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AMERICA'S FOOD

DOES ANTHRAX POSE A THREAT?

by

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Preface

In the wake of the terrorist attacks on 11 September 2001 and bio-terrorist anthrax attacks through the United States postal system, many Americans are perhaps feeling more vulnerable than ever. The reader may think that I latched on to the "hot" topic of the day; however, I want you to know that my topic selection was made well ahead of these shocking and monumentally tragic events.

This paper is an attempt to explore the pathogen *B. anthracis* and the issue of potential malicious contamination of America's food supply. I chose this topic, because I felt strongly that food security needed to be connected to national security well before the words "Homeland Defense" became an American mantra.

Finally, I want to acknowledge my faculty research advisor, Major Bridget Carr, an Air Force veterinarian, without whose technical assistance, overall support and gentle encouragement, this paper could have never been written.

Abstract

The project addresses the pathogen *B. anthracis* and its potential use to maliciously contaminate America's food supply. The potential social, political and economic ramifications of such an agro-terrorism attack are addressed at length. The preparedness of the United States to stave off such an act of aggression is also evaluated. Lastly, the paper's emphasis is the threat of anthrax to America's food and livestock, and its potential to cause fatal food poisoning.

The methodology used is an extensive review of open-source literature, including medical and scientific journals, general publications and current news items. There is much emphasis on food security as an issue of national security.

Conclusions are that the United States has one of the safest food supplies in the world; however nothing is entirely secure. The use of anthrax against United States food supplies would unlikely cause high numbers of deaths, but could instead incite social, political and economic instability through frank terrorism. The paper recommends a closer look at the anthrax vaccination program for animals, but agrees with the CDC that the vaccine is not indicated for first responders and medical personnel, based on the intelligence available regarding the threat. The paper emphasizes food security as an integral part of national security and recommends additional research in this area as part of Homeland Defense.

Chapter 1

Introduction

The US--more by luck than design--has not experienced a major agricultural or food-related disaster in recent memory.

—Dr. Peter Chalk, Policy Analyst, RAND

Food: Next Target for Terrorism?

Target of Opportunity?

Terrorism in the United States. The terrorist attacks on the United States on 11 September 2001 will live in infamy. The civil defense authorities, the military and politicians may debate for years how the events could have been prevented. They may also debate just as long how the subsequent intentional contamination of United States mail with anthrax could have been prevented. While many Americans are now well aware of new weaknesses in airport and mail security, we may wonder about other potential vulnerabilities because of the perceived lack of a threat or insufficient security resources. Common sense tells us that nothing is ever completely secure, yet we may wonder when and where terrorists may strike another significant United States target.

North America and Western Europe have made substantial investments over the past decade to improve in counter-terrorism capabilities. These include enhancements in the ability to detect, prevent, and respond to terrorist threats and terrorist attacks. These im-

provements have linked with an increasingly well-protected public infrastructure. Now more than ever vulnerability threat analyses are used to optimize preparedness and response to terrorism.[1]

Threat to Agriculture. According to Dr. Peter Chalk, Policy Analyst for RAND, "Agriculture is one area that has received little attention in this regard, however. Indeed, in terms of accurate threat assessments, response structures and preparedness initiatives, the sector continues to exist as a glaring exception to the wide-ranging emphasis that has been given to critical infrastructure protection in this country."[2] Sadly, according to Dr. Chalk, agriculture and the food industries remain highly vulnerable to intentional disruption. Factors influencing this include such things as: the large number of lethal and contagious agents against which livestock are not immune; the ease and rapidity that infectious animal diseases spread; and the proliferation of food processing plants which lack sufficient security and safety preparedness measures for today's threat.[3] Certainly, an attack on agriculture could produce economic destabilization and generate fear.

Threat to Consumer Food. When we talk about terrorism, the threat to agriculture may cross our mind; however, most people do not associate terrorism with the food on their plate. Perhaps they should. In June 1997 the Journal of American Medicine (JAMA) featured two articles on incidents in which food was intentionally contaminated. In 1984, someone deliberately put *Salmonella typhimurium* bacteria in restaurant salad bars in Oregon.[4] In 1996, someone spiked pastries with *Shingella dysenterie* bacteria. These pastries were anonymously left for some Texas laboratory workers in their break room.[5]

Food is a ubiquitous source with virtually universal demand - we all must eat. Certainly the technology and skill required to carry out a food-borne terrorist attack are elementary. A small or partially successful attack or series of attacks could generate fear and perhaps raise doubt regarding the ability of the government to adequately protect its people. Food, one of humanity's most basic needs, lends itself to terrorism of the most far-reaching kind. No one is sheltered from the fear that this form of terrorism would clearly generate.

Anthrax, the Terrorist Weapon

Due to its universal distribution, zoonotic tendency, intense lethality, and popular familiarization, Anthrax is among the most discussed biological weapons. Scientists began researching anthrax as a biological weapon more than 80 years ago and today at least 17 nations are believed to have offensive biological weapons programs.[6] It is uncertain how many countries and groups are working on anthrax; however, Iraq has acknowledged producing and weaponizing anthrax.[7]

For clarification, Anthrax is the disease caused by *Bacillus anthracis*, herein called *B. anthracis*. The term anthrax is often used to refer to both the disease and the pathogen when there is no confusion about what the subject is.

In October and November 2001, by anthrax-tainted letter, the United States was delivered her first anthrax associated terrorist attack. This brought the ensuing terror into America's homes on the evening news and into everyday conversations. Some people became afraid to handle their mail as people other than postal workers became sick with the disease. The mail has been used to deliver anthrax. Could our food be used as well?

Scope of Paper

From Farm to Table. The scope of this paper is to examine anthrax as a threat to America's food via two avenues. First, an intentional attack with *B. anthracis* against United States livestock would sicken and kill the animals and contaminated meat could possibly arrive at the consumers' table. Secondly, a direct attack with *B. anthracis* on commercial food ready to serve, or food preparation, storage or serving facilities could cause consumers to eat contaminated foods. These attacks while perhaps causing relatively few casualties could incite widespread fear and panic, and deeply hurt the livestock industry and its significant contribution to the United States economy.

Anthrax is traditionally a disease of livestock. It is normally fatal in immunologically naive animals. The animals, as a food source, die rapidly and do not enter the food chain. This is because suspect animals are normally disposed of and could not pass United States Department of Agriculture inspection. However, a terrorist attack against livestock could cause concerns about overall food safety to be raised.

Inhalational anthrax results from breathing in the *B. anthracis* aerosolized spores. This form causes rapidly fulminant and fatal pneumonia. Less known is that ingestion of the spores can also cause lethal gastrointestinal anthrax. Anthrax, the biological agent, could be used to infect food. Although more common food pathogens, such as *Salmonella typhimurium*, could be studied in relation to food terrorism, simply the words anthrax and food in the same sentence would cause fear in many. Naturally occurring, food-borne anthrax cases are known, but normally confined to the Third World where meat is not inspected and perhaps not cooked thoroughly.[8]

The specific aim of this project is to qualitatively analyze the vulnerability of United States livestock and food to a terrorist attack using weaponized *B. anthracis*.

