

DISPOSAL OF VETERINARY SUPPLIES USED IN RURAL AREAS FROM SANTA FE PROVINCE, ARGENTINA

Pablo A. Tarabla^{1,2*}, Agostina Giacobino^{3,4}, Ana I. Molineri^{3,4}, Marcelo L. Signorini^{3,5}, Oscar S. Anziani⁶ y Héctor D. Tarabla⁷

¹ Universidad Católica de Santiago del Estero, Sede Rafaela, Santa Fe, Argentina / E-mail: lic.tarabla@gmail.com

² Universidad Tecnológica Nacional, Facultad Regional Rafaela, Santa Fe, Argentina

³ Consejo Nacional de Investigaciones Científicas y Técnicas - Instituto Nacional de Tecnología Agropecuaria, Instituto de Investigación de la Cadena Láctea, Rafaela, Santa Fe, Argentina

⁴ Universidad Nacional de Rafaela, Campus Colectora, Rafaela, Santa Fe, Argentina

⁵ Universidad Nacional del Litoral, Facultad de Ciencias Veterinarias, Esperanza, Santa Fe, Argentina

⁶ Universidad Católica de Córdoba, Facultad de Ciencias Agropecuarias, Córdoba, Argentina

⁷ Investigador independiente, Rafaela, Santa Fe, Argentina

Recibido: 21/02/2023
Aceptado: 20/09/2023

ABSTRACT

The disposal of waste from clinical work may impacts on the environment, animal and public health. Nevertheless, few studies have acknowledged the extent of improper management of used syringes, needles, medicine containers and other medical supplies in Latinamerica. The objective of this study was to describe means for disposal of veterinary supplies used in rural areas and the factors associated with their discharge in urban areas. A cross-sectional study was carried out in 421 veterinarians working with large animals in the province of Santa Fe, Argentina, using a structured questionnaire. Statistical analysis included χ^2 and logistic regression. The results showed that less than 50% of the respondents bagged used supplies and a minority did it separately. Potentially hazardous waste was handed out to farm workers for subsequent disposal. Older professionals and those who also worked with small species had, respectively, 1.3 and 1.5 times more risk of discarding in urban areas supplies used on farms. On the contrary, those who had their work residence in the Central Region had a significantly lower probability. Only one in five interviewees had, in their town of residence, availability of accredited transport of hazardous waste. Only 3 to 5% of respondents discarded supplies waste as pathological waste. The close relationship between countryside, towns and cities within the same territory puts public health of urban centers at risk both due to waste disposal and the movement of people from one space to another within the same territory.

Key Words: veterinary, large animal practice, hazardous waste, disposal, risk factors.

DISPOSICIÓN DE INSUMOS VETERINARIOS UTILIZADOS EN EL ÁMBITO RURAL DE SANTA FE, ARGENTINA

RESUMEN

La disposición de desperdicios provenientes de la actividad clínica puede tener un impacto en el ambiente, la salud animal y pública. No obstante, se han desarrollado pocos estudios en América Latina sobre la dimensión del problema de descarte inapropiado de jeringas, agujas, envases de medicinas y otros insumos médicos. El objetivo de este trabajo fue describir las formas de disposición de insumos veterinarios utilizados en el ámbito rural y los factores asociados a su descarte en áreas urbanas. Se efectuó un estudio transversal en 421 veterinarios que trabajaban con grandes animales en la provincia de Santa Fe, Argentina, utilizando un cuestionario estructurado. El análisis estadístico incluyó χ^2 y regresión logística. Los resultados indican que menos del 50% de los entrevistados embolsaba los insumos usados y una minoría lo hacía por separado de acuerdo al tipo de insumo. Residuos potencialmente peligrosos eran entregados al personal de campo para su posterior descarte. Los profesionales de mayor edad y quienes también trabajaban con pequeñas especies tuvieron respectivamente 1,3 y 1,5 veces más riesgo de descartar en áreas urbanas los desperdicios de insumos usados en el campo. Por el contrario, quienes tenían su residencia laboral en la región centro de la provincia tuvieron una probabilidad significativamente menor. Solo uno de cada cinco entrevistados contaba, en su localidad de residencia, con disponibilidad de transporte de residuos peligrosos autorizado. Solo del 3 al 5% de los encuestados descartaba los insumos como residuos patológicos. La estrecha relación existente entre el campo y la ciudad dentro de un mismo territorio pone en riesgo la salud pública de los centros urbanos tanto por el descarte de insumos como por el movimiento de personas de un espacio a otro dentro del mismo territorio.

Palabras clave: veterinaria, clínica de grandes animales, residuos peligrosos, disposición, factores de riesgo.

INTRODUCTION

The province of Santa Fe includes several agroecological areas that can be broadly described as northern (mostly extensive beef cattle breeding), central (includes the most important dairy area in Argentina) and southern (includes intensive production of food of animal origin combined with an important agricultural activity). Agricultural production may have different impacts on each region, causing diffuse or point pollution. The latter enters the environment through drainage ditches and dumping sites (locally known as "cavas") for discarding waste. On this respect, dead animal dumping sites are easily found in most dairy areas of the province. Other example of practices with negative impact on the provincial environment include the massive treatments for tick control in the northern region. Disposal of large amounts of waste from dip baths is of concern because they can be a major source of neurotoxic pesticide contamination in soil and groundwater (Kunz and Kemp, 1994). In the central and southern regions, the frequent use of antibiotics in dairying farms and feed lots can be a significant problem. In intensive livestock areas, veterinary drug residues can be detected not only in the region's water resources, but also in tap water for human consumption since treatment processes are not designed to remove these contaminants (Charuaud *et al.*, 2019).

