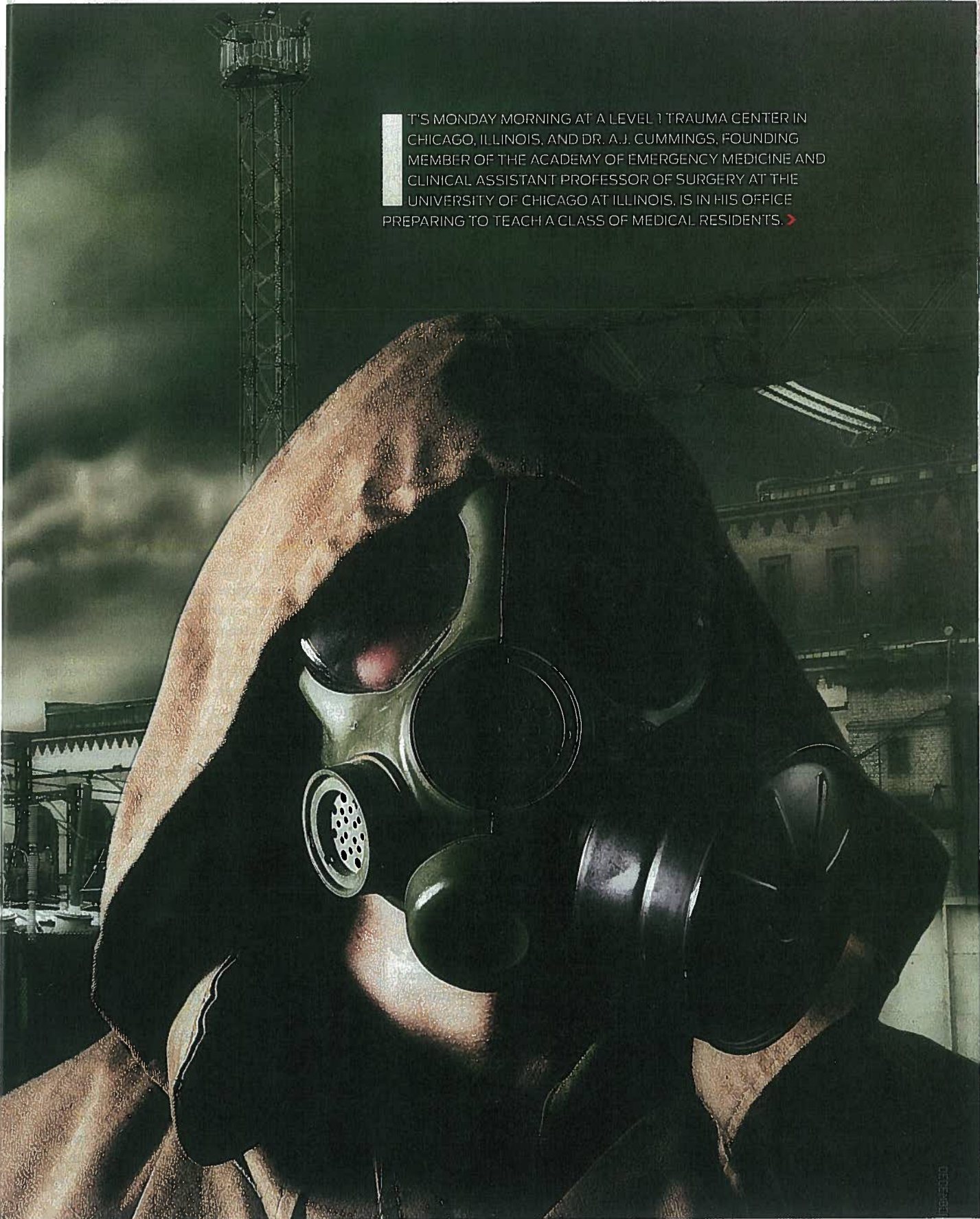




Invisible Weapons

**BACTERIA, BUGS AND BIOTERRORISM:
SURVIVING SOMETHING YOU CAN'T SEE**

Story by **Carrie Visintainer** | Photography Courtesy the Center for Disease Control and Prevention



