

Implementation of an animal health database in response to the 2018 California Camp Fire

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OBJECTIVE

To describe an animal health database used to facilitate effective disaster response and retrospective analysis of data concerning animals other than cats and dogs affected by the 2018 California Camp Fire.

ANIMALS

Veterinary medical entries (n = 206) for evacuated or rescued animals (151) of various species, including avian, bovine, camelid, caprine, equine, ovine, and porcine species, temporarily housed at the Butte County fairgrounds in Gridley, Calif.

PROCEDURES

Case data were collected via a standardized form by volunteers with the University of California-Davis Veterinary Emergency Response Team during triage and treatment of animals brought to the shelter. Collected data were entered into a database. Multiple correspondence analysis was used to evaluate associations among patient species, types and severity of injuries, and behavior.

RESULTS

Burns, respiratory disease, gastrointestinal illnesses, and lacerations were the most prevalent illnesses and injuries among the overall shelter population for the first 12 days of the Camp Fire. Ovine patients were more likely to have had respiratory illness than were other species. The most prevalent medical conditions among equine patients were lacerations and gastrointestinal illnesses. Severe burns were most common among porcine, camelid, and avian patients. The temporal distribution of cases suggested the immediate evacuation of equine species and the delayed movement of bovine and avian species to the shelter.

CONCLUSIONS AND CLINICAL RELEVANCE

Collection of animal health information through the database allowed assessment of prevalent medical conditions among various farm animals following a wildfire. Adaptation of this database to other disasters could improve emergency response protocols by providing guidance for management of resources and allow retrospective assessment for response improvement. (*J Am Vet Med Assoc* 2020;256:1005–1010)

In November 2018, California experienced its most destructive wildfire in history, the Camp Fire. Within 18 days, the fire burned > 150,000 acres—both residential and rural—and destroyed 18,804 structures in Butte County, Calif,¹ with the town of Paradise as the epicenter. Four days after the fire began, it was classified as a major disaster by the federal government, the worst of 16 fire disasters declared by the Federal Emergency Management Agency in California in 2018 alone.² The scope of

this disaster for the animals in the Camp Fire area remains largely unknown.

Systematic disaster response for animals is a fairly new aspect of disaster management and requires development and improvement. The AVMA recognizes the need for incorporating animals in disaster and emergency planning and improving coordination among emergency planning agencies, veterinarians, and animal shelters.^{3,4} After Hurricane Katrina and the highly publicized overwhelming numbers of abandoned and injured companion animals requiring care, the US government passed the Pet Evacuation and Transportation Standards Act of 2006.⁵ This act requires federal agencies to provide rescue, care, and shelter for companion animals but does not encompass food animals or horses. It did not standardize any form of field-based documentation or database

ABBREVIATIONS

MCA	Multiple correspondence analysis
NA	Not available
NVADG	North Valley Animal Disaster Group
UC	University of California
VERT	Veterinary Emergency Response Team

development to measure the scope and clinical epidemiology of disaster-related health consequences for animals. Meeting proceedings⁶ regarding hurricanes in the early 2000s cited the lack of a centralized information database as one of the leading issues limiting health-care services as well as reunification of pets with their owners. Human medicine also lacks standardized methods for health data collection in emergencies, and this represents a gap and limitation in response capabilities.⁷ Disasters can quickly overwhelm and hinder functionality of health-care systems. Therefore, a database for tracking identification and health of animals is a potentially important component of effective preparation, real-time communication during disasters, and retrospective evaluation.

During the early stages of the Camp Fire, the UC-Davis VERT was deployed by the California Office of Emergency Services under Emergency Support Function No. 11 to assist in addressing the veterinary needs of livestock and equine species. An animal shelter was established at the Butte County fairgrounds in Gridley, Calif, to temporarily house animals, other than cats and dogs, evacuated from Butte County. The NVADG was responsible for handling all logistics associated with shelter management, including animal husbandry and registration. Injured and displaced domestic animals included horses, donkeys, cows, goats, sheep, pigs, llamas, turkeys, ducks, and chickens, among others. At the initiation of the disaster response, no protocol or convention existed for documentation of the animals' clinical needs, specific treatments administered, and case dispositions. Because no preexisting database was available to record and evaluate the veterinary management of animals during disasters and to serve as a foundation for evidence-based decision-making, the VERT developed such a tool on an ad hoc basis. The purpose of the present report was to describe our effort to create a simple and concise database of animal health information collected during response to the Camp Fire wildfire. To our knowledge, this would be the first reported description of an animal health database for disaster response.