The disposal of pharmaceutically active compounds and microplastics is an emerging environmental problem in Latin America (Peña-Guzmán *et al.*, 2019; Reichert *et al.*, 2019; Kutralam Muniasamy *et al.*, 2020; Meléndez Marmolejo *et al.*, 2020; Valdez-Carrillo *et al.*, 2020). A wide variety of drugs enter the environment after the elimination of metabolites following veterinary treatments and the inappropriate disposal of unused containers and medicines affecting the physiological processes of other organisms that are not targets of the treatments (Boxall *et al.*, 2004; Zheng *et al.*, 2008; Hemming *et al.*, 2011; Bártíková *et al.*, 2016; Kovalakova *et al.*, 2020; Oliver *et al.*, 2020). Pesticides can cause clinical signs in humans that are difficult to be recognized and often require knowledge of the relationship between patients and environmental exposures (Sanborn *et al.*, 2002). Pollution from agricultural enterprises is a priority issue for some countries, but farmers have limited awareness of the problem (Merrilees and Duncan, 2003).

Although veterinarians generate potentially dangerous waste, the enforcement of current legislation is

relatively low and the awareness on this problem would seem to be inappropriate (McLean *et al.*, 2007). In Argentina, some provinces do not specifically include veterinary care centers (de Titto *et al.*, 2015). However, the National Law 24.051/91 and most provincial regulations consider that biopathogenic residues are the clinical waste resulting from medical care provided in medical centers for human and animal health.

In the case of the province of Santa Fe, there is basic regulations for the management of pathological waste in rural areas (Subsecretaría de Medio Ambiente y Ecología, 1988). This regulation defines the concept of pathological waste, establishes the responsibilities of the waste generator and the conditions to be met by waste generators, collectors and transporters. However, the absence of a defined protocol, the delivery of used supplies to untrained farm personnel, their disposal in towns and cities and the uneven availability of hazardous waste collection services throughout the province may prove to be difficult obstacles to overcome. This problem would have already generated different consequences. For example, many supplies such as disposable gloves, syringes and needles are frequently reused and their final disposal is often inappropriate (Wright *et al.*, 2008; Signorini *et al.*, 2019).

The objectives of this study were: (i) to describe means of disposal of veterinary supplies used in large animal clinic, and (ii) to explore associations between such disposal and selected sociodemographic characteristics of rural veterinarians from the province of Santa Fe, Argentina.

METHODOLOGY

A cross-sectional observational study was performed by using a self-administered structured questionnaire (Figure 1) in veterinarians working with large animal in the province of Santa Fe, Argentina. The questionnaire was answered anonymously in person within the framework of the mandatory continuing education meetings offered by the Medical Colleges of the province of Santa Fe Board 1 and 2. These meetings were held at three locations throughout the province (Rosario, Venado Tuerto, Santa Fe, Sunchales, Tostado and Reconquista). The variables under study included:

(i) Sociodemographic variables: age (further on transformed into dichotomous variable using the median as cut-off point), gender, professional practice (only large or large and small), working geographic region (north, central or south of Santa Fe province). Data

were employed to analyze associations among variables. Geographical regions were broadly defined according to the prevalent type of farming.

- (ii) Means for disposal of veterinary supplies used during clinical practice. In this case, supplies included gloves, syringes, needles, scalpel blades, glass and other sharp items, cotton, gauze, bandages, antibiotic containers, hormones, internal and external antiparasites. The questionnaire did not include cases where discarded elements were on the farms.
- (iii) Frequency of disposal practice. This variable was classified using an ordinal scale with three levels: never, sometimes, always.
- (iv) Availability of accredited enterprises authorized to transport hazardous waste, and environmental certificate.

Sample size ($n = 421$) was estimated with an absolute error of 4%, a confidence level of 95%, and an expected frequency of 50%, adjusted by the size of the population ($n = 1400$). The latter was estimated according to the records of the Boards of Veterinarians, province of Santa Fe (first and second districts).

Statistical analysis was carried out in two stages. Firstly, all sociodemographic variables (risk factors; item i) were compared using χ^2 with the dependent variable "frequency of disposal practice" –item iii: never, sometimes, always– (*i.e.* item that considered if inputs are discarded one or more times in urban areas). Secondly, logistic regression was performed using the same dependent variable ("frequency of disposal practice"). The estimation method was maximum likelihood with a convergence criterion of 0.01 for a maximum of 10 iterations. Only the variables associated with the dependent variable after the χ^2 with a $P < 0.20$ were offered to the model. Associations among sociodemographic characteristics were also tested by means of χ^2 .

RESULTS

Respondents were 46.1 ± 11.7 years old (median 44 years), being women younger than men ($P = 0.028$). Most of them were working on the central (43.0%) and southern (36.1%) regions of the province, while 20.9% had established their professional practice in the northern area. In respect of the gender, 392 out of 421 respondents (93.1%) were males. Veterinarians working in the north of the province were younger ($P = 0.018$) and worked more frequently only with large

animals ($P = 0.002$) than those working in other regions. Professional practice was mostly large animal clinics (68.8%), while the remaining 31.2% also worked with small animals. The latter was more prevalent within females than males ($P < 0.001$). No associations were detected between age and type of practice ($P = 0.817$) nor between gender and region ($P = 0.324$).

