actions are taken to help change how people are using and disposing of PPCPs, the quantities and sources of PPCPs reaching and accumulating in our waterways and the environment could continue to increase.

In 2011, the AVMA signed an MOU (which was renewed in 2016) with the NOAA National Sea Grant College Program to develop an education and outreach campaign to promote environmentally safe use and disposal of medications dispensed for animals (as well as for humans) and to increase awareness of the importance of proper disposal practices. As part of the campaign, the AVMA and the NOAA National Sea Grant College Program developed background information on proper disposal of unwanted medications that veterinarians could share with their clients. In addition, the AVMA created a video on best management practices for disposing of pharmaceuticals and pharmaceutical waste.

The present study was designed to obtain initial information on pet ownership environmental values (ie, the worth an individual places on the environment) in the context of PPCP stewardship practices (use, storage, and disposal), focusing on pet-owning veterinary-care professionals and a subset of their clients, pet-owning educators. The study was directed toward pet owners because they were considered likely to have both human and pet PPCPs in their homes. In addition, pets can be viewed as social enablers that provide opportunities to network with others on PPCP stewardship.

The specific objectives of the study reported here were to understand pet owner attitudes, norms, knowledge, and drivers of behaviors (stewardship practices) regarding the use and disposal of pet PPCPs and to learn whether there were relationships between pet owner use and disposal of pet versus human PPCPs.

Materials and Methods

Study design

This study was designed as a 2-part internet-based cross-sectional survey. The study was designed according to standard guidelines for qualitative research, including development of the research question, study population recruitment, sampling strategy (including reminder frequency and collaborators in distributing the survey), data collection and management, and data analysis and security. Ethics training was completed prior to data collection, including familiarity with consent and confidentiality requirements, data tracking, and storage. No vulnerable populations were interviewed for this study. The study protocol was approved by the Institutional Review Board of Oregon State University.

Study population

The target populations of the study were pet owners who were veterinary-care professionals (practicing veterinarians, veterinary students, and veterinary technicians and trainees) or environmental educators (formal K-12 and community college teachers, informal [eg, museum or zoo] educators, and extension educators) in Washington state, Oregon, and southern California. Potential respondents were identified by key informants who were part of educational and veterinary professional networks, such as state veterinary medical associations and environmental education groups. The membership size of the state veterinary medical associations that were initially invited to take part in the opt-in survey ranged from approximately 1,200 to 3,000. The membership size of the educator associations and environmental education groups ranged from approximately 10 to 2,000. This included state teacher associations (such as the Washington State Teachers Association) and environmental education groups focused on science (such as oceans, marine environments, watersheds, and invasive species and thus groups such as OceanList and the Environmental Education Association of Oregon). In sum, the targeted populations of pet owners were chosen because they were considered likely to be the intended users or beneficiaries of the AVMA-NOAA MOU. We chose to survey segments of the veterinary and environmental science education professions because we wanted to examine whether their training and profession might make them more familiar with PPCP environmental stewardship issues or practices. Because of nonprobability sampling, the scope of inference from this study was restricted to the char-
acteristics of the population that participated in the study, and as such, the study findings were not intended to be representative of attitudes held by the general public.

Data collection

The first part of the study presented veterinary-care professionals and educators with separate survey links to opt in to participate in the study. This opt-in survey provided participants the opportunity to answer questions specific to their profession. The opt-in survey was conducted to create a qualifying subset of pet-owning informants for the general survey. The 10-question opt-in survey was comprised of demographic and multiple-choice questions (eg, state of residence, type of practice or teaching setting, years of experience, age, and gender).

The second part of the study provided those who opted in with an online link to take part in the general survey. The general survey was piloted by 12 external reviewers (university extension specialists who were leaders of a nationwide community of practice that developed and conducted education on PPCP stewardship practices, veterinarians, pet-owning educators, and researchers and managers for water-quality agencies). The vetting process was conducted to critique the survey design and the actual questions. These reviewers were not part of the study population and did not participate in the general survey.

