

## Biological terrorism against animals and humans: a brief review and primer for action

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Since the mid-1990s, there has been a change in the public's perception of the threat from biological weapons. Fears of intentional biological warfare and terrorism were heightened by the revelations that Iraq and the Soviet Union developed extensive biological warfare programs<sup>1</sup> and the Aum Shinrikyo's attempted uses of anthrax and botulinum toxin and successful use of sarin gas.<sup>2</sup> Although concern about the intentional use of biological agents is long standing, actual use is rather limited. In a February 2001 review<sup>3</sup> of potential bioterrorism events, W. Seth Carus, a National Defense University researcher, could only identify "...five groups that used or tried to use biological agents." However, he documented an increased interest in the criminal and terrorist use of biological agents; at least 54 recent open-source accounts of terrorist group activities mentioned an interest in biological agents.

Subsequent to that limited history, the reality of biological weapons has been shockingly underscored by the recent use of anthrax by unknown criminal groups causing 23 cases of anthrax, including 5 deaths, in the United States.<sup>4</sup>

### Biological Threat Agents Against Human Populations

With the realization that the threat of bioterrorism was increasing, the Centers for Disease Control and Prevention (CDC) has developed a strategic plan for the response to biological and chemical terrorism.<sup>5</sup> The plan of the CDC outlines 3 categories of biological agents that could or have been used by terrorist groups. The categories are grouped by priority for preparation as follows:

Category A consists of the highest priority of agents. These agents pose a risk to national security because they can easily be disseminated or transmitted

person to person, cause high mortality with potential for major public health impact, might cause public panic and social disruption, and require special action for public health preparedness. The category A agents are variola major (smallpox), *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), *Francisella tularensis* (tularemia), arenaviruses (Lassa fever and Argentine hemorrhagic fever and related viruses), filoviruses (Ebola hemorrhagic fever and Marburg hemorrhagic fever), and *Clostridium botulinum* toxin (botulism).

Category B consists of the second highest priority of agents because they are moderately easy to disseminate, cause moderate morbidity and low mortality rates, and require specific enhancements of diagnostic capacity and surveillance activities. The category B agents are *Coxiella burnetii* (Q fever), *Brucella* spp (brucellosis), *Burkholderia mallei* (glanders), alphaviruses (Venezuelan/eastern/western encephalitis), ricin toxin from *Ricinus communis* (castor beans), epsilon toxin of *C. perfringens*, and *Staphylococcus enterotoxin B*. A subset of Category B agents includes pathogens that are food or waterborne and include *Salmonella* spp, *Shigella dysenteriae*, *Escherichia coli* O157:H7, *Vibrio cholerae*, and *Cryptosporidium parvum*.

The category C agents are those that include emerging pathogens that could be engineered for mass dissemination in the future because of availability, ease of production and dissemination, and potential for high morbidity and mortality and major health impact. The category C agents are Nipah virus, hantaviruses, tickborne hemorrhagic fever viruses, tickborne encephalitis viruses, yellow fever, and multidrug-resistant tuberculosis.

As part of the strategic planning process, CDC and other federal agencies are providing support to state and local health departments through a number of grants to improve epidemiologic surveillance, public health information management and communication infrastructure, public health laboratory capability, and public health emergency planning.<sup>6</sup> Throughout the planning documents developed for bioterrorism response, veterinarians are considered a key part of the disease surveillance system.<sup>7-10</sup> Additionally, the Department of Justice and the CDC's Public Health Assessment Instrument for Public Health Preparedness recommends that local public health planners develop a roster of individuals with technical expertise able to

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respond to a biological, chemical, or radiological terrorist event; plan to initiate contact with veterinarians and other public health professionals within an hour; disseminate information on terrorist threats to veterinarians within 2 hours; develop a roster of veterinary laboratories for specimen handling and veterinary facilities for handling affected animals; estimate the numbers of veterinarians who have received 8 or more hours in emergency preparedness training in the past year; provide training for veterinarians on decontamination and contagion hazards that may accompany a biological, chemical, or radiation incident; include veterinarians in emergency exercises; and facilitate contact with veterinary researchers.<sup>11</sup>

It is vitally important that all facets of veterinary medicine stay involved in the preparations to respond to bioterrorism. This should be obvious by the known or potential zoonotic nature of many diseases in the CDC bioterrorism categories (anthrax, plague, tularemia, Ebola, Marburg, Lassa fever, Argentine hemorrhagic fever, Q fever, brucellosis, glanders, Venezuelan encephalitis, eastern and western equine encephalitis, salmonellosis, *Escherichia coli* O157:H7, cryptosporidiosis, Nipah virus, hantaviruses, tickborne hemorrhagic fever viruses, tickborne encephalitis viruses, and yellow fever)<sup>12,13</sup> and the recognized potential for expertise, support, and response that veterinarians provide in animal care and in the general response to a bioterrorism attack. Veterinarians have an important role in bioterrorism response preparation, surveillance for potential bioterrorism events, treatment of the ill, and in the control of disease.