The frequency of respondents with availability of accredited enterprises to transport hazardous waste was 11.5% in the north of the province, 22.1% in the center and 22.3% in the south ($P = 0.085$). No associations were found between having this service available and other sociodemographic variable.

Less than 50% of the respondents bagged used supplies and a minority discriminated them in separate bags (Figure 1). Respondents who bagged sharp elements prior to discharge them were younger than those who did not ($P = 0.018$). A variable proportion of respondents discarded used supplies both on the farm and on urban areas. Less professionals disposed of syringes and sharp elements on the farm than other supplies such as used gloves, cotton, gauze, bandages and antibiotic, hormone, and antiparasite containers.

In general, the disposal of the supplies was mainly carried out by the veterinarian; however, potentially hazardous supplies –due to their degree of contamination (*i.e.* necropsy gloves) or the presence of potentially toxic drug residues (*i.e.* external antiparasites)– were handed out to the farmer or the farmer employees (Figure 2). On the other hand, 7 of 10 respondents (71.2%) who discarded latex gloves on the farm proceeded to burn them (sometimes: 9.6%; always: 61.6%).

Syringes and sharps (*i.e.* needles, scalpel blades and broken glasses) were more frequently discarded at the veterinarians' town of residence than at the farm. Although the discarded supplies were mostly handled in the respondent veterinarians' workplace, a significant proportion was taken and discarded at their family residence (Figure 3).

A total of 364 respondents provided complete information about whether they dispose used supplies on the farm or on their town of residence (farm: 116, urban area: 103, both: 145). In the bivariate analysis, discarding one or more used supplies in urban areas was associated with age and type of professional practice (only large or large and small). No significant associations were detected with the availability of accredited enterprises for hazardous waste disposal (Table 1).

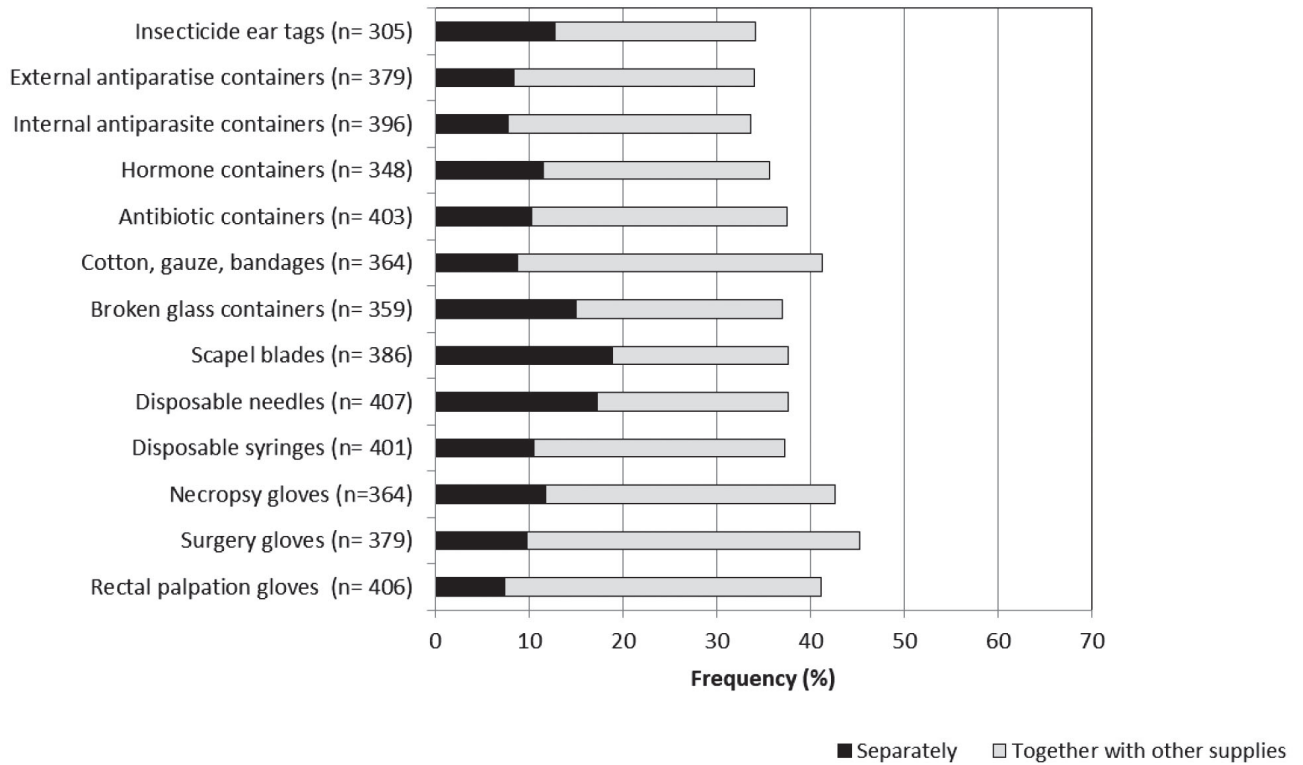


Figure 1. Frequency (%) of veterinarians who bagged the used disposable supplies (n: total of respondents answering each question) separately or together with other supplies. Data were obtained from self-administered structured questionnaires carried out in province of Santa Fe.