Methodology

Literature Review. This project is an analysis of the threat of anthrax to United States food and livestock using unclassified sources. Current open-source scientific literature was reviewed to identify the susceptibility of America's food and livestock to the potential terrorist use the biological agent anthrax; the potential impact that such an attack would have; and reasonable protective measures to mitigate or avert damages.

Notes

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[2] *Ibid*. 3.

[3] *Ibid*. 4-6.

[4] Torok, T.J.;et al. "A Large Community Outbreak of Salmonellosis Caused By Intentional Contamination of Restaurant Salad Bars." *JAMA*, Vol. 278, no. 5 (6 August 1997): 389.

[5] Kolavic, Shellie A., et al. "An Outbreak of Shigella dysenterie Type 2 Among Laboratory Workers Due to Intentional Food Contamination." *JAMA.* Vol. 278, no. 5 (6 August 1997): 396.

[6] Inglesby, Thomas V.; et al. "Anthrax as a Biological Weapon." *JAMA*, Vol. 281, no. 18 (12 May1999), n.p. On-line. Internet, 29 October, 2001. Available from http://jama.ama-assn.org/issues/v281n18/ffull/jst80027.html.

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Chapter 2

Background

Food security can no longer be separated from national security.

— Sen. Dick Durbin, D-Ill.

Anthrax and Food: A Deadly Combination

Anthrax in Livestock

Anthrax is a disease historically associated with livestock, especially herbivores (see appendix A). The route of infection is presumed to be oral by ingestion or possibly nasal by inhalation.[1] The animals normally eat the spores; therefore anthrax in animals is generally gastrointestinal anthrax. When anthrax spores enter the animal by way of the nose or mouth, the disease is almost always fatal for susceptible animals.[2] This animal mortality rate contrasts sharply with the estimated human fatality rate from gastrointestinal anthrax. Although animals are known to be more susceptible to anthrax than humans, still the question remains open that perhaps human fatality rates for gastrointestinal anthrax (25 to 60 percent), based on very limited data, are underestimated.[34]

Large anthrax epizootics in unvaccinated animals have been reported. For example, during a 1945 outbreak in Iran, one million sheep died.[5] For this reason, the Centers for Disease Control and Prevention (CDC) also suggests that neighboring livestock be vacci-

nated and perhaps receive long-term therapeutic levels of antibiotics.[6] These vaccination programs for animals have dramatically reduced the mortality from the disease.[7]

From 6 July through 24 September 2000 an anthrax epizootic in North Dakota resulted in 32 farms being quarantined. A quarantined farm is defined as any farm in which culture-confirmed anthrax has occurred among livestock. This figure contrasts dramatically with an average of two farms per year during the preceding 40 years. The initial cases were detected in May, when four animals were found dead on a farm. The epizootic extended to include 157 dead animals on 31 farms.[8] This illustrates the dramatic impact an outbreak of anthrax can have on farming in terms of money, time and personnel investment to enforce such a large-scale quarantine.

In addition, 62 people were involved with animal care, vaccination, specimen processing, or carcass disposal. One of these individuals contracted cutaneous anthrax. Finally, the CDC does not recommend anthrax vaccinations during these epizootics for veterinarians, laboratory workers, or agricultural workers. They consider the risk of infection low.[9] However, an outbreak of anthrax on a farm poses a risk to all people who come in contact with the infected animals.

An intentional contamination of livestock with *B. anthracis* would result in numerous animal deaths and would place the livestock owners and workers at risk. In addition, the resultant fear and panic would be immense. The costs in money, time, and inconvenience would economically cripple the livestock owners.

Anthrax in Food

Anthrax has received much media attention recently; however, none of it is regarding anthrax as a threat to food. Although no cases of “food poisoning” traced to anthrax have

been reported, it is possible for food to be contaminated with *B. anthracis.* Other bacterial pathogens such as *Escherichia coli (E. coli)* and *Salmonella typhimurium* have received extensive coverage because of public safety concerns. The deaths of four children in the Western United States in 1993 caused by *E. coli* (a fecal contaminant), led consumers to demand better food safety measures. In response to this outcry, consumers received education in proper food preparation procedures and researchers attempted to better understand the pathogen. In addition, new regulations were implemented regarding the livestock slaughter, processing, and inspection process.[10]

Protection from food contaminated with anthrax includes thorough cooking just as one would do to protect from other less exotic food pathogens. However, it is possible to contract gastrointestinal anthrax from consuming raw or undercooked contaminated meat. The known cases of gastrointestinal anthrax are the result of naturally occurring *B. anthracis* that has not been refined in any way. Perhaps it is fair to assume that case fatality rates would be higher with the introduction of weaponized or refined *B. anthracis* to an ideal food medium such that the bacterial concentration and virulence were enhanced beyond that found in naturally contaminated meat.

In July 2000 a farmer in Minnesota who owned an anthrax-infected steer also killed a cow that was unable to stand. Not suspecting anthrax in the cow, a local veterinarian approved the cow for slaughter and consumption by the farmer's family. The carcass was processed at a local custom meat processing plant and the family subsequently consumed the meat. Two of the family members reported gastrointestinal illness and both recovered without treatment.[11]

The Minnesota Department of Health (MDH) investigated the incident. The family reported that the meat had been well cooked. The MDH and the United States Army Medical Research Institute for Infectious Diseases cultured the meat and found that it was thoroughly contaminated with *B. anthracis.* Because the meat was so highly contaminated the family was advised to continue preventive antibiotic treatment and immunization against anthrax. Furthermore, the custom meat packing plant was told by the Minnesota Department of Agriculture to place a hold on all meat processed after the infected cow. They also inspected the plant. The plant was found to have satisfactory sanitation practices and all meat packages were accounted for and incinerated. No meat left the state of Minnesota.[12]

While this case represents only one incident of presumed gastrointestinal anthrax from contaminated meat, it lays out the difficulties of the situation involved. It is also a testament to its rarity; this was the only case in the United States of gastrointestinal anthrax associated with the consumption of tainted meat that was discovered during this study. What accounts for this fact is most likely that the United States has reasonably good food processing safeguards and procedures.

However, a letter to the Editor at the Journal of American Medicine (JAMA) brings to light a problem when food is neither processed in the United States, nor requires thorough cooking. Dr J. Sadjadi of the Iran University of Medical Sciences, Tehran wrote in reference to a 1996 JAMA article, "Unexplained Severe Illness Possibly Associated with Consumption of Kombucha Tea - Iowa 1995."[13] For clarification, the Kombucha "mushroom" is a " symbiotic colony of several species of yeast and bacteria that are bound together by a surrounding membrane."[14] Dr. Sadjadi described an outbreak in Iran of cuta-

neous anthrax related to the Kombucha mushroom. In 1996 in a village on the outskirts of Tehran, 20 people developed skin lesions that were reported as painless and had a central black necrotic area. An infectious disease specialist gave a preliminary diagnosis of cutaneous anthrax and the patients received antibiotics. Cultures from the skin lesions confirmed the presence of *B. anthracis*.[15] Fortunately, the people had not had the mushroom to drink in the form of tea, but had applied the mushroom to various parts of their bodies as a painkiller. Had they consumed the mushroom and its tea, the people could have potentially developed gastrointestinal anthrax, a more fatal form.