Materials and Methods

Deployment of the VERT

The UC-Davis VERT organized and sent teams of veterinarians and veterinary students (first- through third-year veterinary students, to provide hands-on learning) to the Butte County fairgrounds in Gridley, Calif, from November 10 to 21, 2018. The VERT was tasked by the California Office of Emergency Services to assist with the veterinary treatment of livestock and equids evacuated or rescued during the Camp Fire and temporarily housed at the fairgrounds. The VERT collaborated with veterinarians from the Northern California Association of Equine Practitioners and private practices on treatment of animal patients and worked daily with the NVADG on shelter organization. Teams were comprised of 2 to 4 students with

a supervising faculty veterinarian. Faculty veterinarians supervised 1 or 2 teams, and all treatments administered were approved by a veterinarian.

Database development

On the first day of UC-Davis VERT response to the wildfire, 3 of the authors (HGD, LRR, and JEM) developed an initial database to record critical epidemiological, medical, and case features for animals treated by the VERT, with the goal of accounting for the types and numbers of these animals (by species), types and severity of illnesses and injuries sustained, types of management provided, each animal's behavior, and the immediate case disposition. These features were considered key to assessing the health and behavior of animal patients, evaluating personnel and supply needs, and facilitating future evaluation of the response.

The database was created as a spreadsheet^a that included 8 fields: time/date, location, animal species, illness/injury, severity, behavior, treatment, and referral (**Appendix**). Three fields (illness/injury, severity, and treatment) were repeated within a single entry as needed for patients with multiple injuries at a single time point. To streamline and categorize the responses, a numeric code was assigned to 5 fields: illness/injury, severity, behavior, treatment, and referral (ie, case disposition). Severity was subjectively scored as mild, moderate, severe, or expired (ie, deceased). Behavior was subjectively scored as quiet, obtunded, alert, anxious, or aggressive.

The database was preliminarily tested during the first day of VERT deployment and modified on the basis of the authors' experience (HGD, LRR, and JEM) and input received from faculty veterinarians. No adjustments to the database were made after that time. Appropriate database completion was explained to the individual teams daily. Teams were instructed to collaboratively decide on how each patient would be scored, with daily review of those decisions by a faculty veterinarian. On-scene training was provided, as needed, by the faculty veterinarian and more proficient veterinary students to optimize consistency in assignment of severity codes. Each team completed a database entry form to collect specific information on an animal patient every time a veterinary service was provided. These forms were collected daily (acquired for all animals), and the recorded data were entered into the database by one of the authors (HGD).

The database was not intended to replace individual veterinary records but to provide an overarching view of the daily veterinary needs and required supplies, to help manage volunteer deployment, and to establish an objective surveillance tool for VERT response evaluation. The specific goals for the database included facilitating assessment of the types and numbers of animals affected by the disaster, recording the spectrum of specific illnesses and injuries sustained, monitoring treatments administered and case disposition, monitoring the use of and need for veterinary supplies, and facilitating future evaluation of the response. The database also

provided information that supported additional efforts in the recruitment of volunteers with specific skillsets (eg, those with expertise in veterinary care of avian species) and adjustment of needed supplies on a daily basis.

Patient intake

Intake examinations and emergency triage were performed as animals arrived at the fairgrounds. Those with severe injuries were immediately referred to secondary care facilities for advanced care. Results of intake examinations for animals that were deemed healthy and those that were immediately referred to secondary care facilities were not included in the database. The only animals included in the database were patients treated by the VERT and housed at the Butte County fairgrounds.

Statistical analysis

Multiple correspondence analysis was used as a nonlinear approach to evaluate associations among the various categorical variables of interest (species, types of injuries or illnesses, severity of injury or illness, and behavior). Briefly, MCA is an extension of simple correspondence analysis and represents a method similar to principal component analysis but adapted to analyze categorical variables instead of quantitative variables.⁸ This method has been useful for evaluating survey data containing categorical variables in health-care settings.^{9,10} To conduct and interpret the results of MCA, we first created axes to analyze the amount of variability in the data. Then, we identified the axes or dimensions that contained most of the information (in our case, the first 2 dimensions) and extracted the results for the rows and columns to create a graph called a biplot that showed the global patterns within the data. The distance between points in this type of graph provides a measure of those 2 points of association or similarity. The multivariate data analysis functions of freely available statistical software^{11,b,c} were used for analysis.

