Management of a pet dog after exposure to a human patient with Ebola virus disease

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In October 2014, a health-care worker who had been part of the treatment team for the first laboratory-confirmed case of Ebola virus disease imported to the United States developed symptoms of Ebola virus disease. A presumptive positive reverse transcription PCR assay result for Ebola virus RNA in a blood sample from the worker was confirmed by the CDC, making this the first documented occurrence of domestic transmission of Ebola virus in the United States. The Texas Department of State Health Services commissioner issued a control order requiring disinfection and decontamination of the health-care worker’s residence. This process was delayed until the patient’s pet dog (which, having been exposed to a human with Ebola virus disease, potentially posed a public health risk) was removed from the residence. This report describes the movement, quarantine, care, testing, and release of the pet dog, highlighting the interdisciplinary, one-health approach and extensive collaboration and communication across local, county, state, and federal agencies involved in the response. (J Am Vet Med Assoc 2015;247:531–538)

Background

On March 21, 2014, the Guinea Ministry of Health and Public Hygiene reported an outbreak of an illness characterized by fever, severe diarrhea, vomiting, and a high case-fatality rate among 49 persons.1 This was the beginning of the largest EVD outbreak in history, involving 27,515 total cases, including 15,113 laboratory-confirmed cases and 11,232 deaths, as of June 24, 2015. As of this time, the 2014–2015 West African EVD epidemic had involved 6 African countries, with imported cases identified in the United States, the United Kingdom, and Italy.2 The first documented domestic transmission of Ebola virus (Zaire ebolavirus) outside West Africa occurred in Spain in connection with this outbreak.3 In that case, a nurse’s aide at a local hospital in Alcorcón, a suburb of Madrid, contracted EVD after caring for a patient who had become infected with Ebola virus while volunteering in Sierra Leone. On October 6, 2014, a blood sample from the nurse’s aide tested positive for Ebola virus RNA with a reverse transcription PCR assay. While symptomatic with EVD, in the 5 days before Ebola virus infection was confirmed, the aide reportedly had had close constant contact with her pet dog.4 On October 7, Madrid’s regional government secured a court order to euthanize the dog, concerned that it posed a public health risk.

Abbreviations

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<th>Abbreviation</th>
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<tr>
<td>EVD</td>
<td>Ebola virus disease</td>
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<td>PFU</td>
<td>Plaque-forming units</td>
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<td>PPE</td>
<td>Personal protective equipment</td>
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<td>USAMRIID</td>
<td>US Army Medical Research Institute of Infectious Diseases</td>
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The Texas Division of Emergency Management, the City of Dallas Animal Services, and the Dallas County Emergency Operations Center provided assistance. The AVMA organized the Ebola Companion Animal Response Plan Working Group, which provided constructive discussion and input during the quarantine period and generated additional recommended protocols on the basis of this experience. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC. The authors thank Dr. David A. Norwood for assistance in sample testing; Lieutenant Colonel Kathleen Gibson, Elizabeth Grimes, Matthew Becker, and Sergeant Michael McNaney for efforts to develop an Ebola virus testing capacity for military working dogs and the initial verification of testing of dog blood; and Dr. Eleanor Green for providing support to the Texas A&M Veterinary Emergency Team.

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Despite strong public opposition, including an online petition with > 330,000 signatures,8 the Spanish authorities euthanized the dog on October 8 and arranged for the safe disposal of its remains.

To our knowledge, no published reports exist of dogs or cats developing clinical signs of EVD or transmitting Ebola virus to people or other animals. Even areas of Africa with active EVD outbreaks have not reported dogs or cats developing EVD. The only published scientific data on EVD in dogs is from Allela et al.,9 who reported Ebola virus–specific IgG in 8.9% to 25.2% of blood samples obtained from dogs in Gabon following an outbreak involving humans and nonhuman primates.7 However, in that study,2% of dogs from the control group, located in an area where Ebola virus is not found, also had anti-Ebola virus IgG, suggesting issues with the specificity of the assay and raising concerns that the reported prevalence of anti-Ebola virus antibodies was likely an overestimation. Furthermore, in the same study,7 no evidence of Ebola virus infection was found among dogs in Gabon, as all canine blood samples tested for Ebola virus RNA with a reverse transcription PCR assay had negative results.