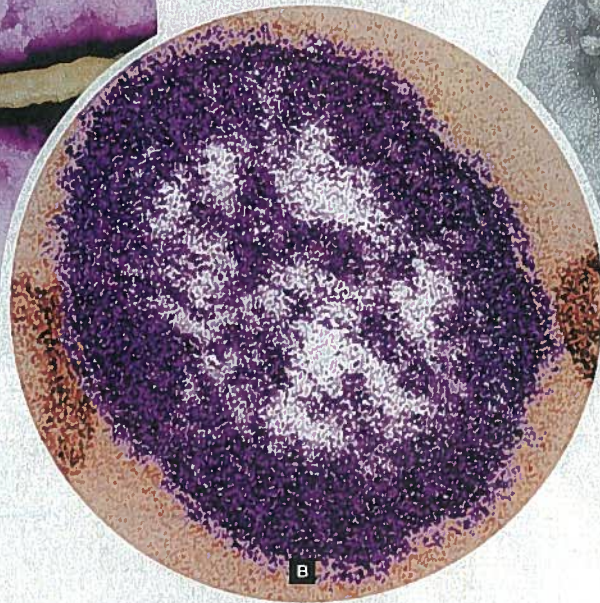
IT'S MONDAY MORNING AT A LEVEL 1 TRAUMA CENTER IN CHICAGO, ILLINOIS, AND DR. A.J. CUMMINGS, FOUNDING MEMBER OF THE ACADEMY OF EMERGENCY MEDICINE AND CLINICAL ASSISTANT PROFESSOR OF SURGERY AT THE UNIVERSITY OF CHICAGO AT ILLINOIS, IS IN HIS OFFICE PREPARING TO TEACH A CLASS OF MEDICAL RESIDENTS. >



A

A. The Ebola virus, shown here, has no known cure and there are no specific treatments available.

B. This thin-section transmission electron micrograph (TEM) reveals a single virus particle of measles virus. **C.** The Avian Influenza A H7N9 was first detected in China in March 2013 and took nearly a year to reach outside China. Reports of the disease have been increasing in 2014. **D.** This colorized scanning electron micrograph (SEM) depicts a colony of Salmonella, found in undercooked or raw meat and poultry products. **E.** This is the influenza virus particle that causes the common flu.



B



C

But just as he clicks open a file to look through a Power Point presentation, he receives an emergency alert from the hospital communications center. The announcement sends chills down his spine. A group of patients have arrived at the ER, and based on their symptoms—fever, chills, difficulty breathing, and nausea—are suspected of having inhaled the bacteria *Bacillus anthracis*: Anthrax.

Cumming's wheels begin turning. Bioterrorism, he thinks, a term that refers to the deliberate release of bacteria or viruses into the environment in order to cause mass illness and casualties; a response he admits comes automatically after 9/11.

Yet there are so many things unknown at the onset. Perhaps the exposure happened naturally. Maybe the patients somehow came into contact with infected cattle or goats and breathed in the rod-shaped bacteria spores? And what is the full scope of the situation? Are these the only people who have been exposed, or will others begin trickling or pouring into the ER as they begin to get sick?

As Cummings hustles down to meet his colleagues, he thinks about what he does know, based on his medical training. He understands that inhaled anthrax is the most serious form of anthrax infection, must be treated immediately upon diagnosis, and isn't contagious. He also knows that anthrax is a Category A biological agent, as described

by the Centers for Disease Control (CDC). Along with smallpox, tularemia, botulism, pneumonic plague, and the viral hemorrhagic fevers, anthrax is among the highest risk of being used as a bioweapon, based on its ability to be easily disseminated, cause public fear and panic, result in widespread illness and death, and ultimately cripple the infrastructure and economy of a society.

