



Anthrax Threats Present Unique Challenges for Airline Crewmembers

Bioterrorist attacks in the United States in 2001 prompted hoaxes involving aircraft worldwide. Authorities say that pilots and flight attendants should know how to respond if suspicious substances are found in their aircraft.

—
Stanley R. Mohler, M.D.

Anthrax is a noncontagious bacterial infection, sometimes fatal, that results when *Bacillus anthracis* bacterial spores enter the body through a cut in the skin, inhalation or ingestion.

For centuries, the disease has occurred naturally among grazing animals, which are infected when they ingest *Bacillus anthracis* spores in the soil, and among humans who come into contact with infected animals or their meat, wool, hides or leather. The bacteria first were used in warfare during World War I in a German attempt to infect livestock and to contaminate animal feed that was to be delivered to Allied troops in Europe.¹ In succeeding years, several countries developed biological weapons programs involving anthrax. An April 1979 accident at a military microbiology facility in Sverdlovsk, 1,400 kilometers (869 miles) east of Moscow in the former Soviet Union, released anthrax spores into the air, infecting at least 79 people, of whom at least 66 died.² A terrorist group in Japan obtained anthrax bacteria that members released into the air in Tokyo in the early 1990s; no one was injured in that attack.

In October 2001 and November 2001, five people died in the United States after they contracted inhalational anthrax, which



authorities said was spread deliberately in the form of a white powdery substance containing bacteria that was inserted in envelopes and sent through the postal system. Thirteen other people who were diagnosed with inhalational anthrax or cutaneous anthrax (the form of the disease that occurs when a person is exposed to the bacteria through a cut, scratch or sore on the skin) recovered.³

In the weeks following the first anthrax death, there were numerous reports worldwide of white powdery substances on commercial aircraft. Discovery of the substances resulted in cancellation of flights, grounding of aircraft and short-term quarantines of airline passengers.^{4,5,6} In every instance involving aircraft, the substances tested negative for anthrax.

John Marshall, vice president of corporate safety and compliance for Delta Air Lines, said that the challenge facing the airlines was to educate their employees quickly about the nature of the anthrax threat and the appropriate response.

“The real issue is to prevent the hysteria that we saw at the beginning,” Marshall said. “Today, it’s handled ... in a very routine, purposeful manner. ... It really is an educational process more than anything else.”⁷

Anthrax Fatality Risks Vary

The most common form of anthrax is cutaneous anthrax, which occurs after the skin has come in contact with the meat, wool, hides or leather of anthrax-infected animals. About 95 percent of anthrax cases worldwide involve cutaneous anthrax.⁸ (From 1955 through 1999, 236 cases of anthrax — almost all of them cutaneous anthrax — were reported in the United States.⁹ From 1900 through 1978, 18 cases of inhalational anthrax were reported in the United States, most of them before hygienic measures were introduced in the 1960s in goat-hair mills and similar factory operations;¹⁰ before the 2001 attacks, the last case of inhalational anthrax was reported in 1976, when a home craftsman working with anthrax-infested imported yarn, contracted the disease and died.)¹¹

The first symptom, which can occur up to 12 days after exposure, is itching at the site of the infection — typically on the hand, the forearm or the face. Then a small bump (papule) appears, caused by the toxin produced by the bacteria. The bump develops into a small fluid-filled cyst (vesicle). Lymph nodes near the infection may swell, but the cyst itself is painless. The cyst disappears after several days, as a depression and a dark area develop in its place. Fluid again accumulates under the skin, and a secondary infection develops.¹² (Anthrax was named because of the dark sores, which resemble specks of coal; “anthrax” is the Greek word for coal.)¹³

If the infection is treated promptly — typically with antibiotics such as ciprofloxacin, penicillin or doxycycline — death is unlikely. If untreated, however, the infection may move into the bloodstream, causing blood poisoning (septicemia). The death rate from untreated cutaneous anthrax may be as high as 20 percent.¹⁴ People who have been exposed to anthrax spores but have not been diagnosed with inhalational anthrax also are treated with antibiotics to prevent development of the disease.

