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Waste not want not: piloting a clinical waste audit at a United States university veterinary teaching hospital

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ABSTRACT

Biomedical waste is a well-recognized environmental problem, yet less is known about the waste generated in the delivery of veterinary care compared to human medicine. The objective of this project was to develop and pilot a waste audit protocol for veterinary medicine that could inform waste management at a US university veterinary teaching hospital and the broader veterinary community. We conducted a multi-day review of the Colorado State University Veterinary Teaching Hospital's small animal surgery and anesthesia units to measure the types and amounts of waste generated during routine surgeries. Metrics included total weight, number of bags, and individual counts for specific items of concern and items with sustainable alternatives. We calculated frequencies and percentages of waste by waste audit material category and noted any erroneous materials sorted. Despite waste being a prioritized sustainability issue in veterinary medicine, this work highlighted opportunities for better education on managing and optimizing existing resources through behavior modification. This article explores ways the 5Rs (Rethink, Reduce, Reuse, Recycle, Research) could be better operationalized in veterinary hospitals.

There is a significant need to address the issue of waste across all sectors. Medicine is particularly resource-intensive; in the US, an estimated 8% of all CO_2 emissions come from the health-care industry.[1] Hospitals are estimated to generate 1% of developed countries' solid waste and have indirect effects through emissions arising from waste transport and incineration.[2] Manufacturing and distribution of medical supplies, many of which are disposable (eg, single-use plastics), are responsible for a significant amount of these emissions.[3] Medical waste can be classified as hazardous (eg, infectious, pharmaceutical, pathological, chemical, radioactive, and sharps) or non-hazardous (ie, waste that does not pose a biological, chemical, radioactive, or physical hazard). According to the World Health Organization, 75% to 90% of health-care waste is considered "general waste."[4] Health-care waste is largely managed as non-hazardous waste, but it is not benign. While it is more challenging to quantitate the effect of non-hazardous waste on human health, it may have far-reaching direct and indirect impacts on human mortality, cancer, reproduction, and well-being.[4]

While the amount and environmental impact of human health-care waste are well quantified, considerably less is known about the amount and type of waste explicitly generated in the delivery of veterinary care. Addressing waste is a top priority of veterinary staff and students who generally seek to elevate sustainability across the profession.[5–8] In 2020, VetSustain (an association of veterinary professionals in the UK) proposed "a no-waste society" as 1 of 6 veterinary sustainability goals whereby we "minimise the usage and disposal of resources and materials, and support a transition to a circular economy."[9] Unfortunately, addressing waste across the profession is complex and nuanced, given the breadth of scope in which veterinarians work. Even within clinical care, there is considerable variability in the amount, and relative components of, waste depending on the type of hospital, services offered, case volume, and local waste handling differences. Resources to aid veterinarians in effective and efficient waste management strategies and practices could help the profession progress toward the no-waste goal. Unfortunately, despite waste being a well-recognized area where veterinarians can act,[10] a recent literature review found few resources to help address this problem.[11]

Progress toward the dual goals of a more sustainable profession and waste minimization requires

knowledge of the current state of our waste. A waste audit can be beneficial to better understand veterinary waste streams, set goals, and establish best practices for waste and recycling in each facility. A waste audit is a systematic evaluation of the type and amount of waste generated from a predefined area over a set period.[12,13] Waste audits identify waste generated, including patterns of use and composition, and inform improvements for waste disposition reduction in areas where efforts will be most effective, as well as raise awareness and provide an educational opportunity for the larger community.[12–14] Waste audits are valuable tools to determine and investigate the areas of potential impact for waste minimization strategies within a health-care facility; once a baseline is established, the success of implementing sustainability practices can be elucidated. There is a growing body of literature on the use of waste audits in human hospitals[2,13–21] to identify areas for waste reduction without compromising patient care.[22] Veterinary medicine has also recognized the importance of upholding best practices, such as maintaining infection control while reducing waste.[9] However, in contrast to human medicine, there is considerably less research on the topic.