As a front line doctor, Cumming's job is to react effectively to immediate medical need. He and his team call up protocol and think through the cascade of events necessary to address the situation, including diagnostic lab testing, chest X-rays, CT scans, treating patients with appropriate antibiotics and antitoxin, and perhaps even paging extra personnel if large numbers of patients begin presenting with symptoms, such as if the spores have been released into the air by a plane or truck.

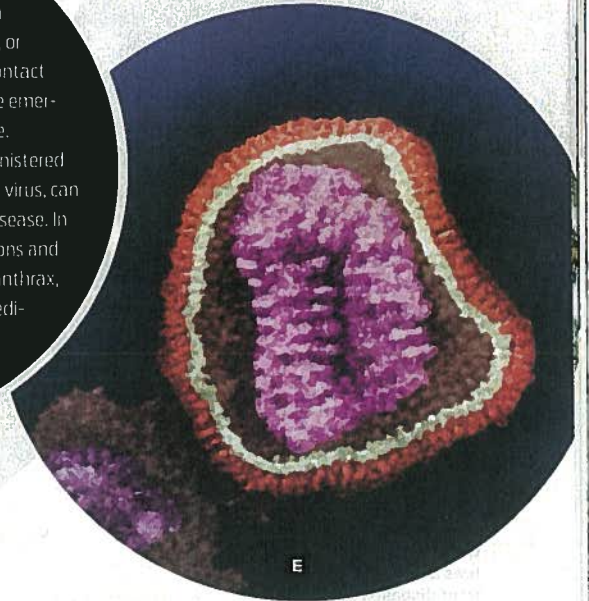
When Cummings and his group are finished, they sigh with relief. After all, this was only a test. A mandatory drill. A mock biohazard disaster. And although the medical personnel knew that this was a practice scenario from the start, including that the patients were volunteers, they felt anxiety and responded like it was a real-life situation, because training like this has everything to do with preparedness.

"Biological attacks may not happen with regularity, but there are huge efforts in plac

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Don't hesitate to seek medical help! If you believe you've been exposed to a biological agent or virus, or have been a victim of an attack, avoid contact with other people and head directly to the emergency room. This could save your life. For example, the smallpox vaccine, if administered within three days of exposure to the *variola* virus, can significantly decrease the severity of the disease. In addition, most biologically caused infections and diseases, including pulmonary (inhaled) anthrax, must be diagnosed and treated immediately for the best chances of a full recovery.



to be ready if they do. It takes vigilance to stay prepared," says Cummings.

After 9/11 and the anthrax attacks of 2001, the Bush administration and future leaders responded by, among other things, placing high priority on hospital preparedness, funding significant efforts to strengthen the U.S. healthcare system.

The All Hazards Preparedness program, including disaster drills like this one, is designed to arm medical centers with the ability to treat large numbers of people affected by anything from an act of bioterrorism to an H1N1 pandemic to a natural disaster like Hurricane Sandy.

This has meant buying more equipment, creating partnerships, termed healthcare coalitions, between neighboring hospitals, convening committees, and adopting protocols. Preparing for, in essence, the worst. And biological attacks are top of mind, because of their use throughout history.

The truth is that germs and warfare are old allies, causing the deaths of friends and foe alike for more than 2,000 years, long before the understanding of what germs were and how they were transmitted.

As far back as 450 B.C., Greek historian Herodotus described the Scythians archers, who ruled a vast region around present-day Iran using poison-tipped arrows. Skilled in guerrilla warfare, the Scythians concocted a mixture of decomposed bodies of venomous

snakes, human blood, and manure and allowed it to putrefy.

The dipped arrows contained the bacteria of gangrene and tetanus, while the snake venom would attack red blood cells and the nervous system, and could even induce a respiratory paralysis. In fact, we get our English word for toxin from the Greek word *toxikon*, which is derived from *toxon*, the Greek word for arrow.