Inhalational anthrax (also known as respiratory anthrax or pulmonary anthrax) is the most deadly form of anthrax. The disease is caused when a person is exposed to a large number of anthrax bacterial spores in the air and inhales them; the number of spores that must be inhaled to cause infection is not known.

Symptoms initially may resemble an upper respiratory infection, with a fever, cough, mild discomfort in the chest and fatigue, but without nasal congestion. Symptoms generally appear between one day and seven days after inhalation of anthrax spores but may appear as long as 60 days afterward.¹⁵

Without prompt antibiotic treatment, the symptoms may progress to severe breathing difficulty, fever, shock and death; in some cases, meningitis (inflammation of the membranes around the brain and spinal cord) also develops. Even with appropriate treatment, death rates may be as high as 75 percent,

said the U.S. Centers for Disease Control and Prevention (CDC).¹⁶ In laboratory studies involving primates, death rates of 50 percent have been estimated after inhalation of between 2,500 spores and 55,000 spores of anthrax bacteria.¹⁷

Ingested anthrax (also known as gastrointestinal anthrax) typically develops after consumption of raw or undercooked meat that contains anthrax bacteria. Symptoms, which appear one day to seven days later, include severe abdominal pain, fever and blood poisoning. The fatality rate is between 25 percent and 60 percent. The effectiveness of early treatment with antibiotics has not been determined.¹⁸

Ingested anthrax also may involve the mouth and throat, or the abdominal area. If the mouth and throat are involved, symptoms may include lesions at the base of the tongue, a sore throat, dysphagia (a sensation that food is not moving normally from the throat to the stomach), fever and swollen lymph glands. If the abdominal area is involved, symptoms may include inflammation of the lower bowel, nausea, loss of appetite, vomiting, fever, pain in the abdomen, vomiting of blood and bloody diarrhea.

Diagnosis of all three forms of anthrax typically is made through blood tests or, in some cases of cutaneous anthrax, through tests of fluid from cysts.

All three antibiotics used to treat anthrax have side effects, including the following:

- Ciprofloxacin may cause vomiting, diarrhea, headaches, dizziness, sensitivity to sunlight and rashes. Rarer problems, experienced by less than 1 percent of patients, include hypertension (high blood pressure), blurred vision, and central nervous system ailments, such as confusion, tremors, hallucinations, depression and an increased risk of seizures — all of which may be more severe if the patient consumes caffeine or medications containing theophylline (sometimes prescribed for asthma). Allergic reactions may include difficulty breathing; swelling of the lips, tongue or face; closing of the throat; and hives. Rare side effects include ruptured tendons and inflammation of the colon;
- Penicillin may cause gastrointestinal upset, diarrhea, anaphylaxis (a potentially life-threatening allergic reaction in which the airways in the lungs constrict; blood vessels may dilate, causing blood pressure to drop; and the person may go into shock). Rare side effects include brain damage and kidney damage; and,
- Doxycycline may cause gastrointestinal upset, sensitivity to sunlight, sore mouth or sore throat, vaginal yeast infection and itching of the mouth. Less common side effects include anaphylaxis, blood problems with symptoms of unusual bleeding or bruising, liver damage and irritation of the esophagus.

After diagnosis of the first of the U.S. anthrax cases in fall 2001, the CDC warned people against buying and storing antibiotics for use in the event of exposure to anthrax bacteria, other biological weapons or chemical weapons.

“CDC does not recommend using antibiotics unless a specific disease has been identified,” the agency said. “There are several different agents that could be used for bioterrorism, such as bacteria, viruses and toxins. Not a single antibiotic (or vaccine) works for all of these agents. Antibiotics only kill bacteria, not viruses or other agents that could also be used in a bioterrorist event.”¹⁹

Vaccine Not Recommended for Most People

A vaccine against anthrax has been developed but has not been tested thoroughly in human trials and therefore is not approved for general use.²⁰ Vaccinations are available, however, for people considered at high risk of anthrax infection, such as people who work with the bacteria in laboratories, some people who work with animal hides (or other products of potentially infected animals in parts of the world where natural outbreaks of anthrax occur) and some military personnel. Civilian aircraft crews typically are not among those designated to receive the vaccine.