Part 1 of the general survey sought to understand the connection between pets and their owners and the connections between PPCPs and the environment. Part 2 examined the connection between pet ownership and environmental stewardship practices (use and disposal of pet PPCPs) in depth. Part 3 was designed to gather information about whether and how the use and disposal of pet PPCPs related to the use and disposal of pet owners’ human PPCPs. Part 4 explored how rational choice (knowledge), social proof (peer pressure), and institutional choice (regulations or policies) might be used to explain the motivations and drivers (social mechanisms) of PPCPs and their use and disposal behaviors or actions (environmental stewardship practices).

Contact and survey administration

The 10-question opt-in survey was emailed to veterinary-care professional and educator networks between November 2013 and May 2014. Each pet owner from these networks who self-selected to opt in to participate in the study received a digital cover letter providing information about the study, an informed consent document, and a unique code required for accessing the general survey.

The general survey was comprised of 38 multiple-choice and open-ended questions. The multiple-choice questions provided quantitative data; the open-ended questions provided qualitative data. To reduce response error from inaccurate or imprecise interpretations of the topic, the general survey first provided a definition of PPCPs. Subsequent parts of the general survey provided questions regarding motivations for pet ownership and respondents’ environmental stewardship practices (use and disposal) related to pet and human PPCPs. These questions related to the number of pet PPCPs participants might have in their household to use, what percentage of their pet PPCPs go unused, and what might be their top 3 methods for disposal of pet and human PPCPs. Additional questions focused on what motivated respondents to dispose of PPCPs and what activities would influence them to take positive actions toward protecting the environment when disposing of PPCPs. The survey also asked respondents to indicate their preferred sources to learn about disposal of PPCPs (eg, product label or health-care provider) and allowed for the veterinary-care professional group to self-report how often they communicated with clients about disposal of pet PPCPs (Supplementary Appendix S1, available at avmajournals.avma.org/doi/suppl/10.2460/javma.252.5.596).

Data analysis

A predictive analytics software program for social sciences was used to calculate descriptive statistics (eg, cross-tabulations and frequencies), bivariate statistics (eg, means, t test, χ² analyses, ANOVA, and Pearson correlation coefficients), and predictions for identifying groups (eg, exploratory factor analysis and cluster analysis). An ANOVA was used to calculate variance and to test for statistical differences between the 2 professions (veterinary and education) and their PPCP disposal methods, and χ² statistics were calculated for categorical variables related to PPCP use and disposal (eg, use completely or none to dispose) and to look at interactions with group variables such as pet versus human PPCPs and by profession. Values related to the environment (eg, clean water, clean air, and shelter) were analyzed along with respondents’ motivations for positive PPCP stewardship practices through an exploratory factor analysis with varimax rotations that yielded groups (factors) of relatable motivations as a way to examine the relationship between variables and to group relatable ones together. Reliability analysis tests were run to confirm internal consistency in groupings and their components.

Exploratory factor analysis (based on Pearson correlations) was also used to identify complex interrelationships between the outreach, social, and economic factors that influenced PPCP disposal methods between professional groups. No assumptions about relationships among factors were made prior to analysis. Varimax rotation allowed for factor groupings from a larger set of response variables (eg, groupings based on relationships between the variables determined by the loadings). Varimax rotation in exploratory factor analysis, which has been used in other survey studies, including work involving veterinary-care professionals, was used to generate simple,
Results

To attempt to evaluate pet owner PPCP environmental stewardship practices and motivations, this study tapped members of professional networks, who served as key informants and helped to “snowball” the study survey to potential respondents. Because these key informants forwarded the opt-in survey to others in their networks (eg, representatives of regional veterinary medical associations) and educator organizations chose to directly distribute the survey through their networks, rather than providing us with each individual member’s contact information, it was impossible to calculate an overall total number of potential respondents to the initial opt-in survey. However, of the 246 respondents who opted in, 191 went on to complete the general survey (78% response rate). The opt-in survey showed that respondents from Washington state represented 26% (52/203) of the total; Oregon and southern California represented 41% (83/203) and 34% (68/203), respectively. A majority of respondents (82% [155/189]) were female, and the top age range of female respondents was between 35 and 44 (25% [47/189]). Of the veterinary-care professionals group, 82% (125/152) practiced companion animal medicine, and 48% (42/87) had 6 or more years of veterinary experience. Seventy-seven percent (70/91) of the veterinary-care respondents practiced medicine, saw patients, and interacted with clinicians. Of the educator group, > 75% (70/93) had 6 or more years of teaching experience, 47% (44/93) taught primarily in a formal setting, and 32% (30/93) taught primarily in an informal setting (eg, zoo, aquarium, science center, museum, or park).