The primary objective of this project was to develop and pilot a waste audit protocol for veterinary medicine that could be adapted to various veterinary settings and assist clinics in meeting their waste reduction targets. A secondary objective was to report the results of a pilot waste audit performed in a US veterinary teaching hospital where the generation of veterinary waste (and, by extension, other hospitals' waste streams) could be altered to meet all our sustainability goals.

Methods

Development of a waste audit protocol

Given the paucity of veterinary-specific resources to perform clinical waste audits, we conducted a broad review to inform protocol development. Briefly, we searched Web of Science and PubMed for examples of audit methods conducted in human medical settings, literature reviews, standard performance improvement measurements, and organizational reports on the topic. We summarized these resources to inform protocol development **(Supplementary Table S1)**. Additionally, we sought consultation from staff and faculty at Colorado State University (CSU) with expertise in campus waste management, sustainable laboratory practices, and clinical services regarding waste practices at CSU and potential audit ideas.

We developed a waste audit protocol and accompanying data entry tool based on the literature review and expert consultation results. Template tables for data collection are available in the supplementary materials **(Supplementary Table S2, Supplementary Table S3)**. For this protocol, we restricted our scope to waste and recyclables placed in a shared bin ("single-stream recycling"), excluding hazardous medical waste, the handling of which would require additional precautions and authorization. We created data collection fields to target specific items identified through the literature review with more sustainable alternatives (eg, reusable vs disposable gowns[23–27]) and items clinical staff and students had anecdotally expressed concern about (eg, the number and fate of syringe casings) as a better understanding these sub-categories was identified as a helpful starting point for revising waste management or procurement protocols within the hospital. Data collected included the total weight, the number of bags, and individual counts for the specific items. We also sought to quantify the amount of material disposed of erroneously, such as recyclable materials in the trash. The final categories assigned to different types of waste in our audit were fabrics, plastics, paper, and others, each divided into sub-categories **(Supplementary Table S4)**.

Pilot waste audit: CSU Small Animal Surgery and Anesthesia

We conducted a 3-day audit (Tuesday, March 22 to Thursday, March 24, 2022) of trash and single-stream recycling from the CSU Veterinary Teaching Hospital (VTH) small animal surgery and anesthesia units using the above-described tool. We chose the small animal surgery and anesthesia units, major waste producers within VTH operations. We chose mid-weekdays as the most representative of the typical clinical caseload and defined spatial boundaries by the primary rooms used for anesthetic and surgical preparation, and the surgical operating rooms (ORs). Department-specific (anesthesia/surgery) staff and rotating cohorts of third and fourth-year veterinary students used the rooms within our boundaries. Anesthetic or surgical prep took place in other departments before transport for surgery and was not included. We collected and counted bags of trash and recycling once daily, at 5 PM, from surgery and anesthesia trash and recycling aggregation sites and transported them to the waste audit site. We weighed trash and recycling bags at the waste audit site using a scale with a sensitivity of 0.1 kg (kg).

Once collected, volunteers sorted the waste from the trash bags. Volunteers included students from the DVM and MPH programs, CSU staff, and faculty (about 10 "sorters" per night) whom we recruited through club activities, word of mouth, and interest in participation. Volunteers wore standard protective equipment while sorting materials, including gloves and masks. Volunteers followed a sorting protocol to sort waste into labeled category bins. Volunteers divided waste in recycling bags ("expected recyclable materials") into recyclables for local single-stream recycling and non-recyclables misplaced in the recycling bins. Volunteers then sorted waste into fabrics, plastics, paper, and others, and their subsequent sub-categories (Supplementary Table S4). Difficult-to-categorize items were evaluated and sorted using the consensus of the "sorters" present. Volunteers marked items that could not be categorized as "unsorted or contaminated" waste.

Sorted material was weighed by category and stratified by the location where the items were found

(trash or recycling). Before weighing waste, we disposed of fluids remaining in receptacles but retained the containers. Additionally, we individually counted previously identified sub-categories of surgical gowns, scrub caps/bouffants, shoe covers, surgical gloves, nitrile gloves, fluid bags, 4x4 gauze, syringes, and syringe casings/caps. Any loose sharps disposed of inappropriately were noted.