For the analyses, animals were categorized by species group (ie, avian, bovine, camelid, caprine, equine, ovine,

and porcine). The categories of bovine, camelid, caprine, ovine, and porcine included all breeds within the species. The equine category included full-size horses of all breeds, miniature horses, donkeys, and mules. The avian category included chickens, geese, turkeys, and ducks. Types of injuries or illnesses were classified as lacerations or traumatic wounds, colic or gastrointestinal illness, lameness, burns, respiratory illness, or other. Types of injuries represented by a small number of animals (1 or 2) were recategorized as other. Severity of injury or illness was categorized as mild, moderate, severe, or NA. Behavior was categorized as quiet, alert, anxious, or NA. If a categorical code was not used for any patient then that category was not included in analysis (eg, expired, obtunded, and aggressive). The category NA was used for those fields for severity or behavior that had missing values, allowing inclusion of the associated animal in the analysis (MCA can be used only for subjects with no missing values).

Results

Animals

The UC-Davis VERT deployed to the Butte County fairgrounds for 12 consecutive days to provide veterinary care for evacuated and rescued animals housed at the large animal shelter there, which included ruminants, camelids, equids, and avian species. In total, 10 UC-Davis faculty veterinarians, 1 veterinary technician, and 55 veterinary students worked at the shelter. The daily number of animals housed at the shelter as reported by the NVADG during VERT deployment ranged from 403 to 881 animals.

A total of 206 sets of database entries were made, representing 151 individual animals treated by the VERT (**Table 1**). Nineteen animals received multiple days of treatment, ranging from 2 to 6 days in duration, and their data were recorded as daily entries. Caprine patients represented the most common species group, with 58 (28.2%) database entries.

Table 1—Numbers of animals treated each day by the UC-Davis VERT at the Butte County fairgrounds in Gridley, Calif, during the California Camp Fire from November 10 to 21, 2018.

November date	Avian				Equine								Total
	Chicken	Duck	Goose	Turkey	Bovid	Alpaca	Goat	Donkey	Horse	Miniature horse	Sheep	Pig	
10	—	—	—	—	—	—	1	—	—	—	—	1	2
11	3	—	—	—	—	1	3	1	11	2	3	—	24
12	—	—	—	—	—	—	5	1	7	1	—	2	16
13	1	—	—	—	—	1	8	1	3	—	7	1	22
14	1	—	—	—	—	1	8	—	5	—	5	2	22
15	2	1	—	—	—	1	7	—	5	—	7	3	28
16	—	—	—	—	—	—	2	—	—	—	—	2	4
17	—	—	—	—	2	1	6	—	—	1	2	1	13
18	—	—	—	—	1	—	4	—	—	—	2	1	8
19	3	2	—	—	2	1	3	—	—	—	5	3	19
20	—	2	4	—	3	—	7	—	—	—	4	3	23
21	12	6	—	1	—	—	4	—	—	—	—	2	25
Total	22 (22)	11 (11)	4 (4)	1 (1)	8 (7)	6 (1)	58 (37)	3 (3)	31 (26)	6 (5)	35 (23)	21 (11)	206 (151)

Data represent 151 individual animals that received care from the VERT during the study period. Data in the total row represent the total number of animal treatments (total individuals requiring veterinary treatment).
— = Not applicable.

Illness and injury

Overall, the most prevalent medical issues (ie, injuries or illnesses) among the 206 entries for patients at the large animal shelter were burns (n = 99 [48.1%]), respiratory disease (29 [14.1%]), gastrointestinal illness (22 [10.7%]), and lacerations (19 [9.2%]). Other medical issues included lameness (n = 10 [4.9%]), eye injury (7 [3.4%]), parasites (7 [3.4%]), reproductive disease (5 [2.4%]), dehydration (4 [1.9%]), and signs of depression, shock, and recumbency (1 [0.5%] each). Severity of illness or injury was classified as mild in 91 (44.2%) entries, moderate in 63 (30.6%) entries, and severe in 41 (19.9%) entries; 11 (5.3%) entries were coded as NA owing to missing data. No patients were recorded as having expired. As previously mentioned, patients that were referred to secondary care facilities for advanced care were not included in the database. Patient behavior was recorded as alert in 119 (57.8%) entries, quiet in 54 (26.2%) entries, anxious in 14 (6.8%) entries, and obtunded in 2 (1.0%) entries; 17 (8.3%) entries were coded as NA owing to missing data.