In this case the Kombucha mushroom was given to people because of its "magical healing power." The individuals prepared it in plastic containers next to a farmyard in the vicinity of cattle. The conditions were reported to be extremely unhygienic. Samples of the contaminated Kombucha mushroom were sent to a laboratory; initially the presence of *B. anthracis* could not be confirmed because of secondary contamination and bacterial overgrowth. However, later in laboratory tests the Kombucha mushroom and its tea proved to be a good host for the growth of *B. anthracis.*[16]

Although, Iran may sound far away and the poor hygiene conditions associated with this case may not be representative of those in the United States, clearly the lesson of this case is that anthrax can thrive in at least one food medium. It may well be able to thrive in many more. The 1995 Kombucha tea case in Iowa may well have been an undiagnosed case of gastrointestinal anthrax.[17] Dr. Sadjadi cautioned readers that, "during the domestic preparation of Kombucha tea, contamination with microorganisms, even spore forming ones, may occur, which can be serious or even fatal."[18]

Lastly, *B. anthracis* could be used to contaminate food either prepared for serving or being processed and packed. In addition to killing livestock, consuming contaminated meat from infected animals could also make people sick.

Notes

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[3] Holmes, Randall K. "Diphtheria, Other Corynebacterial Infections, and Anthrax." On-line. Internet, 14 March 2002. Available from http://www.mheducation.com/HOL2_chapters/HOL_chapters/chapters141.htm.

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Available from http://www.cdc.gov/mmwr/preview/mmwrhtml/rr4915al.htm.

[5] Inglesby, Thomas V.; et al. "Anthrax as a Biological Weapon." *JAMA*, Vol. 281, no. 18 (12 May1999), n.p. On-line. Internet, 29 October, 2001. Available from http://jama.ama-assn.org/issues/v281n18/ffull/jst80027.html.

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[8] "Human Anthrax Associated With an Epizootic Among Livestock-North Dakota, 2000."

[9] *Ibid*.

[10] "Antibiotic Injection Practices on United States Dairy Operations." APHIS, USDA. On -line. Internet, 11 January 2002. Available from http://www.Aphis.usda.gov/vs/ceah/cahm/Dairy_Cattle/d96anti.htm.

[11] "Human Ingestion of Bacillus Anthracis-Contaminated Meat-Minnesota, August, 2000." *JAMA*, Vol. 284, no. 13 (4 October, 2000), n.p. On-line. Internet, 29 October 2001. Available from http://jama.ama-assn.org/issues/v284n13/ffull/jwr1004-4.html.

[12] *Ibid*.

[13] "Unexplained Severe Illness Possibly Associated with Consumption of Kombucha Tea—Iowa, 1995." CDC MMWR. *CDC MMWR*, 8 December 1995, 892-93. On-line. Internet, 14 March 2002. Available from http://www.cdc.mmwr/preview/mmwrhtml/00039742.htm

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[15] *Ibid*.

[16] *Ibid.*

Notes

[17] “Unexplained Severe Illness Possibly Associated with Consumption of Kombucha Tea—Iowa, 1995.”

[18] Sadjadi.

Chapter 3

Analysis

> *This is not about food per se, Americans would not go hungry if we were attacked, but such an attack, or even a credible threat, would severely disrupt America's economic and social infrastructure for weeks, if not months or years.*
>
> —Floyd P. Horn, Administrator, USDA

What is the Threat?

Agro-Terrorism

Definition. For the purposes of this paper, agro-terrorism is defined according to Dr. Peter Chalk as, "the deliberate introduction of a disease agent, either against livestock or into the food chain, for the purposes of undermining stability and/or generating fear."[1] Depending on the pathogen or vector chosen for an attack, the attacker could create mass economic and social disruption as well as directly attacking people through their food.

Economic Impact. "Agriculture and the general food industry remain absolutely critical to the social, economic and arguably, political stability of the US, indirectly constituting roughly two percent of the country's overall gross domestic product (GDP)", testified Chalk before Congress one month after the biggest attack on American soil.[2] The impact that agriculture and the food industry have on the economy is staggering. Approximately one in eight people work in a segment of the agriculture industry, making

it one of the United States' largest employers. More people are included when accounting for food production. In addition, cattle and dairy farmers earn between $50 and $54 billion a year through meat and milk sales.[3] These figures show just a small sliver of the entire value of agriculture to the United States. For a more comprehensive assessment one would include such people as wholesalers, transporters, and restaurants. According to Dr. Chalk, "The downstream effect of any deliberate act of sabotage/destruction to this highly valuable industry would be enormous, creating a tidal wave effect that would be felt by all sectors, impacting, ultimately, on the ordinary citizen him/herself."[4]

There are several historic examples of this broad-spectrum economic impact. For example, in 1983 to 1984, an especially strong strain of avian influenza struck the United States poultry industry. The cost to the government to eradicate the disease was $63 million and this contributed to a $349 million rise in turkey, chicken and egg prices in the first six months of the outbreak.[5] The reach of the direct and indirect costs can be huge. In the 1990s, an outbreak of bovine spongiform encephalopathy (BSE) cost the government of the United Kingdom $9 to $14 billion in compensation to farmers and employees of the dairy and beef industries in addition to costs of protective trade embargoes.[6] The last example cited here is the 1997 outbreak of Food and Mouth Disease (FMD) in Taiwan. The resultant indefinite ban imposed on Taiwanese pork exports caused the country's gross domestic product (GDP) to drop by 2 percent almost immediately.[7]

Although these economic impacts are large, it is important to note that these examples are all the result of contagious pathogens. Anthrax is not contagious. However, an intentional contamination of pastures and the subsequent disease in cattle, for example, could result in numerous losses to unvaccinated animals. In addition, an intentional con-

tamination of food at a food processing plant or in a salad bar could result in many deaths, a loss in sales, and potential job losses. These are the potential consequences of fear, not matter how unwarranted.