We tabulated all collected data using Microsoft Excel. We determined the proportion of recyclable weight attributed to recyclables and misplaced non-recyclables. We also calculated frequencies and percentages of waste by waste audit material category.

Results

Over the 3-day period, we collected and sorted waste from 26 surgeries **(Table 1, Supplementary Table S5)**. A total of 41 bags of trash were collected, totaling 158.3 kg of waste, and 4 bags of expected recyclable materials, totaling 12.2 kg. By weight, 66.7% (2.8 kg) of expected recyclables overall were truly recyclable, and 33.3% (1.4 kg) of expected recyclables were non-recyclable and misplaced into recycling.

Of the 158.3 kg of waste collected, 81.6% (129.1 kg) was sorted and 18.4% (29.2 kg) was "unsorted or contaminated" waste **(Table 2)**. The most common

Table 1—Daily characteristics of bags of waste and recyclables collected during 26 procedures in anesthesia and surgery departments at Colorado Sate University Veterinary Teaching Hospital, Fort Collins, CO, March 22 to 24, 2022.

Characteristics	Day 1	Day 2	Day 3	Daily average	Total
No. of procedures (n)	8	9	9	8.7	26
Waste					
No. of bags (n)	11	14	16	13.7	41
Total weight (kg)	48.8	57.3	52.2	52.8	158.3
Expected recyclable waste					
No. of bags (n)	2	1	1	1.3	4
Total weight (kg)	1.4	1.4	1.4	1.4	4.2
Recyclable waste (kg [%])	1 (71.4)	1.2 (85.7)	0.6 (42.9)	0.9 (64.3)	2.8 (66.7)
Non-recyclable waste (kg [%])	0.4 (28.6)	0.2 (14.3)	0.8 (57.1)	0.5 (35.7)	1.4 (33.3)

Table 2—Weight in kilograms (kg) of waste, by audit material category, collected during 26 procedures in anesthesia and surgery departments at Colorado Sate University Veterinary Teaching Hospital, Fort Collins, CO, March 22 to 24, 2022.

Waste audit material category	Total weight (kg)	Daily average weight (kg)	Percent of total waste by weight (%)
Fabrics			
Drapes	41.1	13.7	26.0
Surgical gowns	8.3	2.8	5.2
Laparotomy sponges	7.5	2.5	4.7
4x4 gauze	3.7	1.2	2.3
Sponges	2.2	0.7	1.4
Shoe covers	0.4	0.1	0.3
Masks	0.2	0.07	0.1
Scrub cap/bouffant	0.1	0.03	0.1
Total fabrics	**63.5**	**21.2**	**40.1**
Plastics			
Hard plastics	10.6	3.5	6.7
Fluid bags	9	3	5.7
Soft plastics	6.8	2.3	4.3
Plastic bags	5.6	1.9	3.5
Syringes	4.5	1.5	2.8
Syringe casings/caps	4.5	1.5	2.8
Soft tubing	3.6	1.2	2.3
Surgical gloves	3.2	1.1	2.0
Nitrile gloves	2.6	0.9	1.6
Plastic bottles	2.2	0.7	1.4
Total plastics	**52.6**	**17.5**	**33.2**
Papers			
Paper/cardboard	3.6	1.2	2.3
Wax paper	1	0.3	0.6
Total papers	**4.6**	**1.5**	**2.9**
Other			
Unsorted/contaminated items	29.2	9.7	18.4
Mixed material	4.1	1.4	2.6
Glass	2.6	0.9	1.6
Metal	1.2	0.4	0.8
Aluminum wrapping	0.5	0.2	0.3
Total other	**37.6**	**12.5**	**23.8**
Grand Total	**158.3**	**52.8**	**100.0**

type of waste was fabrics which accounted for 40.4% of waste (63.5 kg), followed by plastics which accounted for 33.2% (52.6 kg). The most common single items were disposable drapes (26.0%), followed by hard plastics (6.7%), fluid bags (5.7%), syringes and syringe casings (5.6%), and surgical gowns (5.2%).