Lacerations were the most common medical issue among the 40 entries for equine patients (n = 12 [30%]), followed by burns (11 [28%]) and colic (9 [22%]). Some equids had lameness (n = 3 [10%]), an eye injury (3 [10%]), or parasites (1 [3%]). One (2%) equid was classified as recumbent without a specified reason. The only medical issue recorded in the 6 entries for camelid patients was burns (n = 6). Burns (n = 32 [55%]) were the most common medical issue among the 58 entries for caprine patients, followed by lacerations (7 [12%]) and respiratory disease (6 [10%]); other issues included gastrointestinal illness (5 [9%]), dehydration (3 [5%]), lameness (2 [3%]), mastitis (1 [2%]), lethargy (1 [2%]), and eye injury (1 [2%]). Among the 35 entries for ovine patients, the most common medical issue was respiratory disease (n = 22 [63%]); 5 (14%) patients were monitored and assisted in live births at the fairgrounds. Among the 38 entries for avian patients, the most common medical issues were burns (n = 29 [76%]), ectoparasites (6 [16%]), and lameness (3 [8%]). The

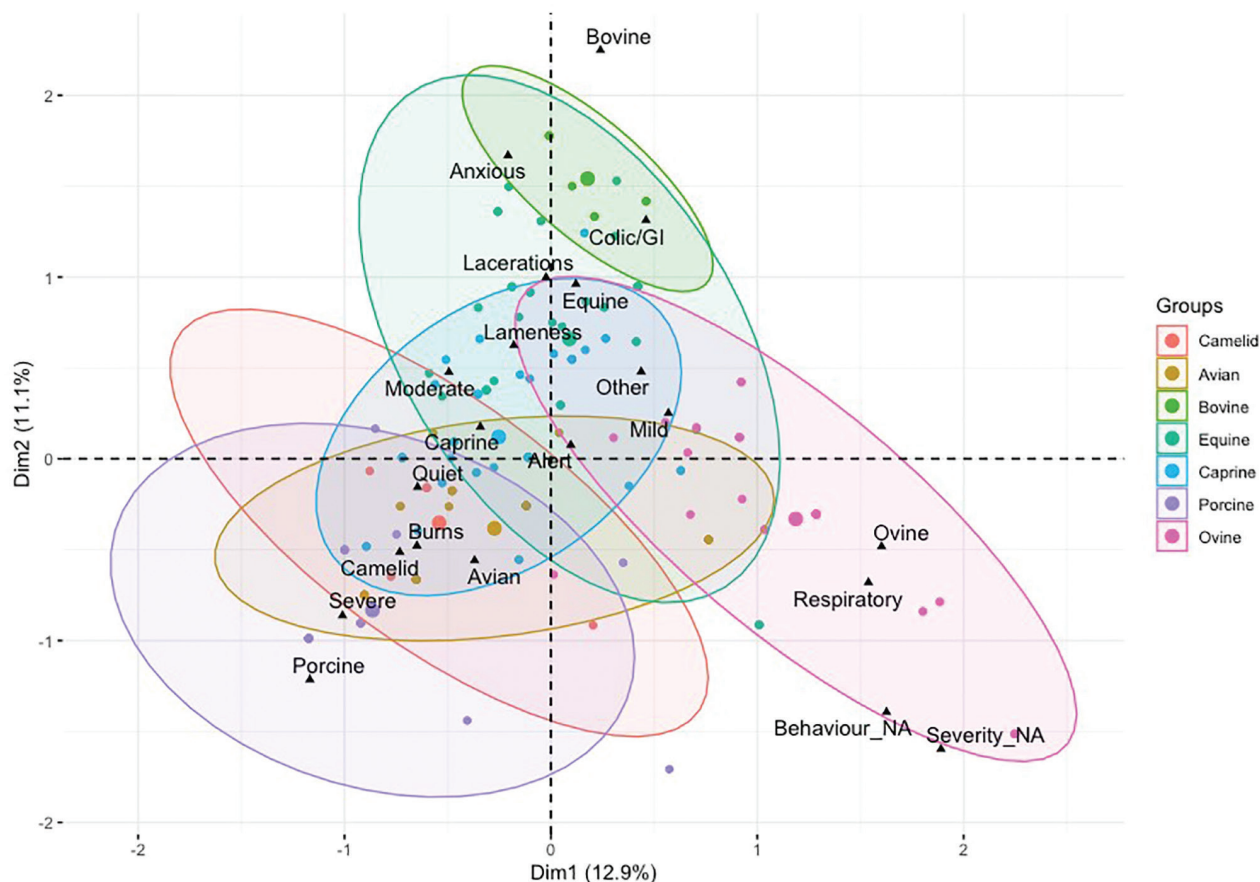


Figure 1—Biplot from MCA representing the global patterns within the medical data for 151 animals (n = 206 sets of data entries) treated by the UC-Davis VERT at the Butte County fairgrounds in Gridley, Calif, during the California Camp Fire from November 10 to 21, 2018. The x-axis represents the first dimension (Dim1), and the y-axis represents the second dimension (Dim2). The percentages shown for these dimensions represent the amount of variability in the data explained by each dimension. Individual animals are represented by small dots color coded by species group as indicated, and the surrounding ellipses represent 95% confidence intervals. Larger dots denote the center of each ellipse. Other patient characteristics (severity of illness or injury and behavior) are represented by black triangles. The distance between small dots indicates their correlation or similarity, with patients represented by closer pairs of dots being more similar than those represented by farther pairs of dots. NA = Not assessed (values missing).

most common medical issues among the 8 entries for bovine patients were gastrointestinal illness (n = 5 [62%]) and eye injury (3 [38%]). Porcine patients represented a group that required multiple days of treatment owing to the extent of their injuries and severity of their illness, which primarily consisted of burns (n = 20 [95%] entries) and respiratory illness (1 [5%] entry).

Temporal patterns

Equine patients were most common among all animals treated by the VERT during the initial 3 days of deployment, but after 8 days, no more horses required veterinary care (Table 1). Oppositely, avian patients comprised a small component of overall patients initially but then increased to become the most prevalent group by the end of the deployment period. Caprine, ovine, and porcine patients were treated with fairly consistent frequencies throughout this period. The few bovine patients evaluated by the VERT were treated in the latter half of the deployment period.