On September 30, 2014, the CDC escalated the US domestic response to EVD after reporting the first laboratory-confirmed case of EVD in the United States in a person (patient 1) who had traveled to Dallas from Liberia. On October 10, 2014, a health-care worker (patient 2) who had cared for patient 1 presented to a local emergency room in North Texas with symptoms of EVD. Two days later, a presumptive positive reverse transcription PCR assay result for Ebola virus RNA in a blood sample from patient 2 was confirmed by the CDC. This was the first occurrence of domestic transmission of Ebola virus in the United States.8,9 On October 12, the Texas Department of State Health Services commissioner issued a control order requiring disinfection and decontamination of patient 2’s residence. This process was delayed until patient 2’s pet dog, a 1.5-year-old approximately 8.6-kg (19-lb) neutered male Cavalier King Charles Spaniel, was removed from the residence. At the time, guidance on management of domestic animals potentially exposed to human patients with EVD did not exist.

The present report describes the movement, quarantine, care, testing, and release of patient 2’s dog, highlighting the interdisciplinary, one-health approach and extensive collaboration and communication across local, county, state, and federal agencies involved in the response. It is our hope that experiences with this dog may assist in the development or revision of plans for the care of pets in future emergency situations involving emerging or imported zoonoses.

**Interagency Coordination**

The response to potential exposure of patient 2’s dog to EVD involved extensive collaboration among city, county, state, and federal agencies focused on animal and human health. This included representatives from the City of Dallas Animal Services, the Dallas County Emergency Operations Center, the Texas Division of Emergency Management, the Texas Animal Health Commission, Texas A&M University, the Texas Department of State Health Services, the USAMRIID, the Defense Health Agency Veterinary Services, and the CDC Animal-Human Interface Team.

In response to the EVD outbreak in West Africa, the CDC Emergency Operations Center had been activated in August 2014 to analyze, validate, and exchange information with response partners during the outbreak.10 On October 10, the CDC Emergency Operations Center activated the Animal-Human Interface Team to serve as a central point of coordination to address Ebola virus–specific animal-human interface needs and inquiries. On the morning of October 12, the day that EVD was confirmed in patient 2, a local disaster was declared in an area of North Texas designated in the Texas Emergency Management Executive Guide as Texas Disaster District 4, which activated a multiagency coordination center to direct the activities of numerous agencies and organizations.11 That same day, the Texas Animal Health Commission was charged with the care of patient 2’s dog and identified as the lead state agency supporting the dog’s quarantine by the State of Texas Emergency Plan. A teleconference was held with personnel from City of Dallas Animal Services, the Texas Division of Emergency Management, regional and state offices of the Texas Animal Health Commission, the Texas Department of State Health Services, and the CDC to discuss management of the dog. Involved agencies collaborated on developing action plans for a variety of contingencies involving not just this dog but also other animal species. Initial issues of importance that were identified included animal transport, quarantine site selection, daily care and feeding, veterinary care, security concerns, PPE and biosecurity practices, hazardous materials support, and dissemination of accurate and appropriate public information. Once a quarantine location was identified for patient 2’s dog, the City of Dallas requested state assistance with daily care and veterinary care. Throughout the process, CDC staff served as public health consultants and provided subject matter expertise in EVD. Subsequent collaboration involved the US Army, the Texas Department of State Health Services, and the USAMRIID to support testing of blood, feces, and urine samples from the dog.