### **Bioterrorism Against Animal Populations**

Traditional thinking and planning regarding bioterrorism has focused primarily on humans as the primary target. If the perpetrator's objectives can be met solely through the creation of human illness, death, and the associated panic, this may be true. However, if economic and political vulnerabilities are factored in as contributing issues, then agricultural bioterrorism (the intentional targeting of a nation's livestock and crop resources) becomes more likely, perhaps even more so than attacks against humans.<sup>14</sup> Further, an attack on the food supply or food economy of a nation might be more attractive to terrorists because of the secondary effects on humans and the potential for deniability that might make the response or retribution less vigorous.<sup>15</sup> A recent General Accounting Office study<sup>16</sup> concluded that intentional disease attacks against agricultural commodities, especially livestock, would be economically devastating and presently are inadequately defended against. Other factors contributing to the vulnerability of US agriculture are the continuing trends of intensive production techniques, vertical integration of the production continuum, the increasing industrial dependence on the export market, and the lack of US livestock resistance against pathogens and pests that no longer prevail in the continental United States.

This agricultural vulnerability, coupled with the relative ease of procuring, producing, and disseminating animal pathogens, allows potential perpetrators to

apply the tenets of asymmetric tactics to significantly harm a nation that is increasingly immune to conventional attack.

### **Veterinarians' Role**

Although the human medical community recently identified many shortfalls in national bioterrorism defense and has initiated great improvements toward their remedy, the veterinary and agricultural communities have lagged behind, especially those portions involved in food animal production. Amidst this seeming backdrop of impending doom, however, the US veterinary community is not wholly unprepared. In fact, a recent study by US public health officials concluded that the veterinary education model "which looks at populations rather than individual patients, might serve as a model for the medical community."<sup>17</sup> The following efforts, individual and collective, are offered as recommendations for improving our national defense against attacks on our livestock and resultant impacts on our social and economic viability.

**Practitioners**—The key prerequisite for any effective surveillance system is knowledge of the baseline disease prevalence and incidence rates. Without this information, it is impossible to tell whether disease occurrences are below or above the threshold for specialized action. Although most veterinary practitioners develop some sense of these disease rates in their areas, formally tracking them over time might prove valuable.

Similar to baseline disease rates, timely knowledge of key production variables will allow early detection of adverse health events. Farm owners and managers will be the primary surveillance system operators in this case. However, clear and frequent lines of communication between the producers and their veterinarians (the "first responders") will facilitate an early and effective response. Examples include dairy herd milk production and breeding rates, swine breeding, farrowing and rate of weight gain figures, poultry egg production, and respiratory disease rates.

Another prerequisite for responding to a bioattack against livestock is the ability to recognize the signs and symptoms of the likely disease agents. Those diseases might include those no longer prevalent in the United States, against which our livestock have low immunity, and which would significantly affect our agricultural economy. Conveniently, the **Office International des Epizooties (OIE)** publishes a list of animal diseases that are highly infectious, capable of rapidly spreading across international borders, becoming widespread, and have the potential to inflict catastrophic economic losses and social disruption.<sup>18</sup> This complete OIE list A includes **foot and mouth disease (FMD)**, vesicular stomatitis, swine vesicular disease, rinderpest, peste des petits ruminants, contagious bovine pleuropneumonia, lumpy skin disease, Rift Valley fever, bluetongue, sheep and goat pox, African horse sickness, African swine fever, classic swine fever, fowl plague, and Newcastle disease. Fortunately, many of these diseases have not been prevalent in the United States for many years, but that may make their timely recognition problematic. To prevent confusion and

costly delays in recognition and reporting, veterinarians should seek continuing education opportunities on natural and intentionally introduced foreign animal diseases.<sup>19-22</sup> This education effort should include a review of the clinical signs of these diseases, as well as variations in their relative species susceptibility. For example, the greater reported susceptibility and shorter incubation period of ruminants (compared with humans in specific regard to anthrax) make them potential sentinel populations in the event of an attack using an aerosolized pathogen.<sup>23</sup> Another way to obtain this knowledge is to attend the 2-week USDA Foreign Animal Disease Diagnostician's Course held several times each year at the Plum Island Animal Disease Center in New York.

One of the first actions a veterinary practitioner takes on suspicion of a natural or intentional outbreak of an important or exotic disease is timely reporting to proper authorities. Unless knowledge of what diseases are reportable, and to whom, is maintained before the event, valuable time will be wasted in "reinventing the wheel."

Practitioners should also engage their human medical counterparts at the local level. Too often, medical providers at local hospitals and health departments plan for medical surveillance and response activities without considering the zoonotic and epizootic diseases that can impact those systems. Veterinarians who have become active in public health endeavors have been well received by their counterparts in human health care and have made important contributions to both animal and human epidemiology.