Loss of Confidence. In addition to the far-sweeping economic impacts that a successful attack against United States agriculture could have, it could also cause a loss of confidence in the government to protect the people. An even partially successful attack could cause people to lose confidence in the safety of the food supply. People might begin to question the ability of the government to protect them against weapons of mass destruction in general. Critics would challenge the United States government regarding prior warning of an imminent attack and the types of safety measures taken to protect the agricultural sector. Unfortunately, the agricultural sector is currently quite exposed to this emerging threat. Also, the images of large-scale culling and disposal of animals in a risk area by the media would certainly fuel discord, fear, and distrust of the government. Furthermore, the perceived ecological impact of incinerating large numbers of carcasses might raise protests. Finally, such operations as culling and incinerating carcasses might spark terror attacks from environmental or animal rights extremists further exacerbating a desperate situation.[8]

Social Instability. Perhaps the most obvious result of a successful terrorist attack against America's food supply would be the fear and mass panic that would ensue. An attack on the farm could create a general atmosphere of uneasiness and vulnerability. In the words of terrorist expert, Dr Bruce Hoffman, " It gets the terrorists' coercive point across but doesn't necessarily cross the threshold of killing people, and thus doesn't create the same kind of backlash."[9] A food-borne attack would do very well in creating

panic because most processed food is distributed to a focused area in a short period of time. Therefore, an outbreak of many unexplained severe illnesses could quickly have an impact on a community.[10] It is possible that many people could become ill with "unexplained gastrointestinal symptoms." Potentially many could die before gastrointestinal anthrax would be suspected, let alone diagnosed.

Anthrax: the Biological Weapon

Weaponized anthrax. Weaponized anthrax is anthrax that has been processed to assure lethality and refined to ensure uniformity of particle size. This effectively makes anthrax a lethal gas-like weapon. The best information about this weapon comes from United States Army's biological weapons program tests performed in the 1950s and 1960s. Particles with a diameter of five microns or less are easily aerosolized and can lodge in the victim's lungs causing disease. Particles of one to three microns in diameter were found in the letter mailed to Senator Daschle in the recent anthrax attacks through the United States mail. Other experiments have shown that few spores remain behind after aerosolized anthrax passes over an area. This means that little "evidence" is left behind and finding a terrorist suspect can be nearly impossible.[11] Weaponized anthrax and a good delivery method in the hands of a terrorist create a weapon of mass destruction.

Sverdlovsk, USSR. Perhaps the most well-known case prior to October 2001 is the Sverdlovsk, USSR anthrax outbreak in 1979. Before the United States postal anthrax cases, Sverlovsk's inhalational outbreak was the largest in the 20th century and remained the primary source of information on anthrax in humans.[12] The Sverdlovsk outbreak resulted in between 64 and 104 deaths.[13] Interestingly, livestock also died of anthrax along the contaminated zone's extended southern axis.[14] In 1992, President Boris Yeltsin ad-

mitted that aerosolized anthrax from the military weapons facility in the victims' city had caused the outbreak.[15]

This case raises the issue that weaponized and aerosolized anthrax can potentially cause deaths in both people and animals. The finding that aerosolized anthrax can persist and be secondarily aerosolized in the area and infect animals either through ingestion or possible inhalation is unique. Also, this case is particularly interesting because anthrax was released accidentally without extensive planning for winds, site selection or other criteria. Sverdlovsk provides the best concrete example of the implications for humans and animals of a release of weaponized and aerosolized anthrax.

China. Although the Sverdlovsk cases resulting from weaponized anthrax are the most known, there is evidence to suggest that this case is not unique. During the Korean War five fatal cases of "inhalational" anthrax presented themselves in northern China during a 30-day period. The cases allegedly broke out after United States aircraft flew over the area and were not associated with occupational exposure. Interestingly, three of the autopsies showed gastrointestinal involvement.[16]

United States mail. The United States mail bio-terrorism related anthrax cases are the first cases of inhalational anthrax in the United States since 1976.[17] Furthermore, there were only 18 cases of inhalational anthrax in the United States during the 20th century.[18] A report from the Center for Disease Control and Prevention (CDC) outlining the first 10 cases laments the difficulty in diagnosing the disease due to the non-distinctive nature of the initial phase, which frequently includes nausea and vomiting symptoms.[19] Also, at least two of the four case fatalities included gastrointestinal symptoms.[2021]

This suggests involvement of the gastrointestinal tract even though the route of infection was initially believed to be inhalational. Interestingly, for the Sverdlovsk outbreak, gastrointestinal lesions were noted in 39 of the 42 fatal inhalational anthrax cases. The *B. anthracis* is thought to have spread via the blood.[22] Also the "inhalational" anthrax cases in China support gastrointestinal involvement. Fortunately, all the patients in the United States bio-terrorism incident received antibiotics; their survival rate, 60 percent, suggests that current treatments are more effective than previous regimens.[2324]

Future implications. Most experts agree that aerosolized anthrax with the potential to cause an outbreak of inhalational Anthrax is the most likely scenario for the intentional use of anthrax.[2526] In 1970, the World Health Organization expert committee predicted that a 50 kilogram (kg) release of anthrax over a dense urban population of 5 million would result in 250,000 casualties. Of these, 100,000 would be expected to die if untreated.[27] A 1993 a report by the United States Congressional Office of Technology Assessment estimated that between 130,000 and 3 million deaths could result from 100 kg of anthrax spores released upwind of the Washington, D.C. area.[28] Furthermore, the CDC estimated a cost of $26.2 billion per 100,000 people exposed to anthrax.[29]

However, in light of the United States recent experience with the use of anthrax as a biological weapon in the United States mail system, these figures need some clarification. First, the American public is now greatly aware of anthrax and perhaps more likely to seek treatment for illness. In addition, health care providers are energized and informed to diagnose anthrax cases. Also it appears that current antibiotics have been more effective than was once believed possible against this deadly pathogen. Finally, it would be more difficult to successfully deliver anthrax because of increased security and homeland

defense initiatives in the wake of the 11 September 2001 terrorist attacks. The level of attention now directed at aircraft security and regulation, including stricter requirements for pilots and closer scrutiny of plane use (such as crop dusters) would make large-scale attacks by aircraft much more difficult to accomplish.

Many have also criticized the projected casualties citing the necessity of proper spore size for aerosolizing anthrax, as well as optimum winds and weather for its distribution. One terrorist group, Aum Shinrikyo, responsible for the release of sarin gas in a Tokyo subway station in 1995, dispersed aerosols of anthrax and botulism throughout Tokyo on at least eight occasions.[30] However, no one fell ill. The reason for this is believed to be improper spore size and poor distribution. A counterpoint to this optimism is that *B. anthracis* appears to be quite viable and able to cross-contaminate mediums more easily than once thought. The death of a New York hospital employee, a person not associated with the post office, raises questions in this arena as well as perhaps the reduced amount of anthrax spores comprising a lethal dose.[31] Minimally, one must question the victim's immunology and her activities in relation to known contaminated areas.

Anthrax food poisoning. Anthrax food poisoning is possible. Sufficient evidence exists to support the fact that anthrax will grow in foods much like other food pathogens. Further, the Sverdlovsk, China, and United States mail cases support gastrointestinal anthrax by ingestion even when the anthrax is originally distributed in an aerosol.

A terrorist could use anthrax to contaminate food at the serving facility, in transportation, or at the preparation and packing plant. This attack would most likely cause many to get sick and could result in a substantial amount of deaths. The terror effect would be

great in that people could become panicked across the nation resulting in dramatic changes in their eating and food buying habits.