The vaccine consists of three injections administered every two weeks, with additional injections at six months, 12 months and 18 months, followed by annual booster injections.²¹

U.S. officials said in December 2001 that they would offer the anthrax vaccine as an experimental treatment to thousands of people — most of them congressional staff members and postal workers — who may have been exposed to anthrax bacteria during the attacks. Those who were exposed had taken antibiotics, but some health specialists said that they were not convinced that the 60-day antibiotic treatment provided adequate protection against the disease. They said that the vaccine might help the body to overcome anthrax bacterial spores that remained in an individual’s lungs longer than 60 days.²²

The CDC said that 30 percent of those who receive the vaccine experience tenderness and redness at the injection site. Severe local reactions, which include extensive swelling of the forearm, are infrequent, and systemic reactions (reactions that involve other parts of the body) occur in less than 0.2 percent of those receiving the injections, CDC said.²³

The U.S. military administered anthrax immunizations during the Persian Gulf War in 1991. The military resumed vaccinations in 1998 as a preventive-medicine measure to decrease risks in the event of exposure during biological warfare. The first immunizations were administered to military personnel being deployed to Southwest Asia or the Korean peninsula, but the government planned to expand immunization

to all armed forces personnel, including members of reserve forces. Some personnel have objected, however, because of concern about the vaccine’s possible side effects.²⁴

Nevertheless, an article in the U.S. *Federal Air Surgeon’s Medical Bulletin* said that use of the anthrax vaccine by the armed forces “has unjustifiably concerned pilots.”²⁵

U.S. Federal Air Surgeon Jon Jordan, M.D., said, “Individuals who have been immunized with the anthrax vaccine are not disqualified from performing civilian airman duties, so long as they do not experience significant adverse side effects that would otherwise be considered disqualifying.”²⁶

As of Dec. 20, 2001, research was continuing on development of new anthrax vaccines.

Other Actions Recommended to Prevent Anthrax Exposure

Civil aviation authorities, airlines and pilots’ organizations have suggested other actions to prevent crewmember exposure to anthrax bacteria.

“In light of the recent media reports surrounding bioterrorism globally, it has become necessary to take note of possible biological threats and the precautionary steps to be taken,” said Ansa Jordaan, senior manager of aviation medicine for the South African Civil Aviation Authority. “These threats are very similar to bomb threats and cannot be ignored.

“Each aircraft owner or operator should have a readily available procedure in place to manage biological threats. The following information needs to be included: general precautions for managing suspicious substances, notification procedures and list of contact numbers.”²⁷

Katherine Andrus, assistant general counsel to the Air Transport Association, whose members are the principal U.S. airlines, said that in the immediate aftermath of the 2001 anthrax attacks, U.S. airlines responded to discoveries of white powders in accordance with existing company guidelines for dealing with discoveries of hazardous substances on aircraft.²⁸

In subsequent weeks, the ATA, the airlines, the CDC and law enforcement officials discussed how those guidelines might be tailored for more specific responses to threats involving anthrax or other biological agents on aircraft. The new guidelines, expected to be finalized and distributed to airline officials early in 2002, are “basically an adaptation of the CDC’s guidance generally” for the handling of anthrax threats in the workplace or at home, Andrus said.

That general guidance, issued Oct. 12, 2001, said that recipients of anthrax threat letters should not shake or empty suspicious envelopes or packages; should not try to clean up spilled

powder; should place suspicious envelopes or packages in containers to prevent leakage; and should cover spilled powders. The guidelines said that recipients then should leave the area, wash their hands and report the incident to authorities. As soon as possible, individuals who had contact with the substance should remove contaminated clothing and place it in a container that can be sealed and given to authorities for proper handling.²⁹

If anthrax is released in a public space, the CDC recommends turning off fans and ventilation units, leaving the area, keeping others away and notifying authorities.