Counts of specifically highlighted sub-categories found 62 surgical gowns, 33 scrub caps/bouffants, 78 shoe covers, 294 surgical gloves, 532 nitrile gloves, 776 4x4 gauze sheets, and 730 syringes. We also noted items outside of the specified waste categories, including unused tape rolls, unused pieces of gauze, expired CO_2 absorbents, and laundry towels. Among the waste, we found 7 improperly disposed sharps.

Discussion

The development and conduct of this waste audit elucidated helpful information that will inform waste and recycling education and practice within the CSU VTH and the veterinary profession more broadly. While we observed considerable waste generated during the pilot study, we were inspired to see much potential for immediate action. Waste management efforts can be expanded from the "3Rs" ("reduce, reuse, recycle") to the "5Rs" with the inclusion of "rethinking" and "researching." Such frameworks have been applied to surgery and anesthesia in human health care[28–30] and are similarly relevant to the veterinary profession, as discussed below.

Rethink

Arguably the most critical mode for reducing waste in the veterinary profession, we need to rethink our mindset on how we traditionally manage waste and reflect upon what can be done differently regarding waste streams. Sub-categorization of waste based on known or desired alternatives helps veterinary teams prioritize efforts to find more sustainable solutions for specific items. More broadly however, this waste audit project revealed several ways we can begin to create awareness and stimulate discussion on waste minimization in the profession and rethink how we approach sustainable practices before materials enter our facilities.

Despite waste named explicitly as a top sustainability issue for veterinary students, practitioners, and hospital staff,[6–8] there is a need for better education on waste management within the veterinary practice. The veterinary community is interested and invested in improved education on minimizing the environmental impact of clinical medicine as a whole.[8] Rethinking our approach to recycling education can help avoid "wish-cycling" when individuals place objects in recycling collection bins in the hope that they will be recycled.[31] In our audit, 33.3% of expected recyclables were contaminants, non-recyclable, and misplaced in the recycling bin. Mixing non-recyclable material with recyclables can contaminate all the material, exacerbating the waste problem. Errors in recycling typically stem from a need for more knowledge regarding specifics and a need to understand the impact of contamination within the recycling stream, from misunderstood signage to limited resources on local recycling services. Anecdotally, even within the sustainability-minded volunteers who participated in the waste sorting activities, there was significant discussion regarding what could and could not be recycled from the collected materials. These discussions highlight that team education can shape behavior and the efficacy of waste management strategies.

Education and behavior change is a nuanced but important strategy for waste management in a hospital setting. For instance, we found several unused tape rolls, stacks of gauze, nitrile gloves, and other unused items in the trash. We can avoid non-recyclable waste with careful attention to how these products can be set aside if not used; some might be able to be reused or even recycled in unique streams for single-use items. We also found 7 erroneously disposed of sharps in our trash audit, highlighting the necessity for education beyond minimizing waste to the proper disposal of hazardous items. Collectively, this suggests that better education on hospital waste management could be an effective way to improve waste minimization practices through ongoing training and education. Such educational efforts must be appropriate for the target audience as recycling is complex and dependent on local, procedural, social, cultural, economic, and personal factors of values and beliefs,[32–35] and there is no single solution for impacting recycling behavior.

Another effective strategy to minimize waste is "rethinking" upstream of "reduce, reuse, and recycle" through mindful inventory management and sustainable procurement strategies. One existing resource for sustainable purchasing recommendations is the SAVE Veterinary Procurement Guide.[36] This e-book compiles current veterinary-serving companies with forward-facing sustainability plans for their products or manufacturing processes. Economic power applies beyond the hospital or clinic procurement practices, as clients have also indicated an interest in veterinary services with reduced environmental impact.[37] As veterinary practitioners, we often have the opportunity to make sustainable product procurement decisions that decrease waste generation before products arrive in the hospital. Rethinking manufacturing and purchasing decisions in favor of sustainable products and procurement strategies will contribute to waste reduction and sustainability within the veterinary community.