**Exposure Assessment and Decision to Quarantine**

On October 11, public health and animal health officials learned that patient 2 had a pet dog, creating an urgent need to determine appropriate, timely actions to ensure care of the dog while also protecting public health. Before any risk assessment could be made, there had been a public proclamation by City of Dallas authorities that the dog would not be euthanized.12 Therefore, public health officials conducted a rapid risk assessment to determine the level of exposure (ie, the type and duration of potential contacts) of the dog to patient 2. Patient 2’s roommate indicated that the dog had brief close contact with patient 2 and reported that while patient 2 was beginning to develop symptoms of EVD, the dog slept in the bed with patient 2 and likely licked patient 2’s face. According to criteria established for humans, public health officials determined that this level of exposure fell into the category of some risk.13
Given this risk assessment and the absence of epidemiological evidence supporting a meaningful role for dogs in Ebola virus transmission, human and animal health officials agreed that quarantine was the most appropriate course of action. Even though the risk that the dog was infected or would transmit Ebola virus was considered low, the fact that this was the first reported exposure of a companion animal to a patient with EVD in the United States warranted an abundance of caution. At the time, species-specific data did not exist to determine the most appropriate quarantine period for dogs following exposure to Ebola virus, no field data describing active Ebola virus infection in canids were available, and experimental infection of canids had not been attempted. Pigs reportedly have a 4-day incubation period and develop predominantly respiratory signs following experimental inoculation with Ebola virus, with Ebola virus RNA detectable in the oronasal mucosa for up to 14 days after inoculation.14 Nonhuman primates became febrile 3 days after experimental inoculation, with clinical signs lasting for 5 to 12 days.15 On the other hand, the incubation period for humans is up to 21 days.16 In the absence of scientific data to guide recommendations, a conservative approach was taken, and a decision was made to quarantine patient 2’s dog for 21 days, the longest known incubation period for EVD.

Transportation, Quarantine, and Care

Transportation—On October 13, the dog was removed from patient 2’s apartment. Protocols for removal and transport of the dog were established by the City of Dallas with input from the state and CDC. A van with a solid barrier between the cargo and cab areas was used to transport the dog. The dog’s collar and all animal-associated items remained in patient 2’s apartment. While wearing PPE, a hazardous materials contractor placed the dog in an airline carrier for removal from the apartment. The carrier was then placed inside another carrier in the cargo area of the van. Double barrier doors were in place to minimize the potential for escape. The driver wore PPE (protective suit, half-face mask, goggles, gloves, and boots) to transport the dog in the carrier from the van to the quarantine building, then disposed of the PPE at the quarantine site. After the dog was transported to the quarantine building, the vendor decontaminated the van with sodium hypochlorite solution according to a preestablished environmental decontamination protocol.

Facility—For the 21-day quarantine period, the dog was housed in a facility at a secured site. Special considerations included controlled access, availability of and access to resources, and ability to decontaminate the premises during and after the quarantine period. The quarantine facility was partitioned on the basis of exposure potential into 3 hazard zones designated hot (highest hazard), warm (intermediate hazard), and cold (lowest hazard) zones. The dog was kept in a single room that met size and climate requirements mandated by the Animal Welfare Act. This room was considered the highest hazard (hot) zone. In the hot zone, 2 wire crates were set up to allow the dog to be transferred to a clean crate while the other crate was being cleaned. The adjacent room, which was separated from the hot zone by a swinging door with a window, was considered the intermediate hazard (warm) zone. This area was where handlers removed (doffed) PPE in the decontamination process of exiting to the rest of the building (cold zone). The flooring throughout the facility was covered in impermeable tarps that were taped at least 1 to 2 feet up the wall. The facility did not have electric power or running water. A portable generator powered 2 sets of portable flood lamps for the facility.

Personnel—Key to planning the quarantine was securing animal care and veterinary specialists trained in hazardous materials response at the operations level for the duration of the quarantine period.17 The City of Dallas secured a hazardous materials vendor to provide food and water for the dog and to complete preliminary cleaning of the site while additional resources were mobilized by the state. At the same time, a request for state assistance was made by the City of Dallas, and the Texas Animal Health Commission was tasked with identifying and deploying available resources and personnel. A Texas A&M veterinarian provided initial care, on October 14 and 15. Because the Texas Animal Health Commission had an established working relationship with the Texas A&M University Veterinary Emergency Response Team, 2 Texas A&M University veterinarians were identified who could provide daily care for the dog from October 16 through the end of the quarantine period. These 2 veterinarians provided care at 7:00 AM, 1:00 PM, and 7:00 PM daily. One entered the hot zone with the dog, while the second remained in the warm zone to support, observe, and assist with removal of hazardous waste and PPE.