Marshall said that Delta used CDC recommendations to develop a detailed checklist for use by crewmembers and other employees responding to discoveries of unidentified powders. Delta had reported about 10 such incidents on aircraft in the days following the first anthrax deaths. Analysis determined that the powders were not hazardous; they were identified as artificial sweetener, coffee creamer, aspirin or similar pain-relief medications, crushed peppermint and other harmless substances, Marshall said.³⁰

Delta also purchased the same type of emergency response kits used by law enforcement hazardous-materials response teams and made the kits available to the emergency personnel investigating suspicious powders found in its airplanes, he said.

The Air Line Pilots Association, International (ALPA) issued a security bulletin to its members on Nov. 13, 2001, recommending that pilots and other crewmembers take similar precautions to minimize the risks of anthrax exposure. (see “Guidelines for Responding to Suspicious Substances”).

“Vigilance, coupled with common sense, will assure safety and minimize unnecessary alarm,” ALPA said. “There are many white powdery substances in our workplaces. . . . If an unknown substance is found on a counter or floor in an area where [coffee] creamer, sugar or soap powder normally [is] found, such as serving trays or the galley floor, there is a good chance that there is no cause for concern.”³¹

Nevertheless, if the substance is a very fine, white or tan dusty powder found in a location where such a powder typically

Guidelines for Responding to Suspicious Substances

The Air Line Pilots Association, International (ALPA) issued guidelines to its members¹ for assessing substances to determine whether they might contain anthrax bacteria. Among the factors to be considered are:

- The appearance of the powder. Anthrax bacteria typically have been found in very fine, white or tan dusty powders with consistent textures;
- The location where the powder is found. If the powder appears in a location where a common powdery white substance is used, such as coffee creamer, sugar or soap powder, the substance probably is not anthrax; and,
- If the substance is associated with any verbal threat or written threat, the substance should be assumed to be harmful.

If, after an initial assessment, the substance is considered suspicious, the following actions should be taken:

- Cover the area where the substance was found;
- Turn off ventilation systems and air-conditioning systems to minimize airflow in the area. Leave the systems off until the substance has been tested and specialists have determined that turning on the systems would be safe;
- Isolate the contaminated area. Move passengers, if necessary;
- Do not smell, taste or touch the substance;

- If you have come in contact with the substance, wash thoroughly with soap and water. Secure in an airtight plastic bag any contaminated clothing;
- Do not try to clean the area. This should be done only by trained personnel using special procedures;
- If in flight, contact the company for further instructions;
- Immediately after exposure to the suspected material, visit a physician for testing; and,
- Ensure that the incident is reported to public-health authorities.

ALPA recommended other precautions, including:

- Storing gloves in the airplane for use by crewmembers;
- Storing mail in cargo compartments that do not share airflow with the cabin and sealing U.S. mail in airtight containers;
- Inspecting aircraft air-filtration systems for anthrax spores;
- Establishing procedures for notifying passengers, crewmembers and others who may have been exposed; and,
- Sealing cargo containers that could introduce infectious diseases into aircraft.♦

Note

1. Air Line Pilots Association, International (ALPA). *ALPA Security Task Force Bulletin*. Nov. 13, 2001.

would not be found, further evaluation is warranted, especially if the substance is associated with a threat, ALPA said.