Reduce

Waste within veterinary hospitals can be reduced at all stages. Reducing waste during surgery and anesthesia can be difficult, but waste reduction can occur before products are even opened within the OR. In human medicine, up to 80% of all OR waste is generated during the setup before the patient arrives for their operation.[2] One area of focus for waste reduction is decreasing overage. Surgery produces overage when prepared items opened for surgery remain unused and end up in the waste stream,[19] typi-

cally items in surgical packs. We can prevent overage by reducing the amount of typically packed but unused materials in pack preparations, and restocking and reusing unused materials in the next procedure so as not to be thrown in the trash and wasted.

Through our audit, it was apparent that our hospital utilizes several non-reusable items within their surgical packs and non-reusable outer wrapping. As it may not be feasible to switch to reusable packs or custom-made packs for each surgery, the goal should be to reduce items from within disposable packs or minimize items from future pack preparation that are consistently unused. For example, items that will not be used during the specific surgery, such as marking pens or plastic towel clamps, can be separated out after a given procedure to be re-sterilized and used for later procedures. This concept also translates to individual items such as 4x4 gauze and laparotomy sponges. For example, in our audit, we found unused 4x4 gauze in the trash that could be reclaimed after the procedure in various non-surgical ways. We can also minimize financial and environmental costs by changing our use of items in packs resulting in less waste from unused portions.[38] Other considerations for waste reduction include the procurement of reusable items such as surgical gowns, drapes, and bouffants,[39] which are further discussed below. Considerations for waste reduction and material conservation should be practiced in both the OR surgical prep and the hospital. There are multiple approaches to decreasing overage. Education programs for clinicians and staff, including reduction goals of overage generating setups and redesigns of surgeon-specific supply pick lists, can lead to a reduction in overage by 45% per case.[19] Rethinking how packs are created and used in the OR can reduce waste before it is generated.

While our audit allowed us to determine areas for reduction within surgery and anesthesia, there are many other areas to target in the teaching hospital. For example, medical equipment and other items are often sent home with patients that owners may not need or use. The reduction here can involve re-examining items sent home and asking owners if they already have certain supplies. In human medicine, reuse programs have reduced durable medical equipment waste.[40] Reduction or elimination of waste can thus occur before product arrival, during product use throughout the hospital, and even as patients leave our doors.

Reuse

Reusable options for products used in the OR can prevent waste from being generated in the first place, and a waste audit allows the identification of high waste content categories for which reusable alternatives can then be investigated.[41] An obvious opportunity for waste minimization through reusability is transitioning from synthetic clothing and drapes to cloth when medically appropriate. Our top waste category by weight was single-use fabrics and drapes accounted for the most. There are reusable drape alternatives to disposable ones that could decrease the waste generated.

Sterility is a critical consideration for material selection in the OR, and there are limited studies available comparing disposable non-woven drapes versus reusable woven drapes to decrease the risk of surgical site infections.[42] Reusable drapes remain a viable choice for clean, elective procedures without the risk of compromising patient health and safety compared to disposable drapes.[25] While further research is necessary to determine the risks associated with reusable drapes for sterile procedures, current limited evidence shows that disposable single-use drapes offer no advantage in reducing the surgical site infections rate compared to reusable drapes.[42] Further research should include the veterinary use of reusable drapes.