On the basis of the general survey, the veterinary-care profession represented 54% (103/191) of the total, whereas educators represented 46% (88/191). Ninety-three percent (178/191) of the total respondents (ie, veterinary-care professionals and educators) listed companionship as the top motivation for acquiring a pet. Health and life expectancy (78% [149/191]), followed by happiness or demeanor (57% [109/191]) and weight or physical activity (41% [78/191]), were the top 3 concerns for their pets’ well-being. In addition, 60% (115/191) cited clean water and clean air as the environmental factors they valued the highest for their pets. Seventy-two percent of the respondents considered buying pet personal care products designed to be environmentally friendly (eg, products that claim to have reduced, minimal, or no harm to the environment). A key reason for not buying environmentally friendly pet personal care products was that respondents were unaware of such products (49% [23/47]).

Status in use and disposal of pet and human PPCPs

Use and disposition of pet and human PPCPs by profession—Respondents were asked to select 1 out of 4 choices on how they used and disposed of pet and human PPCPs. For pet pharmaceuticals, educator respondents in this study were more likely (54% [44/82]) to report completely finishing pet pharmaceuticals (and therefore having none to dispose of) than were veterinary-care professionals (26% [23/88]). Veterinary-care professionals were more likely to keep unused pet pharmaceuticals until they expired and then dispose of them (42% [37/88]); their next most likely course of action would be to store unused pet pharmaceuticals in the house indefinitely (28% [21/88]; Figure 1).

For pet personal care products, 65% (53/82) of educator and 40% (35/87) of veterinary-care respondents reported finishing completely and thus having no leftover product requiring disposal. These results were followed by storing product in the house indefinitely (51% [27/52] and 24% [20/82] for veterinary-care and educator respondents, respectively) and keeping unused pet personal care products until they expired and then disposing of them (29% [25/87] and 11% [9/82], respectively).

Disposal of pet and human PPCPs by profession—Respondents were asked how they disposed of pet and human PPCPs and were able to choose up to 3 options on motivations influencing veterinary-care and educator respondents to take positive actions toward protecting the environment. Values of $P < 0.05$ were considered significant.

<table>
<thead>
<tr>
<th>Use and disposal</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store unused medicines in house indefinitely</td>
<td>28.0</td>
</tr>
<tr>
<td>Dispose of unused medicines when treatment is completed</td>
<td>20.0</td>
</tr>
<tr>
<td>Keep unused medicines until expired, then dispose of them</td>
<td>42.0</td>
</tr>
<tr>
<td>Finish medicines completely; none to dispose of</td>
<td>54.0</td>
</tr>
</tbody>
</table>

Figure 1—Use and disposal of pet pharmaceuticals by veterinary professionals and environmental educators (n = 170).
out of 9 disposal methods. A majority of the total respondents indicated that disposal in the garbage was their typical choice (46% [88/191] for pharmaceuticals and 44% [84/191] for personal care products). When queried about disposal via flushing, 8% (15/191) reported flushing human pharmaceuticals, and 15% (29/191) stated they flush human personal care products down the sink or toilet.

**Pharmaceuticals**

There were no significant differences between professions for human versus pet pharmaceutical disposal methods. Significant differences were observed between human and pet pharmaceutical disposal methods: the number of total respondents who selected “regular community medicine event” was considerably higher for human pharmaceutical disposal than for pet pharmaceutical disposal (24% [46/191] and 12% [23/191], respectively). More human pharmaceuticals were kept indefinitely than pet pharmaceuticals (38% [73/191] and 22% [42/191], respectively; **Table 1**).

**Personal care products**

There were, however, significant differences in human and pet personal care product disposal practices between veterinary-care professionals and educators. Veterinary-care respondents were more likely ($P < 0.001$) to dispose of human and pet personal care products in the garbage (77% [73/95] for human and 59% [56/95] for pet), compared with educators (61% [54/88] for human and 31% [27/88] for pet). In contrast, educator respondents were more likely to give human personal care products to others (19% [17/88] vs 6% [6/95]; $P = 0.008$) and to never use pet personal care products on their pets (38% [33/88] vs 20% [19/95]; $P = 0.009$).

