

Final disposal of cattle carcasses and necropsy remains under field conditions

Disposición final de cadáveres y restos de necropsias de bovinos en condiciones de campo

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ABSTRACT

Objectives To describe means for disposing organic waste from bovine necropsies carried out on-farm, and to look for associated factors.

Materials and Methods A cross-sectional study was carried out in 421 rural Veterinarians on the Province of Santa Fe, Argentina. Data were collected using a structured questionnaire. Data analysis included χ^2 , Fisher's exact test, and Spearman's correlation.

Results Ninety percent of respondents (n=381) performed necropsies. The most frequent practice was to leave the remains in the place where it was carried out or to take them to a specific site, while the least frequent was to cover them with calcium hydroxide and plastic membranes. The geographical region of professional practice was associated in various ways to waste management. These results show inconsistencies in the protocols for organic waste disposal under field conditions in the region under study.

Conclusions It is important to encouraged during undergraduate studies both legal and biological knowledge on the consequences of inappropriate disposal of biopathogenic waste. Moreover, continuing education programs for graduates should include standardized protocols for the safe execution of these practices.

Key Words: Veterinary medicine; cattle; body remains; waste; refuse disposal (*source: MeSH, NLM*).

RESUMEN

Objetivos Describir las formas de descarte del material orgánico remanente de necropsias de bovinos realizadas en campo y explorar factores asociados.

Materiales y Métodos Se efectuó un estudio transversal en 421 médicos veterinarios rurales de la Provincia de Santa Fe, Argentina. Los datos fueron colectados utilizando un cuestionario estructurado. El análisis de los datos incluyó χ^2 , test exacto de Fisher y correlación de Spearman.

Resultados El 90,5 % de los encuestados (n= 381) realizaban necropsias. La práctica más frecuente fue dejar los restos en el lugar donde se efectuó la misma o llevarlos a la cava, mientras que la menos frecuente fue cubrirlos con hidróxido de calcio y membrana plástica. La región geográfica de ejercicio profesional estuvo asociada de maneras diversas con la adopción de dichas prácticas. Los resultados muestran inconsistencias en los protocolos de disposición de restos de necropsias en condiciones de campo en la región bajo estudio.

Conclusiones Es importante incentivar durante los estudios universitarios el conocimiento legal y biológico de las consecuencias de una eliminación inapropiada de residuos biopatogénicos. Por otra parte, los programas de capacitación continua de los profesionales deberían incluir protocolos estandarizados para la ejecución segura de estas prácticas.

Palabras Clave: Medicina veterinaria; bovinos; restos mortales; residuos; eliminación de residuos (*fuentes: DeCS, BIREME*).

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Animal mortality is an unavoidable event in livestock farming. With a population close to 54 million cattle (1), production systems in Argentina generate a significant volume of carcasses that must be disposed safely, practically and economically. Conventional disposal methods include burial, incineration, composting, and processing in specialized facilities by exposing the remains to steam and pressure at high temperatures. Research work has been focused primarily on the removal of poultry carcasses, and comparatively few studies have emphasized on the disposal of mammal remains (2). When cattle carcasses are not destroyed, leachate is produced containing a variety of organic and inorganic contaminants, including increases in turbidity, solids, organic carbon, electrical conductivity, chloride, phosphorus, nitrogen, steroid hormones, veterinary pharmaceuticals, and low levels of dissolved oxygen and redox potential (3, 4). The high concentrations of contaminants are a source of concern, especially because many farm animal disposal sites are neither covered nor isolated (4). The objectives of this study were: a) to describe the means of discarding the organic material remaining from cattle necropsies carried out under field conditions and b) to look for associated factors.

MATERIALS AND METHODS

A cross-sectional observational study was carried out in rural veterinarians in the Province of Santa Fe, Argentina. Sample size (n= 421) was calculated for an absolute error of 4 %, a confidence level of 95 % and a prior frequency of 50 %, adjusted by the population size (N=1400). The latter was estimated from the records of the two veterinary