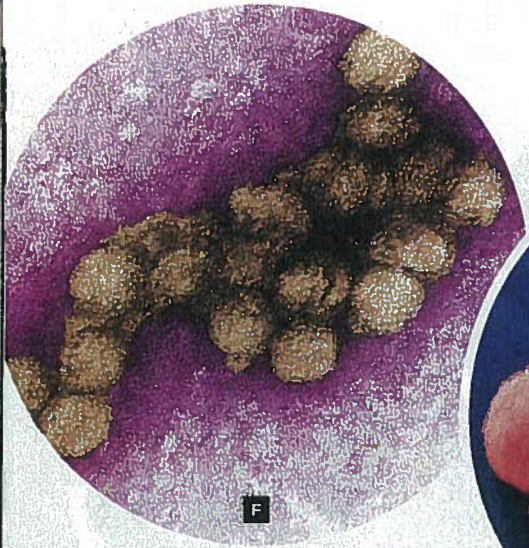
During the siege of the city-state of Athens by the Spartans in the Peloponnesian War, a devastating epidemic broke out, which killed thousands of Athenians. The famous historian Thucydides, writing between 431 B.C. and 404 B.C. reported, "it was supposed that Sparta poisoned the wells."

As well, it has been suggested recently that the "plague of Athens" during the Peloponnesian War was Ebola, most likely brought by the African Green Monkey. A common regimental pet of the African tribes, the Green Monkey is the host for the Marburg virus, a close relative of the Ebola virus.

Fast forward 1,000 years to the Tatars from the Russian steppes. In 1346, during a battle for Kaffa in the Ukraine, the Tartar army hurled dead bodies riddled with the bubonic plague over the walls of the enemy city. From there, Genoese traders returned to Italy, and by 1350, Europe was forever changed, precipitating with it the Dark Ages.

The first recorded "weaponized" biological agent in North America occurred during the

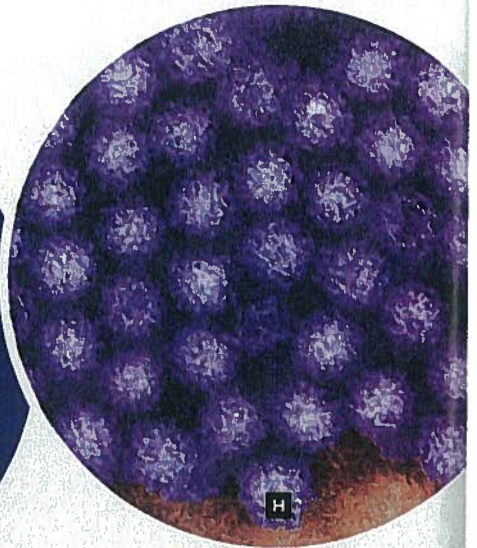
"THE TRUTH IS THAT GERMS AND WARFARE ARE OLD ALLIES, CAUSING THE DEATHS OF FRIENDS AND FOE ALIKE FOR MORE THAN 2,000 YEARS, LONG BEFORE THE UNDERSTANDING OF WHAT GERMS WERE AND HOW THEY WERE TRANSMITTED."



F



G



H

F. The West Nile virus is transmitted via mosquitoes and is in a similar family of diseases as Ebola. The first case in the United States was in 1999, and since, nearly 300 people have died from it in this country. **G.** This colorized scanning electron micrograph (SEM) reveals a small clustered group of Gram-positive, beta-hemolytic Group C *Streptococcus* sp. bacteria. **H.** This transmission electron micrograph (TEM) reveals norovirus virus, a virus that attacks the stomach and intestines. Each year, it causes 19-21 million illnesses, which leads to nearly 800 deaths in the United States. It is the most common foodborne disease in the U.S. **I.** This strain of *E. coli* is an emerging cause of foodborne illness. An estimated 73,000 cases of infection, and 61 deaths occur in the United States each year because of it. Infection can also occur after drinking raw milk, and after swimming in, or drinking sewage-contaminated water. **J.** Once this tuberculosis bacteria begins to multiply, if the immune system can't stop them from growing, the bacteria attack the body and destroy tissue. If in the lungs, the bacteria can actually create a hole in the lung tissue. **K.** This H5N1 viruses (seen in gold) is also known as the avian influenza A. It usually doesn't infect humans; however, several instances of human infections and outbreaks have been reported since 1997.