**Motivations**

Through an exploratory factor analysis, correlations between motivations for disposal decisions yielded 2 groupings of factors (environmental and personal). These groups were confirmed by means of a reliability analysis test for the grouping relationships and their components (**Table 2**). The top motivation for

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**Table 1**—Methods of disposal of unused or expired human and pet pharmaceuticals in a survey of environmental stewardship practices of veterinary-care professionals (practicing veterinarians, veterinary students, and veterinary technicians and trainees) and environmental educators.

<table>
<thead>
<tr>
<th>Disposal options</th>
<th>Human pharmaceuticals (%)</th>
<th>Pet pharmaceuticals (%)</th>
<th>$P$ value (human vs pet)</th>
<th>Effect size ($Φ$)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throw in garbage</td>
<td>47</td>
<td>46</td>
<td>$&lt; 0.001$</td>
<td>0.46</td>
</tr>
<tr>
<td>Keep indefinitely</td>
<td>38</td>
<td>22</td>
<td>$&lt; 0.001$</td>
<td>0.34</td>
</tr>
<tr>
<td>Bring to regular community medicine disposal event</td>
<td>24</td>
<td>12</td>
<td>$&lt; 0.001$</td>
<td>0.54</td>
</tr>
<tr>
<td>Return to drop-off boxes at law-enforcement offices</td>
<td>13</td>
<td>6</td>
<td>$&lt; 0.001$</td>
<td>0.62</td>
</tr>
<tr>
<td>Return to health-care provider (eg, physician or pharmacist)</td>
<td>11</td>
<td>15</td>
<td>$&lt; 0.001$</td>
<td>0.33</td>
</tr>
<tr>
<td>Never have unused pharmaceuticals</td>
<td>11</td>
<td>14</td>
<td>0.002</td>
<td>0.26</td>
</tr>
<tr>
<td>Pour down sink or toilet</td>
<td>8</td>
<td>5</td>
<td>0.022</td>
<td>0.21</td>
</tr>
<tr>
<td>Mix with kitty litter or coffee grounds and then throw in garbage</td>
<td>4</td>
<td>5</td>
<td>0.004</td>
<td>0.30</td>
</tr>
<tr>
<td>Give to others</td>
<td>2</td>
<td>2</td>
<td>0.721</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Respondents ($n = 191$) were allowed to choose up to 3 disposal methods for each type of pharmaceutical.

A measure of strength of the correlation. In the social sciences, an effect size of 0.1 is generally interpreted as small, 0.3 is medium, and 0.5 or greater is large.† Data apply only to respondents’ top 3 choices and do not account for whether respondents used choices that were not 1 of their 3 selections.

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**Table 2**—Results of reliability analysis of correlations between motivations for disposal decisions by respondents to a survey of environmental stewardship practices of veterinary-care professionals and environmental educators in **Table 1**.

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Mean*</th>
<th>Item total correlation</th>
<th>α If item deleted</th>
<th>Cronbach α†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to avoid risk of accidental poisoning</td>
<td>4.33</td>
<td>0.70</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Desire to avoid risk of misuse or abuse</td>
<td>4.10</td>
<td>0.69</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Desire to minimize pet PPCPs in water</td>
<td>4.41</td>
<td>0.70</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Desire to minimize pet PPCPs in landfills</td>
<td>3.95</td>
<td>0.57</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Legal requirement</td>
<td>4.15</td>
<td>0.55</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Desire to purchase only minimum amount of PPCPs for what my pet might need</td>
<td>4.03</td>
<td>0.44</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptability to my family and friends</td>
<td>2.35</td>
<td>0.55</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Financial affordability</td>
<td>3.26</td>
<td>0.48</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>Acceptability to society at large</td>
<td>2.22</td>
<td>0.49</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>Convenience or ease of disposal</td>
<td>4.10</td>
<td>0.41</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Hearing that it is better to flush pet PPCPs</td>
<td>2.20</td>
<td>0.39</td>
<td>0.69</td>
<td></td>
</tr>
</tbody>
</table>