In addition, 2 hazardous materials assistants were present onsite from 7:00 AM to 7:00 PM daily. Hazardous materials personnel helped ensure strict adherence to protocols when donning PPE, provided for daily removal of animal and PPE waste, and ensured veterinary personnel had all necessary supplies for daily decontamination. The initial hazardous materials personnel were instructors from the Texas A&M University Engineering Extension Service hazardous materials program and were pivotal in developing and finalizing site-specific PPE and decontamination protocols. After October 20, a private vendor hired by the City of Dallas took over the provision of hazardous materials support, following protocols established by the Texas A&M University Engineering Extension Service and Texas A&M University Veterinary Emergency Response Team.

PPE and daily decontamination—For individuals directly involved in caring for patient 2’s dog, PPE consisted of respiratory protection, with an external battery pack and hose system, a disposable highly durable impermeable chemical suit, reusable chemical boots, and 2 sets of disposable nitrile gloves (with heavy-duty nitrile chemical gloves as the outer layer to reduce risk of tearing). All seams were taped with heavy-duty duct tape or chemical tape. Under the chemical suits, scrub suits were worn. Products used for disinfection included sodium hypochlorite solution (1:10 dilution) in dipping vats for feet and hands and quaternary ammonium compound disinfectant wipes for PPE surfaces, including helmets,
powered air-purifying respirator and battery packs, inner glove layers, arms, and hands. Quaternary ammonium compound disinfectant was also available in a spray bottle in the room with the dog (hot zone) and in a sprayer in the adjacent room (warm zone). Quaternary ammonium compound disinfectant was sprayed on all surfaces where the dog urinated or defecated, on the exterior surfaces of PPE (in the hot zone), on the heavy-duty gloves and boots after they were removed, and on the exterior of all bagged waste removed from the warm zone. The quaternary ammonium compound disinfectant was allowed to air-dry on boots and gloves, which were placed outside in direct sunlight for additional decontamination via UV radiation.

Daily care—One of the Texas A&M University Veterinary Emergency Response Team mobile emergency response trailers served as a staging area just outside the quarantine facility. The trailer was a 38-foot-long climate-controlled, mobile medical platform, with a 7-kW generator, 50-gallon water carrying capacity, water heater, and office area. It carried medical supplies, provided an area to store and don PPE, and allowed a clean workspace for attending veterinarians to use during pet-care intervals. The trailer was deemed necessary in this response because no other staging area was conveniently available and the quarantine location lacked power and running water.

On arrival at the quarantine location, the attending veterinarians would begin the process of donning PPE. On entry into the quarantine site, 1 veterinarian remained in the warm zone, performing tasks such as removing decontaminated PPE from the previous entry, changing disinfectant supplies, and bagging waste for hazardous materials personnel to remove from the area. The second veterinarian entered the hot zone to care for the dog. This veterinarian made an initial visual assessment of the crate, observed the dietary intake, and then observed the dog in its crate to assess general appearance, alertness, and activity level. After this initial assessment, the dog was allowed out of the crate to eliminate on the tarp-covered floor. To minimize physical contact with the dog and reduce the risk to caretakers, a daily physical examination was not done. Any changes in behavior, dietary intake, or attitude would have initiated more thorough evaluation, including a detailed physical examination and consideration of additional sample collection.

The dog was transferred to a second clean crate to allow cleaning of the crate previously in use. A metabolism cage that would capture all excrement for safe disposal was available on-site if, owing to temperament or other concerns, it became necessary to keep the dog in the cage at all times. However, the dog was well mannered and crate trained. As a result, the dog would not eliminate in the crate and was reluctant to eliminate on the floor of the facility. Several techniques were used to encourage elimination, including use of disposable absorbent pads with plastic backing (eg, disposable diapers, housebreaking pads, and artificial grass pads). Eventually, the dog developed a routine of exiting the crate and proceeding to an area furthest from the crate to eliminate. Because the dog was so well crate trained, the veterinary team strove to ensure that the time between opportunities for the dog to eliminate was < 12 hours.