Gastrointestinal anthrax is a serious condition and gastrointestinal involvement appears to be more closely linked to inhalational anthrax than commonly acknowledged. This is often alluded to in scientific journals, but never really addressed. This is most likely because doctors classify anthrax according to the organs and tissues that are initially infected.[32] If anthrax is delivered through an aerosol the obvious first tissues to be infected are the lungs.

However, modern treatments are very effective. The 60 percent case fatality rate in the United States mail epidemic is lower than the expected historical 80 percent case fatality rate for inhalational anthrax. Furthermore, inhalational anthrax is still almost 100 percent fatal if treatment is not administered right away.[33] The case fatality rate can be as high as 95 percent if treatment begins more than 48 hours after symptom onset.[34] Although these figures refer to case fatality rates for inhalational anthrax, gastrointestinal involvement is often included in "inhalational" cases.

The route of infection for cases resulting from aerosolized anthrax may well be both inhalational and gastrointestinal. Victims can both eat and breathe the spores, not unlike livestock. Therefore the untreated gastrointestinal anthrax case fatality rates estimated at 50 percent to 100 percent in untreated persons may well be more an expression of fatality rates for untreated anthrax regardless of the route of infection.[35] The difference in the concentration of *B. anthracis* may be a better reason for the difference in fatality rates than the route of infection.

Livestock attacks.

Historical context. Given the broad impact that an attack against our food supply could have, it is perhaps surprising that the United States has not yet experienced such an attack. Yet, animal and plant health officials in Washington admit that in most countries, including the United States, the initial impetus is to automatically assume that disease outbreaks are acts of nature.[36] Therefore there is almost no investigation as to whether or not the pathogen could have been intentionally introduced.

The history of this form of terrorism is perhaps longer than originally thought. As early as World War I, the Germans secret service initiated a secret program using glanders and anthrax to infect The Allies' horses and mules to be used for the war effort.[37] During World War II Great Britain produced 5 million "cattle cakes," cow snacks laced with anthrax. The cakes were to be used in Germany, but were later destroyed.[38] In another incident in Kenya in 1952, the Mau Mau, a national liberation movement, poisoned 33 steers at a British mission station using a local toxic plant.[39] In Alabama in 1970, a local veterinarian identified cyanide along the rocks in a stream of a 1,000-acre farm operated by a group of Black Muslims. The poisoning of the water supply resulted in the death of 30 cows. The Klu Klux Klan was suspected of being responsible.[40] In the war between Afghanistan and the Soviet Union, Ken Alibek, First Deputy Chief of Biopreparat alleges that the Soviet Union attacked the Afghan mujaheddin with glanders on a least one occasion. He claims that a senior Soviet military officer informed him of this. According to Alibeck, a glanders attack would have the dual effect of sickening the mujaheddin and killing their horses, their main mode of transportation.[41] These are but a few of the examples of agro-terrorism targeting livestock known to the Center for Nonprolif-

eration Studies. Many more include attacks on crops, an issue that is beyond the scope of this paper.

Anthrax and livestock. The Sverdlovsk outbreak highlights the potential for anthrax to cause disease simultaneously in livestock and humans. Terrorists might attempt to perform practice runs on large cattle feed lots, for example, before a more aggressive attempt such as on a city or large sports stadiums. A large attack (by small plane delivery) against a cattle feed lot would most likely go unnoticed and result in the deaths of many animals. In addition, other human populations in nearby areas could also be affected. Responders to the incident would have a high risk of infection as well. Terrorists would be able to test the lethality of their anthrax preparation with a relatively small probability of detection in a rural, perhaps sparsely populated area. The result of such an attack would be extreme fear. Many consumers and perhaps importers might erroneously conclude that the contaminated meat would be available for consumption.

It is highly unlikely that anthrax-infected livestock and thus anthrax-contaminated meat will get to the consumer for two reasons: federal regulations for livestock slaughtering and meat processing, and nature of anthrax disease which is characterized by rapid death after the initial onset of symptoms. However, misperceptions of meat safety and fear of tainted meat, even if unwarranted, could adversely affect consumer purchasing of beef and perhaps result in a ban on beef exports. Clearly the economic implications would be severe.

Federal Regulations. Federal regulation of livestock slaughtering and meat processing should be sufficient to keep the meat from anthrax-infected livestock off America's tables. The United States Department of Agriculture (USDA) has a comprehensive

meat inspection program that results in the meat that Americans consume being some of the safest in the world. The USDA Federal Meat Inspection Act outlines clear guidance to ensure the safety of meat in the United States. First, the regulation specifies that all cattle, swine, goats, horses, mules and other equines are to be inspected before they are allowed into any facility where they will be slaughtered. Any showing symptoms of disease are set aside for reexamination and inspection to see if they comply with the rules and regulations. Secondly, the carcasses are examined after slaughter. Those that pass inspection are labeled as "Inspected and passed." While those that do not pass inspection are to be destroyed on the premises in the presence of an inspector. In addition, any carcasses brought into an establishment are also subject to inspection in the same manner outlined above. The inspector reserves the right to deny entry of the carcasses on the premises if introduction of them does not comply with the intention of the Federal Meat Inspection Act.[42] These provisions would keep meat from a carcass of an animal killed by anthrax or a slaughtered sick animal from entering the food supply.

There is a small possibility that anthrax tainted meat could be available for consumption, but this would be on a very small scale. A case that illustrates this is the case of the Minnesota family that contracted gastrointestinal anthrax after consuming meat from their own infected cow. The meat was processed at a custom meat processing plant. Regarding this case, the Federal Meat Inspection Act does "not apply to the slaughtering by any person of animals of his own raising, and the preparation by him and transportation in commerce of the carcasses, parts thereof, meat and meat food products of such animals exclusively for use by him and member of his household and his nonpaying guests and employees."[43] Also, in the same manner, neither does it apply to the custom preparation

by any person, firm, or corporation of this meat that is destined for personal consumption.[44] Therefore, the case in Minnesota was a rare instance. Anthrax-contaminated meat would normally only arrive at the livestock owners' table.

How prepared are we to meet an agro-terrorism threat? The USDA has primary responsibility to oversee United States agriculture. In the aftermath of the terrible events of 11 September 2001, federal and state leaders demonstrated renewed attention to food security. Since September 2001, over $20 billion has been proposed by Congress to enhance bio-security readiness.[45] In addition, over $519 million has been appropriated for the USDA. The money was proposed to support several USDA efforts as part of increased homeland security including increased security of USDA facilities; construction of a facility at the Ames, Iowa USDA laboratory to support research; technical assistance to state, local, federal and private sector to improve bio-security; and overall strengthening of response measures to bio-security threats.[464748] It is good to see Washington's recognition that food and agriculture security is intimately and inseparably linked to national security.