*Mean value of scores based on a 5-point Likert scale where 1 = very unlikely and 5 = very likely. †The closer the Cronbach α coefficient is to 1.0, the greater the internal consistency of the items in the scale. Internal consistency describes the extent to which all the items in a test measure the same concept and the interrelatedness of the items within the test.
proper pet PPCP disposal with regard to environmental factors, scored on the basis of a Likert scale of 1 = very unlikely to 5 = very likely, was “desire to minimize pet PPCPs in the water” (4.4 [175/191]), followed by “desire to avoid accidental poisoning” (4.3 [175/191]). Educator respondents rated “reducing impacts to the environment” significantly ($P = 0.003$) higher than veterinary professionals (4.3 [86/191] vs 4.0 [90/191]) as a motivation for PPCP stewardship. Convenience or ease of disposal was the top personal factor motivator (4.1 [175/191]) for choosing a pet PPCP disposal method. Veterinary-care respondents were significantly ($P = 0.003$) more motivated by convenience and ease of disposal methods than educators (4.3 [90/191] vs 4.0 [86/191], respectively).

**Activities associated with PPCP choice, use, and disposal**

Activities associated with positive actions for protecting the environment were grouped as factors labeled outreach, social, and economic for coding purposes. An exploratory factor analysis yielded information on the interrelationships and correlations between factor groups. Confirmed through a reliability analysis, the influential drivers for outreach factors and economic factors were mostly information (outreach) or regulations and laws (economic). The primary driver for social factors was networking (professional communication; Table 3). The most influential outreach activity was “learning about scientific studies on the consequences of a certain activity and positive actions I can take,” followed by “encouragement from my professional organization.” For the social factor, the most influential activity was friends or acquaintances encouraging respondents to take action. The importance of the economic factor (financial incentive or reward or financial penalty) was significantly different between veterinary-care professionals and educator respondents. On average, veterinary-care respondents were significantly ($P = 0.04$) more likely to take positive actions to protect the environment in response to economic factors such as fines or rewards for their PPCP disposal methods, compared with educator respondents (2.33 [90/191] and 2.14 [86/191], respectively).

**Communication between veterinary-care professionals and clients on PPCP disposal**

Veterinary-care professionals were asked additional questions specifically on discussing pet PPCP disposal methods with clients during appointments, barriers to conveying this information, and solutions to assist them in conveying this information during appointments (to the extent possible, veterinary students, who would not yet have clients, were omitted from this analysis). Only 39% of veterinary-care professionals reported they had shared disposal information during appointments with clients, and on average, this communication occurred regularly in approximately 19% of appointments. In open-ended responses, veterinary-care professionals listed barriers such as lack of knowledge about proper disposal, time, and cost and lack of concern on the part of both client and provider. When asked for ideas on how to convey this information, respondents suggested, for example, education, better information (eg, posters and pamphlets), product labels, and convenient places for disposal.

**Needs and sources of information regarding choosing, using, and disposing of PPCPs in a more environmentally responsible way**

Respondents were asked in 2 separate questions what their needs and sources of information were regarding choosing, using, and disposing of PPCPs in a more environmentally responsible way and were able

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**Table 3**—Results of reliability analysis of factors associated with positive actions for protecting the environment in a survey of environmental stewardship practices of veterinary-care professionals and environmental educators.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean*</th>
<th>Item total correlation</th>
<th>$\alpha$ If item deleted</th>
<th>Cronbach $\alpha$†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outreach</td>
<td></td>
<td></td>
<td></td>
<td>0.79</td>
</tr>
<tr>
<td>Ads or public notices encouraging me to take action</td>
<td>2.24</td>
<td>0.71</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>Government agencies encouraging me to take action</td>
<td>2.20</td>
<td>0.67</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>News media coverage encouraging me to take action</td>
<td>2.28</td>
<td>0.71</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>My professional organization encouraging me to take action</td>
<td>2.43</td>
<td>0.46</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Learning about scientific studies on the consequences of a certain activity and positive actions I can take</td>
<td>2.77</td>
<td>0.29</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
<td>0.81</td>
</tr>
<tr>
<td>People I know and trust taking action</td>
<td>2.33</td>
<td>0.68</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>People I know encouraging me to take action</td>
<td>2.34</td>
<td>0.73</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Hearing people talking to others about the dangers of not taking action</td>
<td>2.19</td>
<td>0.57</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
<td></td>
<td>0.69</td>
</tr>
<tr>
<td>Financial incentive or reward</td>
<td>2.12</td>
<td>0.53</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Financial penalty</td>
<td>2.35</td>
<td>0.53</td>
<td>—</td>
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</tbody>
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*Mean value of scores based on a 3-point scale where 1 = no influence and 3 = major influence.