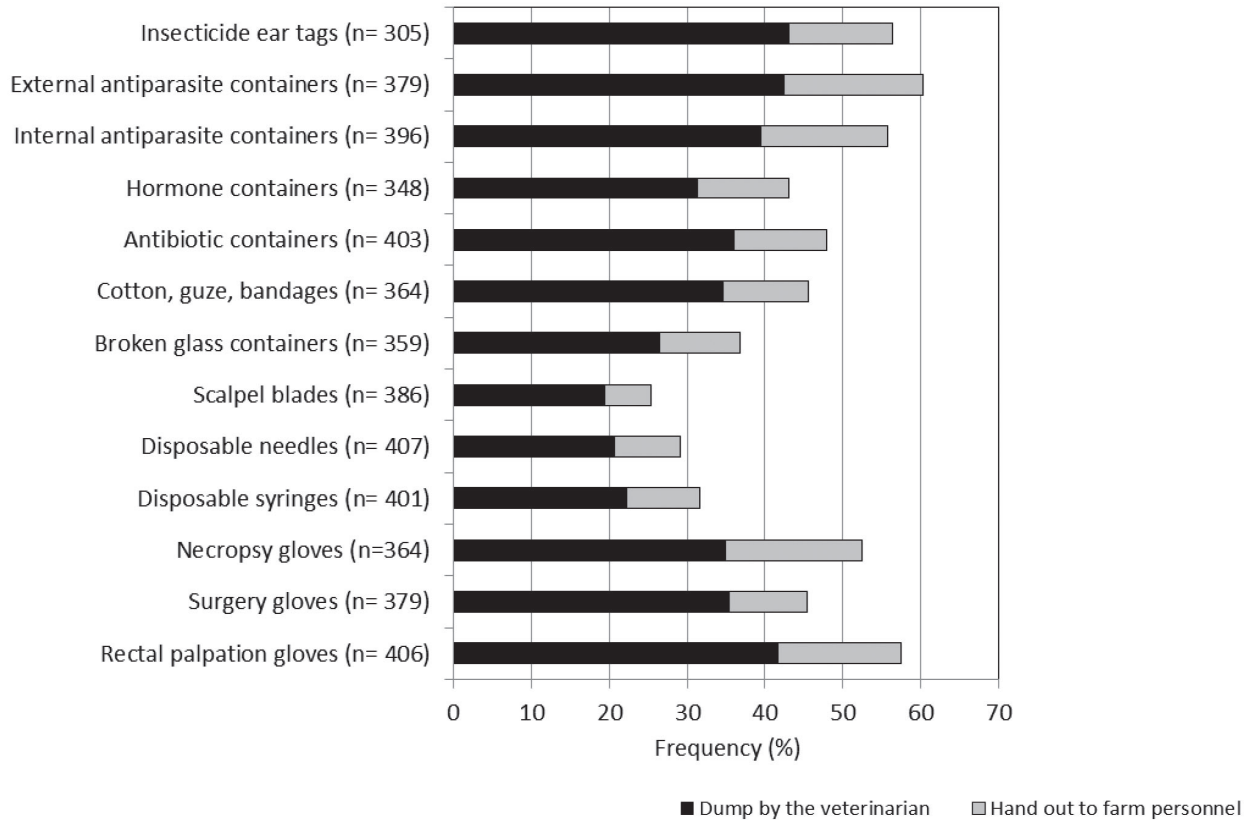


Figure 2. Frequency (%) of veterinarians who disposed used supplies on the farm (n: total of respondents answering each question). Data were obtained from self-administered structured questionnaires carried out in province of Santa Fe.