State Programs. In the aftermath of 11 September 2001 state departments of agriculture rushed to ensure that they were able to meet an attack on their agricultural industries. After the devastating outbreak of foot and mouth disease in the United Kingdom, many states had already taken a heard look at their animal disease response plans. Texas was among them. Texas Agricultural Commissioner, Susan Combs, formed the Texas Border Food Security Coalition, a group of producers, and various agricultural associations dedicated to maintaining the best and safest food supply in the world. In addition, the agriculture department provided a checklist and resource list for producers in the

event of an unusual agricultural incident.[49] Nebraska's department of agriculture provided similar guidelines including a comprehensive listing of procedures to follow in the event that a highly contagious animal disease was confirmed in the United States[50]

The United States has arguably the safest food supply in the world. The foot and mouth disease outbreak in the United Kingdom forced federal and state agencies took a hard look at the safety of the agricultural sector. The terrorist attacks of 11 September 2001 further solidified their activity in ensuring a safe food supply for the American people. Although nothing is ever completely secure, the USDA along with state agencies, have taken prudent and reasonable precautions to ensure the safety of America's agriculture and food supply.

Food attacks

Historical context. Intentional food contamination with microorganisms is rarely reported in scientific literature. Surprisingly, the United States estimated costs associated with human bacteria food-borne illness are $2.9 to $6.7 billion a year annually.[51] Some incidents do stand out for their impact. In Japan during the mid-1960s, several outbreaks of typhoid fever and dysentery were traced to deliberate food contamination by a research bacteriologist. He later infected family members and neighbors.[52] In 1970, four Canadian university students became ill after eating food intentionally contaminated with embryonated *Ascarcis suum* ova, a large roundworm of pigs.[53]

Two recent incidents demonstrate the issues associated with intentional food contamination. The first mentioned earlier is a large outbreak of Salmonellosis caused by intentional contamination of restaurant salad bars in Oregon. In September to October 1984 a total of 751 people became sick from eating or working at area restaurants. The

conclusion was that the outbreak was caused by the intentional contamination of restaurant salad bars by members of a religious commune. The bacteria strain isolated in laboratory tests was the exact strain, *S. Typhimurium*, found at the commune.[54]

Most cases were associated with ten restaurants and the suspect food items on the salad bars differed from one restaurant to another. The cases were brought to light in many instances through the use of the media to encourage patients and health care professionals to report cases; laboratory analysis confirmed cases. In addition, local health department officials and the USDA investigated the original suppliers and distributors of the food. Health department officials inspected all the restaurants where outbreaks occurred, looking for food handling practices that promoted pathogen growth, as well as testing for the pathogen itself. Investigators also conducted interviews of managers to learn of potentially disgruntled employees. Though ill employees may have accidentally contributed to the contamination, they were not the source of it. Also, sanitation practices among the restaurants were deemed sufficient. The Oregon State Police, the sheriff's office and the Federal Bureau of Investigation (FBI) investigated suspicious events. Finally, during the outbreak 38 restaurants were affected by salad bar closings and investigations resulting in monetary losses to restaurants, employment losses, and a health-care burden.[55]

In the second incident from 29 October to 1 November 1996, 12 laboratory workers at a large medical center in Texas became sick after eating pastries anonymously left in their break room. The pastries were deliberately contaminated with *B. Shingella dysenteriae* type 2. The source was most likely the laboratory's own culture. Samples from infected patients matched samples taken from the pastries. Workers confirmed that an

anonymous e-mail was sent out inviting people to eat pastries in the break room. All 12 people who ate the pastries became sick. All were treated with antibiotics, except one who received homeopathic medication. No secondary transmission occurred, but one family member became sick from eating a muffin brought home. During the investigation the laboratory's store of *B. Shingella dysenteriae*, uncommon in the United States, had been disturbed. This incident highlights the need for increased security at laboratories where biological pathogens are stored. This particular laboratory later required a supervisor to open the freezer where the specimens were stored and labeled items with numbers, rather than names.[56]

Anthrax and the commercial table. Anthrax could be used as well to contaminate food items at the supermarket or the salad bar of your favorite restaurant. An ill-intentioned restaurant employee could easily spike food he was preparing with bacteria. A quick study of possible ideal food hosts for the bacteria could allow the terrorist to maximize the potential for the most casualties with little work. In addition, the terrorist might have a low probability of ever being caught. Other scenarios include the introduction of anthrax to food while it is being transported. Here again an employee could possibly taint large quantities of food with minimal risk. All these are low visibility operations that require a minimal degree of sophistication once the anthrax is in terrorist hands.

There exists as well the potential for malicious introduction of anthrax at food processing and packing plants. For example, the introduction of *B. anthracis* could take place through the heating, ventilation, and cooling system. This would allow for quick dispersal of the aerosolized pathogen. The bacteria would land on the equipment, packaging materials, and the food itself thus resulting in contamination. Although cooking the food

would kill the bacteria, the hazard would be greatest for food that does not need cooking or has already been pre-cooked. In addition to contaminating the food, many people would also be expected to get sick by breathing the aerosolized anthrax at the facility. However, in all these cases, it seems like the effect would be less about killing tremendous numbers of people, although the possibility does exist, but in undermining America's social, political and economic system.

FDA. The Food and Drug Administration (FDA) is responsible for safeguarding almost all food other than meat or poultry. Currently, 750 inspectors check 55,000 plants. By contrast, the USDA has 10 times as many inspectors for only 6,000 facilities. To address this, the FDA, hopes to hire 410 new inspectors, lab specialists and other personnel to check produce and other products. Currently these efforts are addressed at primarily imports since at the moment the FDA inspects just one percent of imports.[57]

In addition to the above measures, the FDA is expanding their food safety program that was developed nearly 30 years ago for astronauts. This system is called Hazard Analysis and Critical Control Points, or HACCP. The program involves scientifically based quantitative controls to prevent food-borne illness. The HACCP process involves following food from raw materials to finished product.[58] This comprehensive system offers substantial food safety and is gradually being applied to all foods.[59]

The USDA, FDA, and HACCP guidelines are indicative of the comprehensive food safety measures found throughout the United States. The result is some of the safest food in the world. Because of these strong controls, America's food supply presents a relatively well-hardened target for terrorists.

Notes

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Chapter 4

Conclusions and Recommendations

> *We have taken the appropriate steps to date to ensure the critical needs for USDA are met, however, we must remain vigilant in protecting our nation's food and agriculture.*
>
> —Agricultural Secretary Ann M.Veneman

National Security Includes Food Security

Agro-terrorism is a threat to the security of the United States. Although the use of anthrax against America's food supply either through attacks on livestock or direct assaults on food might cause relatively few casualties, an even mildly successful attack could disrupt our social, political and economic systems.

This study finds that the USDA, FDA, and state agriculture departments have adequate measures in place to mitigate the threat that anthrax poses to America's food supply. Although, no system is ever completely secure, the United States arguably has the safest food supply in the world. Tough regulations and thorough inspection procedures help ensure the safety of America's food. Initiatives like HACCP and enhanced response plans to unusual agricultural events (as a result of foot and mouth disease outbreak in the United Kingdom) help keep the United States as a worldwide leader in food safety. At this time these agencies could not justify increased budgetary expenditures to counter the threat of anthrax to food without significantly increased information from the intelligence community regarding this threat.