— = Not calculated.

See Table 2 for remainder of key.
to choose up to 3 needs and 3 sources. The top 3 needs reported by all respondents regarding PPCP environmental stewardship practices (choice, use, and disposal in a more environmentally responsible way) were more environmentally friendly but effective alternatives (55% [105/191]), drop-off collection boxes (46% [88/191]), and take-back collection events (37% [71/191]).

All respondents indicated that their top 3 sources for information on PPCP disposal were professional organizations (eg, veterinary organizations, AVMA, or teacher [professional educator] organizations; 57% [109/191]), the internet (eg, digital means; 57% [109/191]), and pet PPCP labels (51% [97/191]).

Discussion

With the increased use of PPCPs comes the potential risk of improper disposal, resulting in environmental contamination. This study documented self-reported behavioral influences and motivations behind PPCP environmental stewardship actions taken by pet-owning veterinary-care professionals and educators. All respondents indicated that they valued clean water and air for their pets, and they ranked the “desire to minimize pet PPCPs in water” as one of the top motivations influencing their PPCP disposal practices. This could indicate a level of awareness about the potential negative environmental impacts of improper PPCP disposal. However, these findings may not fully address whether these pet owners completely understand that improper disposal of their personal PPCPs could compromise the environment.

When addressing their disposal of pet PPCPs, most respondents to the present survey indicated that they typically disposed of PPCPs in the garbage. This was similar to prior published literature in which garbage was cited as the top disposal method for human pharmaceuticals.20–22 Garbage disposal may lead to environmental impact because landfill leachate can ultimately reach wastewater treatment plants and pass through the filtration system into the environment.23 The results of the present study indicated that flushing PPCPs down the sink or toilet occurred in between 5% and 15% (10/191 pet pharmaceuticals and 27/183 human personal care products) of households and was more frequent for human PPCPs. The fact that flushing unused PPCPs was relatively uncommon, compared with disposing of them in the garbage, might have been due to outreach from take-back events, implementation of the AVMA-NOAA MOU, and proper disposal methods specified on some manufacturer’s package inserts. However, there are some medications (such as fentanyl transdermal patches) for which flushing is recommended on the manufacturer’s product label. A 15% (27/183) flush rate for human PPCPs is still an important disposal issue. The results of this study indicated that user convenience may be a likely influential factor in disposal practices and that opportunities exist to reduce the proportion of unused PPCPs being flushed. This is important because minimizing pet PPCPs in water was reported as the top motivation for proper disposal of pet PPCPs in the present study, suggesting that respondents (educators and veterinary-care professionals) were aware of the issue of PPCPs in the environment, the impacts on water, and the need for improved environmental stewardship practices.

Clean water and clean air are aspects of the environment viewed by respondents to the present survey as most important for their pets. However, when evaluating specific motivators for PPCP disposal, veterinary-care professionals were motivated more by convenience and ease for work-related efficiency requirements, whereas educators were motivated more by environmental factors. Availability of evidence-based information on the consequences of a certain action and the positive actions one could take were considered most influential regarding activities promoting behavior change in relation to PPCP stewardship in the present survey. The next most influential activity was receiving encouragement from one’s professional organizations. This suggested that both trusted knowledge and professional networks may influence behavior change. Similarly, in the social category, the top influencer was encouragement from “people I know.” This finding supported the idea that social networks are trusted sources of information that can influence respondents to take positive stewardship actions.

Although environmental factors were significant influences in the present study, veterinary-care professionals were influenced more by economic factors such as rewards and penalties than were educators. This might signify that the laws and regulations under which most veterinary-care professionals operate are an integral aspect of the practice of veterinary medicine. In contrast, both veterinary-care professionals and educators were equally influenced by social factors, relying on their trusted networks and colleagues when dealing with uncertainty and unused pet PPCPs.