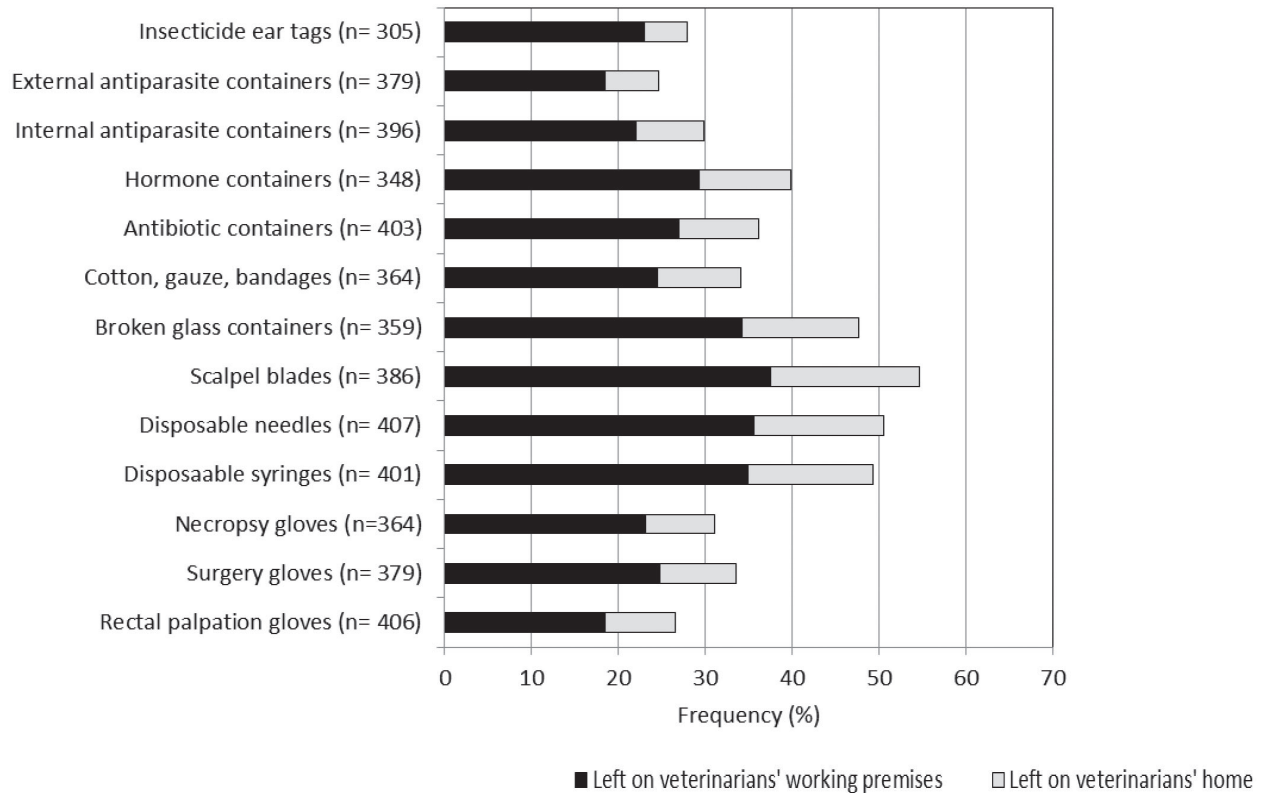


Figure 3. Frequency (%) of veterinarians who brought supplies used on farms to be discarded on their town of residence (n: total of respondents answering each question). Data were obtained from self-administered structured questionnaires carried out in province of Santa Fe.

Table 1. Bivariate associations between the disposal of veterinary supplies in urban areas (yes/no) and selected sociodemographic variables (n= 364). Data were obtained from self-administered structured questionnaires carried out in province of Santa Fe.

Variable	Categories	Disposal		P
		Never	Sometimes/always	
Age (years)	≤ 44	64.8	35.2	0.001
	> 44	41.1	58.9	
Gender	Female	38.1	61.9	0.150
	Male	54.6	45.6	
Practice	Only large animals	66.0	34.0	< 0.001
	Large and small animals	24.6	75.4	
Accredited transport enterprise for hazardous waste	Not available	52.2	47.8	0.547
	Available	57.5	42.5	
Region	South	48.4	51.6	0.054
	Center	64.2	35.8	
	North	45.5	54.5	

The multivariate analysis was employed using the disposal of veterinary waste in urban areas as a dichotomous dependent variable. Older professionals (> 44 years) and those who also worked with small species had respectively 1.29- and 1.47-times higher chances of discharging waste in urban areas than younger veterinarians (\leq 44 years) working with large animals only. On the contrary, those whose working residence was in the central region of Santa Fe showed a significantly lower probability than their colleges established in other regions (Table 2).

Only 8.6% of the respondents held the Environmental Certificate, 10.2% were registered as generators or managers of hazardous waste and 19.8% had, in their town of residence, availability of accredited transport for hazardous waste. One out of 10 veterinarians reused disposable syringes, while reusing other discardable elements was not as prevalent. Burning was the most frequent means of elimination of hazardous waste, while only a small proportion of respondents discarded them as hazardous waste (Table 3).

Table 2. Logistic regression on the disposal (no/yes) of used veterinary supplies in urban areas and selected sociodemographic variables (n= 219). SE: standard error; OR: odds ratio; CI: confidence interval. Data were obtained from self-administered structured questionnaires carried out in province of Santa Fe.

Factors		B	SE	P	OR	CI 95%
Constant		0.34	0.08	0.000		
Age	> 44 years	0.254	0.06	< 0.001	1.29	1.14; 1.46
	\leq 44 years*					
Gender	Female	0.093	0.11	0.399	1.10	0.89; 1.36
	Male*					
Practice	Large and small animals	0.38	0.07	< 0.001	1.47	1.27; 1.69
	only large animals					
Region	South	-0.12	0.09	0.159	0.88	0.74; 1.05
	Centre	0.21	0.09	0.019	0.81	0.69; 0.97
	North*					

* Reference population.

Table 3. Means for disposal of veterinary supplies use on farms (n= 412). Data were obtained from self-administered structured questionnaires carried out in province of Santa Fe.

Used supply (n)	Action (%)					
	Reuse	Wash	Disinfection	Burn	Bury	Hazardous waste
Rectal palpation gloves (406)	0.5	0.7	0.2	64.5	4.9	3.2
Surgery gloves (379)	0.3	0.3	0	62.5	5.5	4.0
Necropsy gloves (364)	0	0	0	61.0	6.6	4.4
Disposable syringes (401)	10.2	7.2	7.2	45.4	5.5	4.5
Disposable needles (407)	5.2	3.9	3.2	34.9	7.1	5.4
Scalpel blades (386)	1.3	1.6	0.5	30.1	1.6	5.4
Broken glass containers (359)	0	0.3	0.3	56.8	16.7	5.0
Cotton, gauze, bandages (364)	0	0	0	47.8	5.8	3.8

DISCUSSION

Emerging environmental pollution is being studied with growing interest throughout the world to improve our understanding of its occurrence, impacts and trends in different ecosystems (Peña Guzmán *et al.*, 2019). In the present work, the results show that many hazardous contaminants that should be bagged separately by veterinary practitioners to be disposed as hazardous waste were sometimes mixed up with other potentially biopathogenic residues. Furthermore, some elements were handed out to the farmer or farmer employees to be dumped after the professional left the premises.