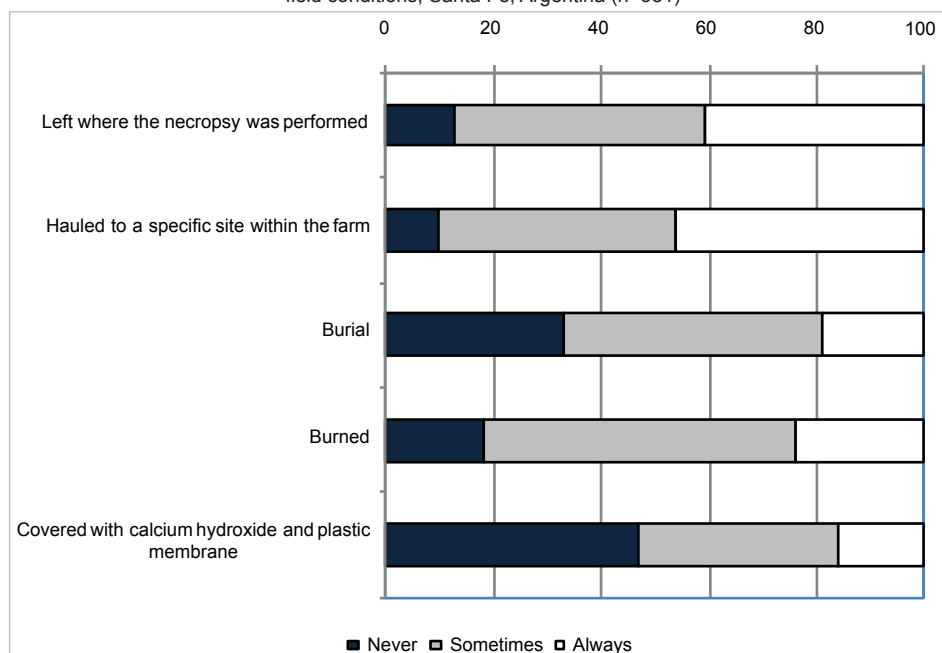
union districts acting in the Province of Santa Fe. Data were collected using a self-administered structured questionnaire that was answered anonymously. The variables studied were the place where the carcasses and necropsy remains were deposited (where the necropsy was performed/ taken to a specific place within the farm) and means of disposal or elimination (cover with calcium hydroxide and plastic membrane/ burn/ bury/ other). To search for associations, four characteristics of the interviewees were recorded: age (transformed into a dichotomous variable taking the median as the cut-off value), gender, type of practice (only large / large and small animals) and working region (Northern, Central and Southern areas of the Province of Santa Fe). Data analysis included χ^2 , Fisher's exact test, and Spearman's rank correlation coefficients.

RESULTS

Three hundred and eighty-one (90.5 %) of the respondents performed bovine necropsies as part of their professional duties. Their average age was 45.9 ± 11.6 years (median 44.0 years), while 6.6% were females. The latter were significantly younger than men ($P=0.004$). No significant associations were recorded between performing necropsies and age ($P=0.694$), gender ($P=0.506$), type of practice ($P=0.311$) or geographic region of professional practice ($P=0.480$).

After the necropsy was carried out, the most frequent action was to leave the remains in the place where the necropsy was carried out or to bring them to an uncovered pit, while the least frequent was to cover them with calcium hydroxide and plastic membranes (Figure 1).

Figure 1. Frequency of veterinarians according to means for carcass and necropsy remains disposal under field conditions, Santa Fe, Argentina (n=381)



No associations were found between the five actions for the disposal of remains with the age, gender or type of professional practice of the respondents. However, geographical region was associated to disposal techniques in various ways. Covering the remains with calcium hydroxide and a plastic membrane ($P=0.002$), burning ($P=0.001$) or burying ($P=0.025$) was less frequent in the central area than in the other two regions. Meanwhile, throwing the carcasses into a pit was less frequent in the Northern region than in the Central and Southern areas of the Province ($P=0.002$) (Figure 1).

Firstly, the sites of disposal were independent of each other. Secondly, all means for disposal were associated with each other ($P<0.001$). Finally, the frequency of veterinarians burying, burning, or covering the remains with calcium hydroxide and plastic sheeting were associated with their hauling to a pit or other ad hoc site, although showing relatively low correlation coefficients (Table 1).

Table 1. Correlation coefficients between the sites and actions for the disposal of carcass and necropsy remains under field conditions, Santa Fe, Argentina (n=381)

Action	Burning	Burial	Left where the necropsy was performed	Hauled to a specific site within the farm
Calcium hydroxide and plastic membrane	$r=0,34$ $P<0,001$	$r=0,60$ $P<0,001$	$r=0,13$ $P=0,147$	$r=0,26$ $P=0,005$
Burning	-	$r=0,48$ $P<0,001$	$r=0,04$ $P=0,674$	$r=0,28$ $P=0,002$
Burial	-	-	$r=0,11$ $P=0,222$	$r=0,34$ $P<0,001$
Left where the necropsy was performed	-	-	-	$r=-0,20$ $P=0,818$

Only 2.9 % of the veterinarians mentioned other means for disposing necropsy remains, being the vast majority a description of the disposal sites (“it is thrown in the bush”, “in an unburied pit”, “it remains in the paddock” or “in the designated place within the farm”).