Single-use surgical gowns were also common in our waste stream, and there may be opportunities for switching to cloth gowns for a subset of the procedures. Reusable gowns and disposable gowns have similar barrier effectiveness at the same barrier rating; thus, reusable gowns do not compromise barrier effectiveness and may even be more durable with increased protection and cost savings.[24] A summary of life-cycle assessments comparing reusable versus disposable gowns found that reusable gowns have between 50 to 127 reusable cycles.[43] Reusable gowns are thus an attractive alternative to disposable gowns. As with reusable drapes, further work is needed to determine the differences in the impact of reusable versus disposable gowns for veterinary use.[42]

An argument against using cloth materials in surgery is the energy, water, chemical use, and costs associated with cleaning and sterilization. However, recent studies show that reusable gowns have half of the water consumption in a life-cycle assessment than disposable gowns and reduce greenhouse gas emissions, energy consumption, and, of note for us, solid waste generation.[26,27,44] This trend of lowered environmental impacts through reusable textiles also applies to clothing such as reusable scrubs.[23] While we focused on reusable textiles due to fabrics being the largest category of waste generated by weight in our audit, reusable products other than textiles also show benefits in life-cycle assessments. For example, in a comparison of blue wrap packaging versus reusable rigid sterilization containers (RSC) for use in surgical instrument sterilization in human medicine, RSCs had 85% less environmental impact in carbon footprint.[45] There are options for reusable medical instruments instead of single-use disposables; appropriately chosen reusable products can minimize environmental impacts and potentially reduce costs.

In addition to reusable textiles, there are also opportunities for reusing other materials and products. For example, empty fluid bags are often reused to protect bandages from water. In veterinary teaching hospitals, we could reuse unused disposable instruments as training instruments. Reusing items can go beyond the hospital, such as medical equipment lending libraries discussed above, like Sebastian's Love at CSU.[46] We encourage the veterinary community to think creatively about reusing and sharing

products and determine areas within practice where reusable alternatives can replace disposables.

Recycle

If the quantity of materials used cannot be further reduced and reusable alternatives are not available or viable, veterinary product manufacturers should strive for recyclability. As discussed above, rethinking our approach to materials will contribute to the incorporation of behavioral and procurement strategies that play a role in supporting the recycling process. Recycling begins with the procurement of recyclable products, but once in the hospital, recycling practices rely on the educational element for proper sorting. While some human hospitals have achieved 40% of total waste being recycled,[29] there are challenges in personal and community understanding of waste and recycling streams. Education can help avoid "wish-cycling"[31] that could have contributed to the impact of misplaced recycling seen in our audit. Procurement can support our efforts by selecting recyclable products where available, and these procurement decisions signal to manufacturers the desires of the consumer.

Recycling education must be hospital-wide and ongoing to ensure items within the hospital are placed correctly in recycling containers and to support a behavioral culture of recycling. Ongoing education and outreach can substantially impact minimizing contamination of the recycling stream in small animal surgery and anesthesia and supports the proper sorting of waste and recycling. Contamination of the recyclables stream simply results in more waste as it is condemned to the trash. In our audit, several the materials we found in the trash (eg, glass, paper, metal) could have been recycled through our local recycling program if not contaminated at the time of deposition in the bin.

The availability of programs and the variety of materials that can be recycled differ depending on hospital location and resources within a geographic area. Recycling alternatives offered by local haulers or government agencies vary greatly, as some cities offer very few recycling options while others have recycling centers inclusive of hard-to-recycle materials. In the US, resources such as the EPA Common Recyclables[47] are available to provide a baseline for recycling information, yet understanding local recycling programs is essential to increase proper recycling and decrease contamination.

Our audit team, because of the surprising volume, was particularly interested in recycling opportunities for syringes and their casings/caps. Syringes and their packaging used at the CSU VTH are made of #5 plastics, which cannot be recycled through our local recycling facilities. Despite the lightness of these materials, the syringes and their casings and caps accounted for 5.6% of our audit's total waste weight. Some proposed interventions for our #5 plastic syringe caps and casings include: identifying options for reusing or repurposing the syringe cases and caps, solving the logistical challenges of getting these items to a "hard to recycle" materials facility, or altering the manufacturing process allowing for a closed-loop system. Blue wrap, 100% polypropylene, is also classified as a #5 plastic. Despite difficulties finding recycling programs to accept blue wrap, there have been successful facility blue wrap recycling programs implemented in human medicine.[48] Cooperation between human and veterinary medicine has the potential to make a significant impact on the recycling of products that overlap between these medical fields. Other specific recycling programs may be desired, such as nitrile glove recycling programs, if identified as a high-impact category through a waste audit.