After the dog eliminated, the dog was allowed to roam around the room and was engaged in 10 to 15 minutes of enrichment time to encourage exercise, reduce boredom and stress, and facilitate well-being. During this time, the veterinarian completed any necessary feeding and cleaning. The dog was fed its typical diet, as determined on the basis of information from the owner's family, and dietary intake was carefully monitored. Bottled water was used for drinking water because no running water was available in the facility. Daily cleaning included changing the disposable absorbent pads that lined the floor, cleaning and refilling food and water bowls, and straightening up the bedding. Because the dog never eliminated in the crate during the quarantine period, cleaning the crate because of soiling was not necessary.

All urine and feces were captured in or with disposable absorbent pads. The area under the pad was sprayed with quaternary ammonium compound disinfectant spray and, after a minimum of 10 minutes of contact time, was wiped with a clean pad. All soiled pads, urine, and feces were placed in red biohazard disposal bags and then in a 3-gallon sealable waste bucket supplied by the hazardous materials vendor. All PPE waste was placed in 2 layers of bags and sprayed with sodium hypochlorite solution. When the waste bucket was full, the lid was sealed and the bucket was removed from the facility. A veterinarian transferred waste from the warm zone to a hazardous materials technician wearing PPE in the cold zone. The hazardous materials technician then transported the waste out of the facility and placed it into a hazardous materials waste container for later pickup. All waste was hauled away daily at midday.

Once the dog's area was clean and the dog had been exercised and fed, it readily returned to the crate. The veterinarian exited the room, moving from the hot zone to the warm zone to begin decontamination. The decontamination process was greatly enhanced by working together as a team while moving through the stages of decontamination from the initial sodium hypochlorite dip buckets (minimum of 60 seconds of contact time), to the quaternary ammonium compound disinfectant spray area (minimum of 10 minutes of contact time), and finally to the doffing area. Each step was carefully orchestrated among team members to ensure safety and completeness, with assistance available when needed. After both veterinarians had doffed their PPE and entered the cold zone, they returned to the staging area for a final disinfection of arms, hands, and the powered air-purifying respirator helmet with quaternary ammonium compound disinfectant wipes; the disinfectant was allowed to air dry on equipment and skin surfaces. Time required to care for the dog during each visit, including time for setting up and donning the PPE, entering the quarantine area, and decontaminating and doffing the PPE, was typically 1 to 1.5 hours. After the last daily care visit, the veterinarians changed back into street clothes and returned to off-site accommodations.

Sample collection—To test for evidence of Ebola virus infection and shedding, urine, fecal, and blood
samples were collected on days 10 and 18 of quarantine (October 20 and 28) on the basis of recommendations from the Texas Department of State Health Services and CDC for testing during the first week of quarantine and shortly prior to completion of the 21-day quarantine period. Urine samples (> 6 mL) were obtained by free catch; fecal samples (> 1 g) were collected after elimination. For blood sample collection, 2 veterinarians entered the hot zone. In addition, a hazardous materials assistant remained in the warm zone to observe, process the samples as they were passed through for decontamination, and assist with PPE. A second hazardous materials assistant observed from outside the window of the hot zone. The entire process was observed closely both for purposes of safety and to provide assistance if needed. Blood was collected by cephalic venipuncture and placed into a plastic tube containing EDTA. Because of the dog’s temperament, chemical restraint or sedation for blood sample collection was considered unnecessary, and the attending veterinarians were able to collect blood on both occasions by the same approach without any resistance or difficulties. The only modification in PPE for blood sample collection was to substitute extra-thick, extra-long nitrile examination gloves for the heavy chemical outer gloves, providing a double layer of protection while still maintaining necessary tactile ability.

After collection, samples were removed from the hot zone, and the outsides of the tubes were wiped with quaternary ammonium compound disinfectant wipes. The tubes were allowed to dry and then sealed with paraffin film and placed in plastic shipping bags held by the hazardous materials personnel in the cold zone. Samples were removed from the facility, packaged, and shipped overnight to the USAMRIID for testing by a Texas Animal Health Commission Foreign Animal Disease Diagnosticsian, according to instructions from the CDC.