Glass, plastic, and sharps disposals are often inadequate in rural areas (Scherer de Oliveira *et al.*, 2019), where farmers and their families receive little training on the occupational risks they are exposed to. Real knowledge is limited by a cultural background that targets chance or lack of attention rather than the objective working conditions as causes of occupational accidents and professional diseases (Posada and Vaca, 2002; Molineri *et al.*, 2014; Koziol *et al.*, 2016). Under these conditions, charging them with the task of handling sharps, medicines or hazardous residues is inappropriate and can be dangerous. Moreover, waste from some frequent practices at the herd level, such as the massive administration of ectoparasitic drugs, can contribute to environmental contamination (Kunz and Kemp, 1994). Meanwhile, antibiotic residues, resistant bacteria and resistance genes found in livestock waste can contribute to the emergence and spread of bacterial resistance, decrease microbial diversity and damage other organisms (Oliver *et al.*, 2020). The administration of antimicrobials without prior veterinary advice is a common practice in livestock systems in Argentina. Farmers have little awareness on the possible impacts of antibiotic resistance on human health. Even if they take some preventive measures, they lack of a holistic view of the problem and do not have the necessary technical knowledge or skills to measure the consequences of incorrect use of these drugs (Golding *et al.*, 2019; Doidge *et al.*, 2020; Wemette *et al.*, 2020). In a recent study in Southern Brazil, more than 80% of farmers had inappropriately disposed medicines, failing to comply with basic standards of good practice and current legislation. Many farmers had unsafe drug storage practices, with the risk of making them accessible to unauthorized persons, including children (Scherer de Oliveira *et al.*, 2019). On this regard, of every 10 veterinarians surveyed in the

present work, between three and six professionals discarded pharmaceutical drugs and containers on the farm or were left in the hands of farm workers, a clearly inadequate practice.

Gloves are the most frequent personal protective equipment adopted by large animal clinicians (Tarabla *et al.*, 2017; Navarrete and Tarabla, 2018). However, the results obtained showed that means of disposal did not meet safety standards. Similar results were obtained as far as disposable syringes and needles were concerned. Reusing hypodermic needles (Huertas *et al.*, 2019; Signorini *et al.*, 2019) arises the chance of iatrogenic transmission of diseases such as leukosis or anaplasmosis. Although 61-65% of respondents burned used gloves and 45% followed the same procedure with syringes, less than 5% complied with current regulations and treated them as hazardous waste. Syringes are made of polypropylene, one of the most frequent polluting polymers in Latin America. Knowledge of the sources, occurrence, transport, destination and potential impacts of microplastics remains largely unexplored, and relatively few studies have been conducted in the region (Kutralam Muniyasamy *et al.*, 2020). It is unknown to what degree syringes and other plastic supplies from the veterinary clinic contribute to global contamination. However, small it may be, this contribution could be zero if responsible behaviors are adopted. Besides, some soft plastics, such as ear tags impregnated with insecticides are widely used in livestock production. These elements can show traces of active ingredients after four months of use, when they must be removed from cattle.

The presence of hazardous waste could be related to the transportation of used supplies to urban areas for disposal. It's reasonable to think than the availability of hazardous waste transportation companies in urban areas could be related to the transfer of used supplies to urban areas for proper disposal. However, in the present study there was no association between these two variables. Although availability was low, the respondents' adoption of hazardous waste transportation enterprises was even lower, suggesting a dichotomy between availability and usage. Older veterinarians and those working in large and small animal practice were more likely to discard supplies in urban areas than younger respondents working only with large animals. Coincidentally, respondents working in the center and south regions were older and practice on both types of clinics than those

working in the north one. Chances to dump waste in urban areas may be related to these factors or to other variables not included in this survey. Obviously, the lower the frequency of dumping waste in urban areas, the higher the chances of leaving it on the farms. Cross-sectional observational studies do not allow inferences about causality. Their greatest contribution is not to provide answers but rather to generate new hypotheses about cause-effect relationships. In this sense, it is possible that, as well as risk perceptions and the adoption of personal protective equipment (Tarabla *et al.*, 2017), the decision to dispose on urban areas supplies that were used in farms may be also linked to other factors not included in this study (*i.e.* costs, pressure of control in the different jurisdictions, habits and traditions).

In Latin America, the lack of environmental monitoring and regulation contributes to the abundance of emerging pollutants (Meléndez Marmolejo *et al.*, 2020). In many areas of Argentina, there is a close relationship among farms, towns and cities. This fact can put urban public health at risk both due to the movement of

workers from one space to another within the same territory and to the disposal of rural supplies in urban areas (Tarabla *et al.*, 2019). The disposal of hazardous waste under field conditions is regulated in the province of Santa Fe (de Titto *et al.*, 2015). This work shows the necessary to standardize protocols for the elimination of potentially dangerous residues from veterinary activities. In the province of Santa Fe, veterinarians working on the management and care of large animals in rural areas are recognized and trained as sanitary co-responsible by the Veterinary Boards. In a context where the "One World, One Health" concept becomes increasingly important, a program lead by these provincial Boards can serve as a firm basis for progress.