Finally, veterinary practitioners can greatly contribute to natural and intentional disaster response efforts by volunteering for the various federal response teams. Under the National Disaster Medical System, and an agreement between the AVMA and the USDA, **Veterinary Medical Assistance Teams (VMATs)** were formed to provide assistance in the control, treatment, and eradication of animal disease outbreaks. Comprised of volunteer veterinarians, technicians, and support personnel, VMATs can be called to federal service for up to 14 days as "special needs" employees of the US Public Health Service. If activated, VMAT personnel are paid a salary and also receive various associated benefits.<sup>24</sup>

Another opportunity to contribute to the early response and control efforts for a veterinary emergency is the regional emergency animal disease eradication organization. This response capability consists of 2 regional task forces comprised of USDA employees, state veterinarians, military support personnel, and industry liaisons. Information on these service opportunities, as well as printed material on foreign animal diseases, can be obtained from USDA-APHIS-VS-Emergency Programs.<sup>25,a</sup>

**Academicians**—As stated, most veterinary students receive more training on epidemiologic affairs than do most medical students. However, this effort could be enhanced by including and standardizing the basic tenets of disease causation and surveillance, outbreak investigation, population sampling and biostatistics,

study design and evaluation, and effective risk communication.

Zoonotic and foreign animal diseases are other areas currently taught with various degrees of success. Zoonoses, representing the main interdigitation between animal medicine and human medicine, wax and wane across major species boundaries as a result of intricate social and evolutionary subtleties. The realization of Dr. Calvin Schwabe's visionary "one medicine"<sup>26</sup> can be achieved only through a clear understanding of their processes and control strategies. As for foreign animal diseases, their names say it all. Graduates of US veterinary colleges in the past several decades likely have not seen any cases of diseases such as FMD, classic swine fever, and rinderpest. However, all of these diseases are prevalent over much of the globe and could certainly reappear within our borders without warning. Although no conceivable outbreak scenario suggests the possibility of a general shortage of the American food supply, serious economic ramifications would result from the reintroduction of an OIE list A disease.

Finally, the safety and wholesomeness of our food supply has been a major factor in America's relative international affluence. Veterinarians play an increasingly important role in this ever-evolving "farm to fork" continuum, and their basic and continuing educational needs must be met with the same degrees of completeness, flexibility, and responsiveness.

**State and federal government**—Although agriculture comprises more than 13% of our national gross domestic product and nearly 17% of employment,<sup>27</sup> it was not included in the first round of presidential decision directives addressing potential bioattacks.<sup>28</sup> In the past 5 years, however, there have been gradual improvements toward its parity with the public health community regarding the preparation for an attack and the subsequent recovery. For this to continue, agriculture leaders must be proactively assertive in their dealings with counterparts in the law enforcement, defense, public health, and intelligence communities.

Although all states have veterinarians in key positions throughout their agriculture departments, not all have positions for public health veterinarians. The establishment of these positions in every state would facilitate necessary cross communication with the human medical community and contribute to a true medical surveillance system.

In conjunction with veterinary educators, state and federal government must implement training opportunities on the recognition, prevention, and control of foreign animal diseases. This could be facilitated through an initial and ongoing accreditation process.

To further an effort already begun, state and national laboratories must be upgraded to a level where they can provide timely diagnostics and research on preventions and therapies against likely natural and intentional disease agents. These laboratories must also be seamlessly connected into the human-animal disease reporting system, with both trunks leading to an appropriate endpoint, such as the CDC or the newly created National Office of Homeland Security.

**Legislators**—Greater penalties must be levied against those who plan or promulgate attacks against US agriculture. Although the recently signed Animal Health Protection Act, which substantially increases the penalty for each threat or attack against agriculture and updates and consolidates animal quarantine laws, is a step in the right direction, current laws may not adequately contribute to an effective deterrent against such activity. Therefore, all future antiterrorism legislation must include agricultural commodities as worthy of protection.

The vast capabilities of the US military are increasingly becoming known to, and drawn upon by, the national emergency response phases of crisis and consequence management. Some of these capabilities (veterinary and public health) can specifically contribute to the response against an attack on agriculture. Others (logistics and communications) represent key support capabilities necessary for effective disaster management. Regardless of the expectation for military involvement, these resources must be specifically tasked and therefore manned, equipped, and trained in advance of their requirement.

Unfortunately, our ability to prepare for and respond to intentional biological events may continually lag behind those of motivated, intelligent terrorists. Therefore, our goal should be to prepare our resources and ourselves as best we can to minimize the effects of those events through continual training, exercise, and vigilance.

<sup>a</sup>USDA-APHIS-VS-Emergency Programs, Riverdale, Md.

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