Sample Testing

**Development of testing protocols**—At the time patient 2’s dog was quarantined, routine testing for Ebola virus infection of dogs was not available. However, in September 2014, in an effort to develop testing capacity for military working dogs that might be deployed in support of an EVD outbreak response, blood samples from 3 healthy military working dogs collected during routine semiannual physical examinations were submitted to the USAMRIID Diagnostics Systems Division Special Pathogens Laboratory to determine whether the EZ1 real-time reverse transcription PCR assay developed by the Department of Defense19 and performed according to Special Pathogens Laboratory standard operating procedures could detect Ebola virus in experimentally spiked canine blood. At the time, the EZ1 test was widely used as a diagnostic tool for the detection of Zaire ebolavirus, the virus species responsible for the West African outbreak, in suspected human cases. Briefly, in all canine blood samples spiked with Zaire ebolavirus, Zaire ebolavirus glycoprotein RNA was detected with the EZ1 real-time reverse transcription PCR assay and Zaire ebolavirus nucleoprotein RNA was detected with a nucleoprotein-specific real-time reverse transcription PCR assay20 at detection levels similar to those reported for human blood samples, suggesting that the assay could be used to identify Ebola virus RNA in canine blood samples.5

On October 20, to determine whether Ebola virus could be detected in canine fecal and urine samples, feces from one dog and urine from another dog were collected and submitted to the USAMRIID Diagnostics Systems Division Special Pathogens Laboratory. A negative control sample and a positive control sample spiked with Zaire ebolavirus were prepared for each sample type.

Fecal samples were processed in a modification of a previously developed protocol that used a viral RNA detection kit for isolation of viral RNA from feces. Two samples were prepared by suspending 0.2 g of feces in 2.0 mL of saline (0.89% NaCl) solution, and 1 was spiked with 20.0 µL of stock irradiated Ebola virus supernatant antigen containing 1.7 × 10⁵ PFU/mL (final concentration, 1.7 × 10⁴ PFU/mL). Suspensions were allowed to settle at room temperature (approx 22°C), and 1.0 mL of each suspension was removed and clarified by centrifugation at 4,000 × g for 20 minutes. Then, 150.0 µL of each clarified suspension was passed through a 0.22-µm spin filter at 6,000 × g for 3 minutes. Finally, 70.0 µL of each final sample was obtained, and nucleic acid was extracted by means of a modification of the kit manufacturer’s protocol for purification of viral RNA (spin protocol).

For testing of urine samples for Ebola virus, a 1.0-mL urine sample was spiked with 10.0 µL of stock irradiated Ebola virus supernatant antigen containing 1.7 × 10⁵ PFU/mL. Next, 70.0 µL each of nonspiked and spiked urine samples was extracted with a viral RNA detection kit by means of a modification of the manufacturer’s protocol for purification of viral RNA (spin protocol).

A real-time reverse transcription PCR assay for detection of Zaire ebolavirus glycoprotein RNA was performed in triplicate on each fecal and urine extract with a PCR instrument. As expected, Zaire ebolavirus RNA was detected in spiked urine and fecal samples but was not detected in samples that had not been spiked. An internal positive control assay was run to detect any possible matrix inhibition. No inhibition was detected with either sample type.

**Testing of samples from the quarantined dog**—Blood, fecal, and urine samples collected from patient 2’s dog on days 10 and 18 of quarantine (October 20 and 28) were submitted to the USAMRIID Diagnostics Systems Division Special Pathogens Laboratory for Ebola virus testing.