The International Air Transport Association (IATA) was reviewing the issue of how to handle anthrax and other biological substances on aircraft, along with the Global Aviation Security Action Group, which includes security specialists from IATA, regional airline associations, the Airports Council International, Airbus, The Boeing Co. and the International Federation of Airline Pilots' Associations (IFALPA).³² IFALPA also was developing a policy on the matter.³³ Denis Chagnon, a spokesman for the International Civil Aviation Organization (ICAO), said that the issuance of specific guidelines on the handling of anthrax, "if deemed necessary, rests with individual contracting states of ICAO, in the same way that they might issue guidelines for the handling of anthrax in other public places."³⁴

Crewmembers should be aware not only of the symptoms of anthrax but also of the recommended response in the event that a suspicious powdery substance is discovered in an airplane. If they have accurate information, crewmembers can respond appropriately to unusual conditions and threats involving suspicious substances.♦

Notes

1. Christopher, George W.; Cieslak, Theodore J.; Palvin, Julie A.; Eitzen, Edward M. Jr. "Biological Warfare: A Historical Perspective." *JAMA* Volume 278 (Aug. 6, 1997): 412–417.
2. Meselson, Matthew, et al. "The Sverdlovsk Anthrax Outbreak of 1979." *Science* Volume 266 (Nov. 18, 1994): 1202–1208. Soviet officials initially said that the anthrax epidemic resulted from consumption of contaminated meat, but in 1992, Russian President Boris Yeltsin — who in 1979 had been the chief Communist Party official in the region including Sverdlovsk — said that the outbreak was caused by "our military developments." The authors said that the epidemic was the largest documented outbreak of inhalation anthrax in history. They said that the anthrax was released accidentally from a military microbiology facility in Sverdlovsk, a city with a population of 1.2 million, and spread by the wind. Most of the people who were infected lived in a narrow zone between the military facility and the city's southern boundary.
3. Associated Press. "Fliers on Sender of Spores Planned." *The Washington* (D.C., U.S.) *Post*, Dec. 14, 2001, A19.
4. Davis, Aaron; Feder, Barbara. "Airports on Alert After False Alarms; Teams Preparing to Counter Bioterrorism." *San Jose* (California, U.S.) *Mercury News*, Oct. 16, 2001, 13A.
5. South African Press Association. "Latex Glove, White Powder Negative." Oct. 26, 2001.

6. Adams, Lisa J. "Fear of Anthrax Grips Latin America." *AP Online*, Oct. 19, 2001.
7. Marshall, John. Telephone interview with Werfelman, Linda. Alexandria, Virginia, U.S. Jan. 14, 2002. Flight Safety Foundation, Alexandria, Virginia, U.S.
8. United Nations World Health Organization (WHO). *Fact Sheets: Anthrax*. <www.who.int/inf-fs/en/fact264.html> October 2001.
9. U.S. Centers for Disease Control and Prevention (CDC). *FAQ's About Anthrax*. <www.bt.cdc.gov/DocumentsApp/FAQAnthrax.asp> Dec. 7, 2001.
10. Inglesby, T., et al. "Anthrax as a Biological Weapon: Medical and Public Health Management." *Journal of the American Medical Association* Volume 281 (May 12, 1999): 1735–1745.
11. CDC. *FAQ's About Anthrax*.
12. Inglesby, T., et al. "Anthrax as a Biological Weapon: Medical and Public Health Management." *Journal of the American Medical Association* Volume 281 (May 12, 1999): 1735–1745.
13. WHO. *Guidance on Anthrax*. <www.who.int/emc/faqanthrax.html> Oct. 18, 2001.
14. CDC. *FAQ's About Anthrax*.
15. Ibid.
16. Ibid.
17. Inglesby et al.
18. CDC. "Update: Investigation of Anthrax Associated With Intentional Exposure and Interim Public Health Guidelines, October 2001." *Morbidity and Mortality Weekly Report* Oct. 19, 2001.
19. CDC. *FAQ's About Anthrax*.
20. WHO.
21. CDC. *FAQ's About Anthrax*.
22. Connolly, Ceci; Vedantam, Shankar. "U.S. Offers Anthrax Vaccine to Thousands." *The Washington Post*, Dec. 21, 2001, A1.
23. CDC. *FAQ's About Anthrax*.
24. Virtual Flight Surgeons. *Anthrax Vaccine: Facts vs. Fiction*. <www.aviationmedicine.com/anthrax.htm> Dec. 3, 2001.
25. Borrillo, Donato J. "Immunizations and Flying." *Federal Air Surgeon's Medical Bulletin* Volume 00-4 (Winter 2000).