Research

The final "R", research, aims to address gaps in knowledge of waste management within the OR and veterinary medicine. Our team developed our waste audit protocol based on work done in human health care, as we were unaware of existing resources specific to veterinary medicine. This assessment is consistent with previous work by our colleagues who found that few resources are available for veterinarians interested in implementing more environmentally sustainable practices into their clinical care.[11] In a systematic review of waste audits in health care, studies focused on veterinary practices were excluded,[3] highlighting the separation of research on waste minimization between human and veterinary medicine. While veterinary medicine has a lot to learn from human health care, we also differ when considering regulations associated with human waste biohazards and non-medical waste in human hospitals associated with hospital food.[13] The development of more discipline-specific resources would help veterinary clinics and practitioners refine their actions.

To meaningfully address (rethink, reduce, reuse, or recycle) waste management in veterinary medicine, we need to better understand, through research, the footprint of veterinary care, including waste, more broadly. While projects like our pilot waste audit are a helpful starting point, there are several limitations to the data obtained. Undoubtedly, our described audit needs more internal validity as it is unlikely that the 3 days of the audit are truly representative of the CSU VTH caseload, which varies by staffing, scheduling, and seasonality. Similarly, information gleaned from the quantification of our VTH waste stream has limited external validity, as we only obtained it from the surgery and anesthesia departments of the VTH. A teaching hospital is not representative of other veterinary clinics in terms of caseload or staffing, as there are a greater number of people involved in cases. Many individuals, specifically students, may be less efficient with materials, and teaching hospitals may thus produce greater waste compared to non-teaching hospitals with increased use of supplies and longer operating durations.[49] Additionally, waste management, particularly recycling, is variable by location, education, politics, and pro-environmental behaviors. Our waste stream at CSU will differ significantly due to these internal and external factors, and this or future audit data will reflect that unique time and location.

Much like the assessment of diagnostic tests, we can evaluate auditing tools to ensure they provide the information needed to inform appropriate action that addresses the underlying concern. A perceived strength of our waste audit template lies in its simplicity and ease of setup and implementation. While there may be few in-depth waste analysis tools, our template provides a baseline for a veterinary clinic or hospital department and can serve as a starting point for implementing sustainability best practices. For example, the tool can be customized to different settings based on individual and community interests using specific highlight items determined during the audit design. Another benefit of a standardized template and methods is that larger-scale data collection is possible, allowing for comparison and collaboration within the veterinary community, which could help to inform priority areas to work in and to influence manufacturers and suppliers. The tool can be a quick, low-resource option to initiate and garner support for sustainability practices in individualized settings. The repeatability and reliability of the tool also require further testing. Beyond our pilot audit, further research is necessary to determine the feasibility of periodic audits of VTHs and other facilities. Collectively, this highlights the need for future multisite studies that can help refine the waste audit tool described herein and begin understanding the collective burden of veterinary waste.

Finally, there is a need to better understand the barriers to adoption of pro-environmental behaviors within the veterinary sector. While minimizing the negative impacts of clinical care is reportedly a priority for veterinarians, veterinary students and clients, several studies have highlighted a lack of evidence that this aspiration is being realized.[6–8,11,37] Research in the social sciences may help to characterize existing challenges, and identify solutions, in such a way that can better support veterinary professionals in this space.

Conclusion

There is great interest in sustainability practices within the veterinary profession,[6–8,10] and we hope that sharing our experience creating and implementing this waste audit protocol will help support others as they seek to meet their waste minimization goals. While this project began with an interest in better understanding our own waste streams and opportunities to minimize them, we also sought to generate interest in sustainability within our veterinary community. Audit volunteers included DVM, MPH, undergraduate students at CSU, faculty and university staff from the Veterinary Health System (VHS) and the greater university community. We want to encourage and nurture the veterinary community to conserve resources and promote human and animal health through sustainability.

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Supplementary Materials

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