DISCUSSION

Throughout history, the most used methods for the on-farm disposal of dead animals have been burial and, to a lesser extent, burning. In some countries the possibilities of elimination are limited by compliance with strict legislation. For example, the European Union only allows incineration (on or off farm), alkaline hydrolysis, disposal in worm farms or by licensed collectors (2). Regulations can even vary within the same country, for example, while in Ontario (Canada) composting was only authorized below 60 cm of organic substrate, such as sawdust or straw, burial at the same depth away from all waterways or collection by authorized companies (5), in Alberta natural

exposure was allowed for the carcasses to be consumed by scavengers (6). However, in other countries with very different regulations and socioeconomic and demographic characteristics, dead animals are dumped on farms, roads and rivers, creating different economic, environmental and biosafety problems (7-8).

In Argentina, cattle are generally left at the site of death or taken to specific disposal sites within the same farm. The Province of Santa Fe allows the use of sanitary landfills in rural establishments for the treatment of pathological waste, but the existing sites are generally precarious and far from meeting the required standards (9). In our study, only approximately two out of every 10 respondents always buried, burned or covered the remains with calcium hydroxide and plastic membranes. Burial has been prohibited in other countries due to fears that infectious agents could cause environmental contamination or enter into human food chains (2). Incomplete destruction during burial can cause infectious agents to survive and increase the concentration of soluble nitrogen in soil and water, but its environmental impact in the case of livestock farms is still under discussion (10). Many of the conclusions on the subject have been made after mass burial in high-mortality cases, and the results of such studies are unlikely to provide an accurate representation of the risks represented by routine burial of fatalities on farms. For that reason, extrapolation of the results of studies of such extreme events may be erroneous (2). Nevertheless, it has to be taken into account that some infectious materials such as *Bacillus anthracis* spores may endure in the soil after carcass decomposition and be ingested by animals (11). Non burial to allow natural exposure has only been recommended in large areas of land, where carcasses are deposited away from human and livestock populations. Problems such as pathogen transmission, bad odors, conflicts with neighbors, contamination of water supplies and increased population of scavengers and flies can be aggravated if dead cattle are just left out in the open field (6). Natural exposure is not an option in most of the Province of Santa Fe, where the permanence of carcasses in the open increases the risk of lethal consequences for human beings due to direct contact with animals killed by anthrax (12), or for the introduction of other zoonoses such as tuberculosis or leptospirosis into wildlife (13,14). In addition, many other zoonotic diseases of great relevance in Argentina have wild components, although studies on the relative importance of fauna in their cycles are scarce (15).

Incineration is a procedure that is not accessible under field conditions in Argentina, since it requires temperatures above 850 °C to produce inorganic ashes (16). On the other hand, pyro-burning of dead cattle is a common disposal method in many countries and has been widely used in many outbreaks of diseases such as foot-and-mou-

th disease (17). In our study, approximately one out of four professionals always burned the necropsy remains. Although this practice can generate odors and the release of dioxins and furans as a result of incomplete combustion (17), evidence of soil contamination after the burning of thousands of animals killed in FMD outbreaks was found to be negligible and emissions only affected air quality in the vicinity of the pyre (2).

Alkaline hydrolysis using sodium or potassium hydroxide in sealed steel containers subjected to high temperatures and pressure (2) is not affordable under the current possibilities of bovine production in Argentina. However, an accessible method such as the application of calcium hydroxide effectively reduces pathogen survival and the chances of pathogen transfer, minimizing the biological risk of soil and water contamination (8). Calcium hydroxide can prevent the growth of all microorganisms by inhibiting the natural degradation process and slowing down carcass decomposition. In a context of improved biosecurity, it appears as a simple, affordable, and accessible procedure for many farmers (19). Unfortunately, this practice was the least used by the surveyed veterinarians. It is likely that the associations between the geographical region of professional practice and waste management were related to the type of livestock production in the different regions. To a large extent these areas can be characterized as: Northern area of extensive beef production, central area as mostly devoted to dairying, and Southern area as mainly agricultural region with some milk and cattle fattening farms.

Our results show inconsistencies in the protocols applied by rural veterinarians for the disposal of necropsy remains in cattle in the Province of Santa Fe. The curricula taught in Veterinary Schools include valuable details on the techniques to perform necropsies in different species, the pathological findings, and the diagnostic tests to reach an accurate diagnosis. However, many times it is not taken into account that these activities can result in direct and indirect risks to animal and human health. The uncontrolled disposal of organic waste causes aesthetic and environmental pollution and impacts public health by providing a source of nutrition and shelter for rodents, promoting the spread of their ecto and endoparasites and viral zoonoses (20). It is considered important that, in addition to the techniques for an accurate diagnosis, Veterinary Schools should encourage legal and biological knowledge about the consequences that an inappropriate disposal of necropsy remains can cause. Moreover, it is suggested that training programs for veterinary graduates must include standardized protocols for the safe execution of these practices. Veterinary boards in this Province have a rich history working with registered professionals on continuing education and can

channel the necessary actions to improve the safe disposal of necropsy remains ♦

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