MCA

The MCA allowed visualization of the associations among species group, type of injury or illness, severity, and behavior (**Figure 1**). Ovine patients were more likely to have had respiratory disease than were all other species groups. The field in the database form for behavior in this patient group was often left blank, suggesting less familiarity of the recorders with sheep or suggesting the recorders' inability to assess behavior. Porcine patients had high severity scores associated with burn injuries. Camelid and avian species were also associated with high severity and burns. Overall, camelid, porcine, and avian patients had higher severity scores than did other species groups. Lastly, equine patients were more likely to have had lacerations and gastrointestinal illness than were other species and were more frequently scored as anxious.

Discussion

In the present report, we describe for the first time the creation of an animal health database for animals in disaster settings. These findings represented the experience of the UC-Davis VERT with livestock and equids treated at the Butte County fairgrounds over the first 12 days of the Camp Fire. The animal species documented in the database were representative of the overall population at the shelter facility. Overall, this database reflected the clinical spectrum of the large animals and avian species of Butte County.

In addition to the VERT, veterinarians from the Northern California Association of Equine Practitioners and private practices treated injured and ill animals. Therefore, not all patients received at the large animal shelter were assessed and treated by the VERT and included in the database. Also not included were

cases that were triaged, and patients assessed to be in too severe a condition to stay at the shelter were immediately transported to secondary care facilities. Consequently, the data reported here may not necessarily represent the distribution and severity of injuries of animal species affected by the Camp Fire. For some species and species groups, the sample size was small. The database also excluded several patients that received intake examinations and had no injuries. Hence, our results likely apply only to patients with mild to moderate illnesses or injuries and to patients managed by the VERT.

The illnesses and injuries treated at the large animal shelter mainly represented fire trauma and the associated effects of fire, heat, and ash on the respiratory and ocular surfaces. The database also captured a large number of injuries sustained during attempts of animals to flee an area or during transportation. Stress-related illnesses such as colic were also frequent, particularly in equine species. It was found that horses developed colic, potentially because of overfeeding and abrupt changes in diet, and required adjustment in husbandry and additional medical supplies for that specific need.