All samples were processed and nucleic acids were extracted in a BSL-4 class II biosafety cabinet. By use of a stomacher, 5.0 g of feces was homogenized in 50.0 mL of saline (0.89% NaCl) solution in a filtered stomacher bag. The homogenate was transferred with a serologic pipette to a 50.0-mL conical tube, and bleach (0.94% NaClO) solution was added to remaining homogenate in the stomacher bag, which was then discarded. The homogenate was allowed to settle at room temperature...
(approx 22°C) while the biosafety cabinet was cleaned and equipment (stomacher, scale, and waste) was removed. Next, 1.0 mL of the homogenate was removed and clarified by centrifugation at 4,000 x g for 20 minutes. Then, 150.0 µL of clarified homogenate was passed through a 0.22-µm spin filter at 6,000 x g for 3 minutes. Finally, 70.0 µL of filtered homogenate was obtained, and nucleic acid was extracted by means of a modification of the viral RNA detection kit manufacturer's protocol for purification of viral RNA (spin protocol). Similarly, nucleic acid was extracted from 70.0-µL aliquots of blood and urine samples by means of a modification of the kit manufacturer's protocol for purification of viral RNA (spin protocol). A real-time reverse transcription PCR assay with the Zaire ebolavirus target and internal positive control (inhibition assay) was run in triplicate for each extraction. All assays were analyzed with a PCR instrument according to the manufacturer's operating instructions and assay conditions described in the original literature.

No Zaire ebolavirus RNA was detected in any of the samples, no inhibitors were detected, and all assay controls worked as expected to confirm assay performance.

**Release**

The dog remained healthy during the quarantine period and was released from quarantine on November 1, 2014, after meeting the following criteria: a minimum of 21 days from the last known potential exposure (October 10); negative results for Ebola virus reverse transcription PCR assays performed on blood, urine, and fecal samples collected on days 10 and 18; and no signs of illness at the time of release as determined through evaluation by a veterinarian. As a courtesy, the dog was bathed on the day of release. By this date, the dog's owner (patient 2) had been successfully treated for EVD and released. A discharge summary and instruction sheet as well as contact information for questions or concerns were given to the dog's owner at the time of the dog's release. The dog's owner subsequently contacted the attending veterinarian on several occasions to discuss aspects of the discharge summary and the dog's transition from quarantine. Following release of the dog, the quarantine facility was decontaminated at the direction of the City of Dallas by privately contracted hazardous materials personnel.

**Discussion**

At the time of this dog's quarantine, the West Africa EVD outbreak had reached a critical point. Domestic Ebola virus transmission had been described for the first time in countries outside West Africa and in regions where EVD had not been previously been reported, causing considerable public concern and fear. Containment was the main priority, and many decisions had to be made quickly on the basis of limited available data. When patient 2 was hospitalized for treatment of EVD, she requested that her dog be cared for. Local, state, and federal human and animal health officials determined the most appropriate course of action was to quarantine the dog for 21 days. This decision was made on the basis of a risk assessment and the ability to safely isolate the dog.

Given the experiences with this dog, state and local emergency planners and public health and animal health agencies should review their statutory authority to put in place hold, control, or quarantine orders for animals exposed to foreign or emerging diseases with zoonotic potential. Criteria to issue, maintain, and release such orders must be thoroughly understood. A good working relationship among agencies and a structured emergency management system provide the flexibility to deal with novel situations; however, it is better to address questions of statutory authority before a situation arises. Note that this authority may vary from state to state and on the basis of animal species or disease in question.

The response to potential exposure of patient 2's dog to Ebola virus relied on substantial interagency collaboration. The ability to respond successfully to this situation and provide the necessary resources was enhanced by prior development and exercise of emergency management plans on the local and state level and a preexisting network of human and animal health officials with experience collaborating on animal-human interface issues. Consistent interagency communication in the form of daily conference calls involving veterinarians and animal-care workers from the Texas Animal Health Commission, Texas A&M University, Texas Department of State Health Services, and CDC proved to be a successful means of discussing details of the dog's quarantine and testing and of ensuring that resource needs were communicated and met through the state emergency management system.

At the time patient 2 developed EVD, the issue of managing companion animals potentially exposed to Ebola virus had not previously been addressed and no guidance was available. Recommendations for such situations have changed, largely owing to the experiences described in the present report. Guidance documents have been developed that outline a procedure for risk assessment and, if warranted, quarantine. These documents emphasize adherence to Animal Welfare Act regulations, include recommendations for following up with individuals known to have been exposed to Ebola virus to identify contacts with animals, and stress the importance of mitigating exposure of animals to symptomatic EVD patients by advising restrictions on animal contact for individuals in high-risk categories being actively monitored for EVD and thorough risk assessment in the event of exposure. Ultimately, the experience in Texas showed the importance of these mitigation steps in reducing or eliminating the need for quarantine of companion animals.