French and Indian Wars (1754 to 1767) and the agent was smallpox. The method of delivery was blankets, not bombs. Sir Jeffrey Amherst, who was the commander of British forces in North America formulated a plan to "reduce," as he so clinically expressed it, the size of the Native American tribes that were hostile to the crown.

In late spring 1763, there was an outbreak of smallpox in the garrison of Fort Pitt. This produced a bacterial delivery system that the medical world would now refer to as a "fomite," an inanimate object capable of naturally containing or transporting an infectious agent. Blankets and a handkerchief laden with the pus or dried scabs from the smallpox sores of the infected British troops were collected in Fort Pitt's infirmary. These blankets and handkerchiefs were usually burned. This time, they were saved.

On June 24, 1763, one of Amherst's subordinates, Captain Ecuyer, ceremoniously gave the blankets and one handkerchief to the Indians invited to confer at the Fort. Captain Ecuyer recorded rather chillingly in his diary, "I hope it will have the desired effect." This "gift" may have had its intended effect. Native American tribes in the Ohio Valley suffered a smallpox epidemic.

What is remarkable is the fact that science did not discover the germ theory and how diseases are transmitted until the late 1870s. With the work of Louis Pasteur (1822-1895) and Robert Koch (1843-1910) and the subsequent development of microbiology in the late 19th century, it was finally possible to isolate, produce, and weaponize biological

agents in a more formal way, opening the door to expand weapons of warfare into new and chilling territory.

The reason that this history is so important is that it tends to repeat itself. Here we are in the 21st century, with the government in constant surveillance for public health emergencies, including outbreaks, pandemics, and acts of bioterror.

When considering the face of the current biological threat, Dr. Amesh Adalja, an infectious disease physician at the University of Pittsburgh Medical Center who's interested in how national security and infectious disease intersect in natural or intentional ways, tends to focus on what has already happened successfully.

"Things that have worked in the past are most likely to be used again," he says. He and his team hold brainstorming sessions where they consider a whole range of possible bioterrorism scenarios—none of which he can share publicly, for privacy reasons—but ultimately, in planning for the future, they partly keep their eyes on the past.

Adalja emphasizes that the CDC's list of Category A agents and diseases are top concerns. In addition, he and his colleagues study agents, toxins, and diseases that might not be thought of as weapons of bioterror. For example, the bacteria salmonella, causes the illness Salmonellosis and is characterized by fever, abdominal cramps, and diarrhea, and sometimes requires hospitalization.

Salmonella is listed as a Category B agent by the CDC—rated moderate risk for ease of dissemination and potential illness. Adalja

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recalls an event of more recent history that had a significant public health effect: the Rajneeshee bioterror act of 1984, in which salad bars in 10 restaurants in Oregon were deliberately contaminated with salmonella by followers of Bhagwan Shree Rajneesh, sickening 751 people and hospitalizing 46. Because of acts like this, contamination of public food and water systems remain a top concern.

Adalja says there's also been an increase in the use of Ricin, another Category B agent, as a bioweapon over the last couple of years. Ricin is a poison found naturally in castor beans and can be made into a pellet, powder, or mist, has no antidote, and can cause death in infected patients depending on the dose and method of exposure. Although Adalja says Ricin has been historically used as more of an assassin's tool than a weapon of mass destruction—such as in 1978, when a Bulgarian journalist died after a man injected a ricin pellet under his skin using an umbrella—there have been recent threats of significance. For example, letters containing Ricin have been mailed to the President of the United States, a senator, and a judge, all within the last year.