Out of many excellent proposals on the table to enhance the safety of America's food supply (see appendix B), one stands above the rest. Over the long term Dr. Peter Chalk, RAND analyst, recommends the consolidation of food and agricultural safety within a single federal agency that has budgetary and programmatic powers.[1] This agency would function over a broad spectrum of domains to help standardize food security, as well as reduce duplication of effort in response to an animal or food disease national emergency. Senator Richard Durbin (D-Ill.) has led a push in congress to consolidate the government food inspection system, now divided between the FDA and the USDA, in an effort to improve food security.[2] This would result in a United States coordinated effort to ensure the safety of America's food supply. Finally, a consideration for future research involves looking at this proposed umbrella food and agricultural safety agency, and food and agricultural security in general, as an integral part of Homeland Defense.

Anthrax Vaccinations

Vaccination of humans and livestock remains the only truly secure way to ensure protection from anthrax (see Appendix C). However, according to the CDC vaccinations in preparation for a bio-terrorism event are not recommended. Although groups have considered vaccination for such people as emergency first responders, medical practitioners, and private citizens in preparation for a terrorist attack, this is not deemed prudent. According to the CDC, "Recommendations should be based on a calculable risk assessment. At present, the target population for a bio-terrorist release of *B. anthracis* cannot be predetermined, and the risk exposure cannot be calculated."[3] Similarly, there is a need to carefully consider the consequences before expanding livestock vaccination programs beyond those already in force. The agro-terrorism threat from anthrax is not yet quanti-

fied. Further research may be necessary to see if the expense is justified based on the threat assessment.

The Bottomline: Prepare Now

Cynics may argue that perhaps potential terrorists will read this paper and therefore consider anthrax and the United States agricultural sector or food supply for their next attack. However, agro-terrorism has a long history and anthrax is one of the most weaponized pathogens. More importantly, the United States needs to be prepared to mitigate the damage from such an attack. In Dr. Chalk's words, "The US--more by luck than design--has not experienced a major agricultural or food-related disaster in recent memory. There has, as a result, been no real appreciation of either the consequences or threat potential of such an event taking place in this country."[4]

The increased national focus on securing America's food supply as part of Homeland Defense is right on target. As the war on terrorism continues, this area cannot be allowed to fall to the back burner. The United States agricultural and food sector is tremendously large and an attack on it could cause a devastating economic impact. Finally, the potential to instill fear in the American people through an attack on their food could make the fear of traveling that many Americans experienced after the 11 September 2001 terrorist attacks insignificant in comparison.

Notes

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Appendix A

Anthrax: A Primer

What is Anthrax?

Although anthrax is a word that is now familiar, particularly over the past months, because of the anthrax-tainted letters in the United States postal system, most people have only a vague idea of what it is. Anthrax is one of the most dreaded infectious diseases in history. The fifth and sixth plagues described in the Bible may have been outbreaks of anthrax in cattle and humans respectively. Also, the "Black Bane" that swept through Europe in the 1600s causing numerous deaths in humans and animals was probably anthrax.[1] Anthrax is a disease caused by the bacterium called *Bacillus anthracis.* The bacterium can produce sexually and asexually; in the latter case, anthrax can reemerge from dormancy by releasing spores that can lay dormant sometimes for years, wanting a susceptible host. Humans and animals become infected when then come in contact with the spores, through inhalation, ingestion, or skin contact. *B. anthracis* exists in infected animals and humans as a vegetative bacillus and in the environment as a spore. It is important to note that spores do not form in the infected host unless the body tissues are exposed to air. Anthrax spores can survive for decades and remain viable in even the most adverse conditions.[2] For example, "anthrax zones" in the United States., areas where the

soil is heavily contaminated with anthrax, closely follow the cattle drive trails of the 1800s.[3]

Anthrax is zoonotic, in that humans and non-human animals can be infected. Animals such as cattle, sheep, goats, and horses contact spores when they graze. Herbivores become infected, by inhaling or ingesting spores, when they forage for food. Humans, on the other hand, most commonly contract anthrax when the spores enter the body through minor skin lesions. This can take place when humans come in contact with infected animals, their hides, wool, or other contaminated products. Humans can also become infected from ingesting contaminated meat or from inhaling spores.[4]

Anthrax in Humans

Inhalational Anthrax. Although anthrax in humans has three clinical presentations, inhalational anthrax is the form of anthrax that presented itself from 4 October to 2 November 2001 by intentional release of *B. anthracis* spores through mailed letters in the United States postal system. This came as a great surprise since contact with infected animals or the various parts and by-products was part of the historical presentation.

In the early 1900s, human cases of inhalational anthrax where relegated primarily to workers in the textile and tanning industry. In the last part of the 20th century, the number of cases decreased dramatically with cleaner industrial practices and limitations on imported animal products. However, fatalities among those infected remained high at greater than 80 percent. Before October 2001, the last case of inhalation anthrax in the United States was reported in 1976. On 4 October 2001 a journalist in Florida became the first person in the United States diagnosed with inhalational anthrax associated with the purposeful release of the pathogen.[5]

Anthrax is among the most lethal agents on the planet. Inhalation anthrax results from breathing in only 8,000 to 50,000 spores of *B. anthracis*. Incubation periods are thought to range from one to 43 days. Antibiotics are effective against the germinating or vegetative *B. anthracis*, but do not kill the spores. Therefore the disease can be prevented if therapeutic levels of antibiotics are given to kill the germinating *B. anthracis* organism before it multiplies enough to sicken the host. If spores were formed and are sufficient in number after antibiotics are terminated, they may then grow and result in disease. This accounts for the delayed onset sometimes seen in inhalational anthrax cases.[6]

Initial symptoms of inhalational anthrax include sore throat, mild fever and muscle aches that may not be recognized as anthrax. The symptoms then progress after several days to severely difficult breathing and shock, and frequently meningitis. Death usually results even with aggressive treatment. Because of the high probability of death, inhalational anthrax is considered the most severe form of this disease.[7]

Inhalational anthrax occurring naturally is very rare. In the United States only 18 cases were reported from 1900 to 1978. Most of these occurred in high-risk groups including goat hair mill and goatskin workers, as well as wool and tannery workers. Only two of the cases were laboratory associated.[8]

Cutaneous Anthrax. Over 95 percent of anthrax cases are cutaneous. Infection normally occurs when *B. anthracis* enters the body through a cut or scrape o the skin. Historically these cases are associated with people handling infected animal products. The incubation period for cutaneous anthrax is from one half day to 12 days. Skin infection usually begins with a small bump, progresses to a vesicle in one to two days and erodes leaving a necrotic ulcer. The lesions are usually painless and may be accompa-

nied by swelling of nearby lymph glands, fever, malaise, and headache. Cutaneous anthrax is fatal in 20 percent of cases without treatment and less than one percent with antibiotic treatment.[9] Cutaneous anthrax, although the most common with an estimated 2,000 cases reported annually, it is the least fatal.[10]