ACKNOWLEDGMENTS

To all veterinarians participating in the survey. To the Veterinary Boards ("Colegios de Médicos Veterinarios de la Provincia de Santa Fe, 1^{ra} y 2^{da} Circunscripciones"). This study was financed by "Proyecto 19-56-AET-FCV-TH Un Mundo, Una Salud: descarte de residuos veterinarios, Res. C.S. UNL 122/19".

REFERENCES

- Bártíková, H., Podlipná, R. y Skálová, L. (2016). Veterinary drugs in the environment and their toxicity to plants. *Chemosphere*, 144, 2290-2301. <https://doi.org/10.1016/j.chemosphere.2015.10.137>
- Boxall, A. B., Fogg, L. A., Blackwell, P. A., Kay, P., Pemberton, E. J. y Croxford, A. (2004). Veterinary medicines in the environment. *Rev Environ Contam Toxicol.*, 180, 1-91. https://doi.org/10.1007/0-387-21729-0_1
- Charuau, L., Jardé, E., Jaffrézic, A., Liotaud, M., Goyat, Q., Mercier, F. y Le Bot, B. (2019). Veterinary pharmaceutical residues in water resources and tap water in an intensive husbandry area in France. *Sci. Total Environ.*, 664, 605-615. <https://doi.org/10.1016/j.scitotenv.2019.01.303>
- De Titto, E., Montecchia, M., Brunstein, L. y Chesini, F. (2015). Normativas para la gestión de residuos biopatógenos. *Rev. Arg. Salud Pública*, 6, 7-14. https://www.argentina.gob.ar/sites/default/files/normativas_para_la_gestion_de_residuos_biopatogenicos_en_argentina.pdf
- Doidge, C., Ruston, A., Lovatt, F., Hudson, C., King, L. y Kaler, J. (2020). Farmers' perceptions of preventing antibiotic resistance on sheep and beef farms: risk, responsibility, and action. *Front. Vet. Sci.*, 7, 524. <https://doi.org/10.3389/fvets.2020.00524>
- Golding, S. E., Ogden, J. y Higgins, H. M. (2019). Shared goals, different barriers: a qualitative study of UK veterinarians' and farmers' beliefs about antimicrobial resistance and stewardship. *Front. Vet. Sci.*, 6, 132. <https://doi.org/10.3389/fvets.2019.00132>
- Hemming, J., Schauer, J. J., Shafer, M. M. y Barry, T. (2011). *Assessing occurrence, persistence and biological effects of hormones released from livestock waste*. EPA Grant R833421. <https://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/8424/report/F>
- Huertas P. S., León E. A. y Tarabla, H. D. (2019). Zoonosis and veterinary waste disposal in rural practice. *Rev. Arg. Microbiol.*, 51, 251-254. <https://doi.org/10.1016/j.ram.2018.08.004>
- Kovalakova, P., Cizmas, L., McDonald, T. J., Marsalek, B., Feng, M. y Sharma, V. K. (2020). Occurrence and toxicity of antibiotics in the aquatic environment: a review. *Chemosphere*, 251, 126351. <https://doi.org/10.1016/j.chemosphere.2020.126351>
- Kozioł, E., Vanasco N. B., Signorini, M. L. y Tarabla, H. D. (2016). Conocimiento de zoonosis en operarios tamberos de la Provincia de Santa Fe, Argentina. *Vet.*, 18, 45-52. <http://www.fvet.uba.ar/archivos/publicaciones/invet/vol18-1-2016/T02.pdf>
- Kunz, S. E. y Kemp, D. H. (1994). Insecticides and acaricides: resistance and environmental impact. *Rev. Sci. Tech. Off. Int. Epiz.*, 13, 1249-1286. <https://doi.org/10.20506/rst.13.4.816>
- Kutralam Muniyasamy, G., Pérez Guevara, F., Elizalde Martínez, I. y Shruti, V. C. (2020). Review of current trends, advances and analytical challenges for microplastics contamination in Latin America. *Environ. Pollut.*, 267, 115463. <https://doi.org/10.1016/j.envpol.2020.115463>
- McLean, M., Watson, H. K. y Muswema, A. (2007). Veterinary waste disposal: practice and policy in Durban, South Africa (2001-2003). *Waste Manag.*, 27, 902-911. <https://doi.org/10.1016/j.wasman.2006.05.004>