For a variety of reasons, including lack of knowledge and time, respondents reported that veterinary-care professionals who have face-to-face time with pet owners seldom discussed disposal of pet PPCPs. Only 39% of veterinary-care professionals reported that they had shared disposal information during appointments with clients, and on average, this communication occurred regularly in approximately 19% of appointments. These results may illuminate an opportunity; the AVMA could target outreach efforts to veterinarians and their staff to raise awareness of proper PPCP disposal methods, and this outreach may in turn encourage them to share this information with their clients.

Respondents indicated a strong desire for “more environmentally friendly and effective products,” with almost half reporting that they could not find...
the environmentally friendly products they wanted and that they also had some concerns over efficacy and price. Veterinary-care professionals might support this request by working with product developers and suppliers to promote such products and advocate for an increase in their available options. Respondents also listed their health-care provider, such as their veterinarian, as a top source of PPCP disposal information. This might be an example of how veterinary-care professionals can serve as role models for other pet owners regarding PPCP environmental stewardship practices.

The 2011 AVMA-NOAA MOU (renewed in 2016) was created to promote outreach and education to veterinary-care clients on proper disposal of unused animal medications, and it continues to represent an important development that exemplifies the AVMA’s strong sense of professional responsibility in preventing the misuse, abuse, and improper disposal of animal and human pharmaceuticals. The results from the present study suggested that AVMA members and other veterinary-care professionals are supportive of these efforts and knowledgeable about the consequences of improper PPCP disposal. In short, these results pointed toward the potential benefits of applying the principles of the MOU for pharmaceutical environmental stewardship practices. Yet the actual PPCP choice, use, and disposal practices reported in this study suggested that further progress must also be made to increase adoption of the MOU goals and desired practices and outcomes. Renewal of the MOU and an emphasis on implementing its 5 goals might be a call to action for MOU implementation and warrant an increase in partner collaboration. Because the results of the present study suggested that PPCP stewardship practices were infrequently discussed in veterinary client visits, an emphasis in the MOU implementation might be to increase discussion or provide additional means of educational outreach regarding PPCP environmental stewardship practices during veterinary patient visits. Recommendations that veterinary care professionals might consider implementing are provided (Appendix).

Similar to other survey-based studies, this research had limitations that may affect the interpretation of results. Several sources of biases could have been introduced through the use of a convenience sample versus a probability-based sample. This may have led to underrepresentation, overrepresentation, or both of either veterinary-care professional or educators. Similarly, because of the nonprobability sampling protocol, the results of the present study should not be generalized. In addition, some of the motivations and influential activities could have been double coded (eg, rational choice and social proof) and may have been dependent on professional background (eg, environmental educator). Even with these limitations, by examining how and why a specific subset of pet owners acquire, use, and dispose of PPCPs, we may begin to understand some of the drivers that influence decisions and potential outcomes in this emerging contaminant issue, leading to improved communication with stakeholders. Veterinary-care professionals should serve as role models, resulting in more effective programs, studies, and policies on PPCP environmental stewardship practices. Furthermore, baseline data collected in this study may help to inform more directed studies such as those related to specific types of PPCPs being disposed of and may help guide and improve the original goals of the AVMA-NOAA MOU, thus increasing awareness of and knowledge of PPCP environmental stewardship practices. Without action directed at how we use and dispose of PPCPs, the quantities of PPCPs in the environment are likely to continue to increase.

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Footnotes
a. IBM SPSS Statistical Software, version 21, IBM Corp, Armonk, NY.

References

Appendix

Recommended environmental stewardship practices for veterinary care professionals relating to use and disposal of PPCPs.

- Share and promote new information and knowledge about possible PPCP environmental stewardship practices through the AVMA and other professional networks, electronic media, and PPCP product labels.
- Promote using only the minimum amount of PPCPs needed in client appointments.
- Raise awareness of drop-off collection boxes and PPCP collection events in your area. Be clear that these are for both pet and human PPCPs.
- Be role models to others in your community through leading by example and promoting positive PPCP environmental stewardship practices.