Gastrointestinal Anthrax. The intestinal form of anthrax normally occurs after eating contaminated meat. However, evidence suggests that anthrax can grow in other food mediums as well.[11] In addition, it would be fair to say that "accidental ingestion" of the pathogen cannot be dismissed.[12]

Gastrointestinal anthrax is characterized by an acute inflammation of the intestinal tract. The incubation period of gastrointestinal anthrax is thought to be one to seven days. Symptoms may include oropharyngeal involvement seen as lesions at the base of tongue or nostrils, sore throat, fever, and local swelling of the lymph glands. Initial signs include nausea, loss of appetite, vomiting and fever. These are followed by abdominal pain, vomiting of blood, and bloody diarrhea. The fatality rate for gastrointestinal anthrax is not specifically known, but it is estimated between 25 and 60 percent.[13]

Anthrax in Livestock

Anthrax is a disease historically associated with livestock, especially herbivores who contact the spores when they graze. Anthrax disease is perpetuated through infected animals shedding the bacilli from hemorrhages or in blood at death. The vegetative form of the bacterium then generates spores that can remain viable in the soil for decades. Also, processed skins and hides can contain the spores and are a common means of the propagation of the disease globally.

Anthrax is a federally regulated disease; all suspected and confirmed cases must be reported and investigated. Federal regulations dictate quarantine procedures in outbreaks in order to prevent further infections. Because the anthrax spores can survive for years in the carcasses of dead animals if they are buried, the preferred method of disposal is incineration. Also, soil in the area should be decontaminated with quicklime. In no case should the animals be used for hair, wool, bone or hide processing.[14] In addition, the healthy animals should be removed from the affected pasture and the farm should be quarantined.

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[10] Inglesby.

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[12] Jernigan.

Notes

[13] *Use of Anthrax Vaccine in the United States: Recommendations of the Advisory Committee on Immunization Practices*.

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Appendix B

Future Recommendations

What the Experts Say

Dr. Peter Chalk, RAND analyst, makes several excellent recommendations to improve the overall effectiveness of the general agricultural and food response structure in the United States. First, more investment should be made in the human, physical and logistical infrastructure. Second, the overall veterinary science curriculum should be reformed to involve emphasis on large-scale husbandry and exotic disease recognition and treatment. Third, more attention needs to be given to involve local veterinarians with the USDA's overall emergency management system. Next, better coordination is required between U.S agriculture, criminal justice and intelligence groups. Additionally, a good national agricultural insurance plan to compensate farmers in the event of a major agricultural disaster is required. Finally, more effective bio-security, surveillance and response at food packing and processing centers, especially small ones, should be initiated.[1]

In addition, food security expert Doug Archer, PhD, recommends enhanced personnel security including background checks; knowing more about the transportation process of food and providing increased security; re-evaluating anti-tampering and HACCP plans; fine-tuning customer complaint practices and recall procedures; and improving readiness of all employees with training or drills.[2]

All these actions would put the United States in a better position regarding an agro-terrorism threat, whether it came from anthrax or other pathogens. All these measure will demand a substantial investment of time and money. One might expect the increased cost of food security to be passed on to the consumer.

Notes

[1] Chalk, Peter. *Terrorism, Infrastructure Protection and the US Food and Agricultural Sector: Testimony before the Subcommittee on Oversight of Government Management, Restructuring and the District of Columbia,* United States Senate, 10 October 2001,10-12.

[2] Archer, Doug and Fred H. Degnan. "Steps to Protect Against Threats of Food Terrorism." *Institute of Food Technologists,* 31 December 2001. On-line. Internet, 4 March 2002. Available from http://www.ift.org/press/releases/terrorism/shtml.

Appendix C

Anthrax: The Vaccine

Historical Context

Anthrax is a pathogen with a long history. *B anthracis* was not only the first bacteria to be proven to cause disease, but also the first against which a vaccine (bacterin is also correct, but vaccine is the more common term) was developed.[1] In fact Louis Pasteur created the first vaccine against it in 1881.[2] Today the United States military has a controversial anthrax vaccine program using the Anthrax Vaccine Absorbed (AVA), a product licensed by the FDA since 1970.[3] It is important to note that the vaccination program for humans requires six subcutaneous injections at zero, two, and four weeks; six, 12 and 18 months, and annually after that.[4] This regime is lengthy and costly for large numbers of people.

The decrease in naturally occurring cases is most likely due to the vaccination of high-risk personnel and livestock where anthrax is known to be endemic.[5] In 1945, for example, with no vaccination program, 1 million sheep died in an anthrax outbreak in Iran.[6] The largest human outbreak of anthrax, mostly cutaneous form, occurred in Zimbabwe from 1978 to 1980.[7] In this outbreak, over 9,700 people became infected and died.[8] Significantly, this outbreak was associated with a regional war in which such ser-

vices as animal vaccinations and medical care were defunct. This case underscores the importance of preventative measures to control human and animal anthrax disease.

Notes

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[2] *Ibid*, 19.

[3] *Ibid*,25.

[4] Zoon, Kathryn C. "Vaccines, Pharmaceutical Products, and Bioterrorism: Challenges for the United States Food and Drug Administration." *Emerging Infectious Diseases*. Vol. 5, no 4 (July-August 1999): 535

[5] Davis, 19.

[6] Inglesby, Thomas V.; et al. "Anthrax as a Biological Weapon." *JAMA*, Vol. 281, no. 18 (12 May1999), n.p. On-line. Internet, 29 October, 2001. Available from http://jama.ama-assn.org/issues/v281n18/ffull/jst80027.html.

[7] Hersack, Richard A. "The Anthrax Vaccine Debate: A Medical Review for Commanders." The Counterproliferation Papers Future Warfare Series No 10. Maxwell AFB, AL: Air War College.

[8] *Ibid*.

Glossary

APHIS	Animal Plant Health Inspection Service
AQI	Agricultural Quarantine Inspection
AU	Air University

bacterin. A suspension of killed or weakened bacteria used in a vaccine

CDC	Centers for Disease Control and Prevention
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
FMD	Foot and Mouth Disease
HACCP	Hazard Analysis and Critical Control Points
JAMA	Journal of American Medicine
MDH	Minnesota Department of Health
NAHEMS	National Animal Health Emergency Management System

spore A dormant non-reproductive body formed by certain bacteria in response to adverse environmental conditions.

USDA	United States Department of Agriculture

vaccine. A preparation of weakened of killed pathogen, such as a bacterium or virus, or a portion of a pathogen's structure that upon administration stimulates antibody production or cellular immunity against the pathogen but is incapable of causing severe infection.

vegetative. Of , relating to , or capable of growth.

zoonotic A disease that can be transmitted from animals to humans.

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