- Meléndez Marmolejo, J., García Saavedra, Y., Galván Romero, V., Díaz de León Martínez, L., Vargas Berrones, K., Mejía Saavedra, J. y Flores Ramírez, R. (2020). Contaminantes emergentes. Problemática ambiental asociada al uso de antibióticos. Nuevas técnicas de detección, remediación y perspectivas de legislación en América Latina. *Rev. Salud Ambient.*, 20, 53-61. <https://www.researchgate.net/publication/341539736>
- Merrilees, D. y Duncan, A. (2003). *Reviews of attitudes and awareness in the agricultural industry to diffuse pollution issues* (pp. 12-18). Diffuse pollution conference, Dublin, Ireland, 11 Public Awareness/ Education. https://www.ucd.ie/dipcon/docs/theme11/theme11_03.PDF
- Molineri, A. I., Signorini, M. L. y Tarabla, H. D. (2015). Hazards for women and children in rural settings. *Rev. Salud Pública*, 17, 22-32. <https://doi.org/10.15446/rsap.v17n1.40090>
- Navarrete, M. B. y Tarabla, H. D. (2018). Factores asociados a los riesgos ocupacionales y el uso de elementos de protección personal en la práctica veterinaria con bovinos y equinos. *Vet.*, 20, 275-286. <http://www.fvet.uba.ar/archivos/publicaciones/invet/vol20-2-2018/ART-3-VOL-20-N-2.pdf>
- Oliver, J. P., Gooch, C. A., Lansing, S., Schueler, J., Hurst, J. J., Sassoubre, L., Crossette, E. M. y Aga, D. S. (2020). Invited review: Fate of antibiotic residues, antibiotic-resistant bacteria, and antibiotic resistance genes in US dairy manure management systems. *J. Dairy Sci.*, 103, 1051-1071. <https://doi.org/10.3168/jds.2019-16778>
- Peña Guzmán, C., Ulloa Sánchez, S., Mora, K., Helena Bustos, R., López Barrera, E., Alvarez, J. y Rodríguez Pinzón, M. (2019). Emerging pollutants in the urban water cycle in Latin America: A review of the current literature. *J. Environ. Manage.*, 237, 408-423. <https://doi.org/10.1016/j.jenvman.2019.02.100>
- Posada, M. y Vaca, C. (2002). *Diagnóstico sobre necesidades de capacitación en el sector rural. Fundación para la promoción de la seguridad y salud en el trabajo. Programa salud y seguridad en el trabajo*. Banco Interamericano de Desarrollo. <http://www.fediap.com.ar/administracion/pdfs/Diagnostico%20sobre%20Necesidades%20de%20Capacitaci%C3%B3n%20en%20el%20Medio%20Rural%20-%20FUSAT.pdf>
- Reichert, G., Hilgert, S., Fuchs, S. y Azevedo, J. C. R. (2019). Emerging contaminants and antibiotic resistance in the different environmental matrices of Latin America. *Environ. Pollut.*, 255(Pt 1), 113140. <https://doi.org/10.1016/j.envpol.2019.113140>
- Sanborn, M. D., Cole, D., Abelsohn, A. y Weir, E. (2002). Identifying and managing adverse environmental health effects: 3. Pesticides. *Can. Med. Assoc. J.*, 166 (10), 1287-1292. <https://www.cmaj.ca/content/cmaj/166/11/1431.full.pdf>
- Scherer de Oliveira, K., Morello, L., Vassem de Oliveira, S., Agostinotto, L., da Silva, B. F. y Sieglösch A. E. (2019). Disposal of animal healthcare services waste in southern Brazil: One Health at risk. *Saúde Debate* 43, 78-93. <https://doi.org/10.1590/0103-11042019S306>
- Signorini, M. L., Molineri, A. I., Meléndez Orantes, C. E. y Tarabla, H. D. (2019). Factores asociados al uso, disposición y eliminación de elementos de protección personal en clínicas de grandes animales. *Rev. FAVE* 18, 26-29. <https://doi.org/10.14409/favecv.v18i1.8299>
- Subsecretaría de Medio Ambiente y Ecología. (1988). *Normas para el manejo y tratamiento de los residuos patológicos*. Decreto 388/00. Provincia de Santa Fe, 15 p. <https://www.santafe.gov.ar/index.php/web/content/download/96932/474580/file/Decreto%20N%C2%BA%200388-00.pdf> (21/04/22).
- Tarabla, H. D., Hernández Villamizar, A. C., Molineri, A. I. y Signorini M. L. (2017). Percepción y prevención de riesgos ocupacionales en veterinarios rurales. *Rev. Vet.*, 28, 152-156. Universidad Nacional del Nordeste. <https://revistas.unne.edu.ar/index.php/vet/article/view/2543/2249>
- Tarabla, P. A., Signorini, M. L., Imoberdorf, C. G., Huertas, P. S., Molineri, A. I., Navarrete, M. B. y Tarabla, H. D. (2019). *Residuos patológicos veterinarios: ¿un problema territorial de nivel nacional?* Ir Congreso Latinoamericano de Ciencias Sociales, Villa María, Córdoba. http://biblio.unvm.edu.ar/opac_css/38293/2354/TaRaBLa-et.al.pdf
- Valdez Carrillo, M., Abrell, L., Ramírez Hernández, J., Reyes López, J. A. y Carreón Díazconti, C. (2020). Pharmaceuticals as emerging contaminants in the aquatic environment of Latin America: a review. *Environ. Sci. Pollut. Res. Int.* 27, 44863-44891. <https://doi.org/10.1007/s11356-020-10842-9>
- Wemette, M., Safi, A. G., Beauvais, W., Ceres, K., Shapiro, M., Moroni, P., Welcome, F. L. y Ivanek R. (2020). New York State dairy farmers' perceptions of antibiotic use and resistance: A qualitative interview study. *PLoS One*. 15, e0232937. <https://doi.org/10.1371/journal.pone.0232937>
- Wright, J. G., Jung, S., Holman, R. C., Marano, N. N. y McQuiston J. H. (2008). Infection control practices and zoonotic disease risks among veterinarians in the United States. *JAVMA*, 232, 1863-1872. <https://doi.org/10.2460/javma.232.12.1863>
- Zheng, W., Yates, S. R. y Bradford, S. A. (2008). Analysis of steroid hormones in a typical dairy waste disposal system. *Environ. Sci. Technol.*, 42, 530-535. <https://doi.org/10.1021/es071896b>