26. Jordan, Jon L. Correspondence from Jordan, the U.S. federal air surgeon, to the U.S. Office of the Army Surgeon General, Oct. 14, 1999. <www.aviationmedicine.com/anthraxjordan.pdf>.
27. Jordaan, Ansa. "Management of anthrax and other bio-terrorism threats." *South African Civil Aviation Authority Safety Link* Volume 1(5): 8-10.
28. Andrus, Katherine. Telephone interview by Werfelman, Linda. Alexandria, Virginia, U.S. Jan. 10, 2002. Flight Safety Foundation, Alexandria, Virginia, U.S.
29. CDC. *CDC Health Advisory: How To Handle Anthrax and Other Biological Agent Threats*. <www.bt.cdc.gov/DocumentsApp/Anthrax/10122001Handle/10122001Handle.asp> Oct. 12, 2001. In *FAQ's About Anthrax*, the CDC said that public health agencies use a two-part process to determine whether the suspicious substance is anthrax. The initial screening test can be completed in as little as two hours; results of the second, more accurate, laboratory test typically are available after one day to three days.
30. Marshall.
31. Air Line Pilots Association, International (ALPA). *ALPA Security Task Force Bulletin*. Nov. 13, 2001.
32. Meyer, Herb. E-mail communications with Werfelman, Linda. Alexandria, Virginia, U.S. Jan. 6, 2002; Jan. 10, 2002. Flight Safety Foundation, Alexandria, Virginia, U.S.
33. Woodburn, Paul. Telephone interviews with Werfelman, Linda. Alexandria, Virginia, U.S. Jan. 7, 2002; Jan. 11, 2002. Flight Safety Foundation, Alexandria, Virginia, U.S.
34. Chagnon, Denis. E-mail communication with Werfelman, Linda. Alexandria, Virginia, U.S. Jan. 11, 2002. Flight Safety Foundation, Alexandria, Virginia, U.S.

About the Author

Stanley R. Mohler, M.D., is a professor, vice chairman and director of aerospace medicine at Wright State University School of Medicine in Dayton, Ohio, U.S.

Mohler, who holds an airline transport pilot certificate and a flight instructor certificate, was director of the U.S. Federal Aviation Agency's Civil Aviation Medicine Research Institute (now the U.S. Federal Aviation Administration's Civil Aerospace Medical Institute) for five years and chief of the Aeromedical Applications Division in Washington, D.C., U.S., for 13 years.

Mohler received the 1998 Cecil A. Brownlow Publication Award for journalism that enhances aviation-safety awareness.

Want more information about Flight Safety Foundation?

Contact Ann Hill, director, membership and development,
by e-mail: hill@flightsafety.org or by telephone: +1 (703) 739-6700, ext. 105.

Visit our World Wide Web site at <http://www.flightsafety.org>

We Encourage Reprints

Articles in this publication, in the interest of aviation safety, may be reprinted, in whole or in part, but may not be offered for sale, used commercially or distributed electronically on the Internet or on any other electronic media without the express written permission of Flight Safety Foundation's director of publications. All uses must credit Flight Safety Foundation, *Human Factors & Aviation Medicine*, the specific article(s) and the author(s). Please send two copies of the reprinted material to the director of publications. These reprint restrictions apply to all Flight Safety Foundation publications.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Human Factors & Aviation Medicine*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for material submitted. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.

Human Factors & Aviation Medicine

Copyright © 2002 by Flight Safety Foundation Inc. All rights reserved. ISSN 1057-5545

Suggestions and opinions expressed in FSF publications belong to the author(s) and are not necessarily endorsed by Flight Safety Foundation. Content is not intended to take the place of information in company policy handbooks and equipment manuals, or to supersede government regulations.

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and, Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

Subscriptions: One year subscription for six issues includes postage and handling: US\$240. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708