Database entries provided insight into the temporal distribution of animal species being treated at the shelter. The initial peak in equine patients could have been attributable to the early evacuation of horses owing to the strong human attachments formed with these animals or the availability of appropriate transportation. As reported previously, farm animals can be abandoned during natural disasters given that the size of the animals and requirements needed to transport them can prohibit their evacuation, thereby risking their health and welfare.¹² Our finding that the bovine patients were treated during the second half of the VERT's deployment period supported this observation. A unique feature of the documented situation was the high number of avian species treated and the increasing number of avian patients that were presented as time progressed. This pattern might have been due to a high density of birds in the area, lack of alternative housing options, or delay in transportation of these animals to the shelter.

A major challenge faced by the VERT was lack of animal identification. Animals were identified by their stall or pen number, which could have led to discrepancies if animals were moved or released to owners and replaced by new animals. An improvement to the overall organization of the shelter and database would be to more formally identify animals with a medical identification number or microchip number.

Overall, the database described in the present report provided an epidemiological tool to record the number, type, and severity of veterinary cases and to assist in planning and resource deployment. It helped to facilitate immediate animal management and overall disaster response by the UC-Davis VERT.

During the disaster response, the data obtained were used to determine which species-specific personnel should be on our team and which veterinary supplies were needed given the types of illnesses and injuries seen. Afterward, the data provided a foundation for response assessment and future disaster preparedness and response improvement.

Additional research on veterinary preparedness and field treatment in emergency or disaster settings is warranted. We believe our database can serve as a facile tool for on-scene standardization of health data collection in emergency and disaster events, allowing for electronic data archiving and data coding for rapid interpretation. Although additional research is required to validate the usefulness of such a database, our findings supported that a centralized, electronic animal-tracking system should be used collectively in emergencies and disasters. A common animal disaster database, used universally in all natural and manmade disasters, would considerably improve our understanding of the health consequences of disasters in veterinary species. Such a unifying operational tool would also facilitate evaluation of key elements of disaster responses, such as personnel deployment, resource allocation, communication, and hospital surge planning.

Acknowledgments

The authors declare that there were no conflicts of interest.

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Footnotes

- a. Microsoft Excel, version 16.33, Microsoft Corp, Redmond, Wash.

- b. R: A language and environment for statistical computing, version 3.5.3, R Foundation for Statistical Computing, Vienna, Austria.
- c. Factoextra: extract and visualize the results of multivariate data analyses, version 1.0.5, Kassambara A, Mundt F. Available at: CRAN.R-project.org/package=factoextra. Accessed Apr 18, 2019.

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Appendix

Description of fields used in a database regarding medical information on ill and injured animals requiring veterinary care during the 2018 California Camp Fire.

Field	Description
Time/date	Time and date at the start of patient examination.
Location	Location of the patient (stall and pen number) at the Butte County fairground facilities in Gridley, Calif.
Species	Patient species.
Illness/injury	Entries included laceration (numerically coded as 1), lameness (2), burns (3), other skin lesion (including mastitis; 4), depressed (5), major bleeding (6), respiratory (including coughing and nasal discharge; 7), dehydration (8), shock (9), gastrointestinal (including colic; 10), eye injury (11), and parasites (including ectoparasites and endoparasites; 12).
Severity	Subjective entries reflecting severity of the illness or injury included mild (numerically coded as 1), moderate (2), severe (3), or expired (4).
Behavior	Entries for behavior as assessed at the beginning of the examination or treatment included quiet (numerically coded as 1), obtunded (2), alert (3), anxious (4) and aggressive (5).
Treatment	Entries included evacuation only (numerically coded as 1); burns (topical or systemic; 2); eye care (3); wound care (4); bleeding control (5); other injury care (6); isotonic electrolyte solutions given PO, SC, or IV (7); colic treatment (including fluids, probiotics, or mineral oil; 8); analgesics (9); antimicrobials (10); and nutritional supplement (including thiamine; 11).
Referral	Entries reflected the severity of the patient's illness or injury and included discharge to the owner's care (recorded as "owner residence"; numerically coded as 1), remain at evacuation shelter (2), hospital referral (which the VERT coordinated; 3), euthanized (4), and dead on arrival (5).