The care for the dog described in the present report illustrated the importance of considering the human-animal bond and providing for animal care in an emergency response. Patient 2 reported that knowing the type of care her dog was receiving was a psychological aid in her own recovery. Public safety during emergencies is dependent on the willingness of the public to follow the directions of the emergency management system. Individuals may be willing to jeopardize their own safety and the safety of first responders to protect their pets, as made clear during Hurricane Katrina in 2005. The Pet Evacuation Transportation Standards Act...
The risk of Ebola virus infection in companion animals is considered to be low or nil. To date, there is only serologic evidence of exposure to Ebola virus in companion animals, viral RNA has never been detected in companion animals, and virus has never been isolated from companion animals. In addition, no epidemiological data exist to support a role for companion animals in Ebola virus transmission. In contrast, the risk of human-to-human transmission is higher, and reporting possible EVD symptoms early in the course of disease is essential to facilitate prompt isolation to minimize further transmission and implement supportive clinical management. The knowledge that a pet will be cared for if the owner is ill may assist in the timely disclosure of possible EVD symptoms.

In many respects, the dog described in the present report represented an ideal patient; it was well-trained and well-mannered, did not require medications, and was responsive to the care provided. The ability to conduct the type of care described will vary dramatically on the basis of species, temperament, health status, and available jurisdictional resources. The extensive amount of resources needed to care for this dog highlights that the best strategy is for individuals under active monitoring for EVD to minimize unnecessary contact with animals and, importantly, to immediately cease contact with any animals if EVD symptoms develop. Our understanding of EVD in the spectrum of companion animal species remains limited, but at least 1 study suggests that active infection and virus shedding do not commonly occur in a wide variety of animal species. The highest priority in controlling an EVD outbreak is caring for human patients. However, ensuring that members of the public have confidence in the official response to EVD, including the response to potential companion animal exposures, will aid in continued efforts to control the spread of disease.

References

Effects of premedication with sustained-release buprenorphine hydrochloride and anesthetic induction with ketamine hydrochloride or propofol in combination with diazepam on intraocular pressure in healthy sheep

Bonnie J. Gatson et al

**Objective**—To determine the effects of diazepam combined with ketamine hydrochloride or propofol for induction of anesthesia (IOA) following premedication with sustained-release buprenorphine hydrochloride (SRB) on intraocular pressure (IOP) in sheep.

**Animals**—20 healthy adult sheep.

**Procedures**—Diazepam with ketamine or propofol was given IV to each of 10 sheep after premedication with SRB (0.01 mg/kg, SC); after >4 weeks, each sheep received the other induction combination with no premedication. For both eyes, IOPs were measured before premedication (if given), 10 minutes prior to (baseline) and immediately following administration of ketamine or propofol (time of IOA), after endotracheal intubation, and at 5 minutes after IOA. Peak end-tidal PCO₂, globe position, and pupillary diameter were also analyzed.

**Results**—Data were not available for all sheep on all occasions. Propofol-diazepam administration alone had no significant effect on IOP, whereas there was a significant decrease in IOP immediately following ketamine-diazepam administration alone. At 5 minutes after ketamine-diazepam administration, SRB-premedicated sheep had significantly higher IOP than unpremedicated sheep. Intracocular pressure was significantly higher at baseline, at intubation, and 5 minutes after IOA in SRB-premedicated sheep receiving propofol-diazepam, compared with unpremedicated sheep. Peak end-tidal PCO₂ at intubation was significantly higher in SRB-premedicated sheep. For sheep receiving either anesthetic treatment, IOPs did not differ significantly with or without SRB premedication. Globe position or pupillary diameter and IOP were not significantly related at any time point.

**Conclusions and Clinical Relevance**—Results suggested that both ketamine-diazepam and propofol-diazepam combinations are suitable for IOA without increasing IOP in sheep. The use of SRB should be avoided in sheep when increases in IOP are undesirable. (Am J Vet Res 2015;76:771–779)