Because of this, one means Adalja and his team focus on is the dissemination of pathogens through the postal service. The anthrax attacks of 2001, as well as the more recent Ricin poisoning attempts, have created ongoing surveillance and heightened awareness related to white powders in the mail. As a result, the postal service has protectors and a protocol in place at their facilities in case they come into a contact with a

letter than may contain biological material.

From a public health perspective, Adalja notes that biological agents or diseases used in acts of bioterrorism are some of the most complicated to understand, because unlike a bomb, or even chemical exposure, people don't always know if they've been infected right away. Many bacteria and viruses have a long incubation period, which means it can take a person up to 60 days to get sick from an agent like pulmonary anthrax, up to 12 days for the smallpox virus, and up to 10 days for foodborne botulism, making it difficult to immediately understand the scope of the situation, or how it was initiated.

In addition, Adalja emphasizes it's often it's often difficult to tell a natural event from an intentional one. "You always want it to be natural, because 'intentional' sets off a cascade of actions that have a lot of implications," he says. "Whereas a natural outbreak can be dealt with from a public health standpoint, a deliberate attack involves national defense and forensic issues that need to be addressed as well."

He notes that during the 1984 salmonella poisoning resulting from Oregon salad bars, the outbreak was originally investigated and thought to be natural, but was actually intentional. "It takes a very astute investigator to tease apart that kind of thing," he says. "Even during the anthrax attack in 2001, it was thought maybe it was a natural outbreak because the first victim had been out in the wilderness in North Carolina and might have come in contact with an animal that had died of anthrax."

Have a Plan

The CDC has the following emergency preparedness plans for all types of bio-hazards. This is tons of information, and it applies to all hazards versus exclusively bioterrorism. In the meantime, look into ways to:

- > Stock an emergency supply kit
 - > Create a family communication plan
 - > Stay informed
-



BIOTERRORISM AGENTS

There are thousands of diseases that affect millions of people throughout the world, and many of those diseases come from a handful of viruses and bacteria that are rarely seen in the United States. This makes them perfect candidates for agents of bioterrorism. They are classified by the CDC into three categories based on priority and severity.

Category A

The U.S. public health system and primary healthcare providers must be prepared to address various biological agents, including pathogens that are rarely seen in the United States. High-priority agents include organisms that pose a risk to national security because they:

- Can be easily disseminated or transmitted from person to person
- Result in high mortality rates and have the potential for major public health impact
- Might cause public panic and social disruption
- Require special action for public health preparedness.

Agents/Diseases

- Anthrax (*Bacillus anthracis*)
- Botulism (*Clostridium botulinum* toxin)
- Plague (*Yersinia pestis*)
- Smallpox (*variola major*)
- Tularemia (*Francisella tularensis*)
- Viral hemorrhagic fevers (filoviruses, e.g., Ebola; and arenaviruses, e.g., Lassa, Machupo)

Category B

Second highest priority agents include those that:

- Are moderately easy to disseminate
- Result in moderate morbidity rates and low mortality rates
- Require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance.

Agents/Diseases

- Brucellosis (*Brucella* species)
- Epsilon toxin of *Clostridium perfringens*
- Food safety threats (e.g., *Salmonella* species, *Escherichia coli* O157:H7, *Shigella*)
- Glanders (*Burkholderia mallei*)
- Melioidosis (*Burkholderia pseudomallei*)
- Psittacosis

Chlamydia psittaci

- Q fever (*Coxiella burnetii*)
- Ricin toxin from *Ricinus communis* (castor beans)
- Staphylococcal enterotoxin B
- Typhus fever (*Rickettsia prowazekii*)
- Viral encephalitis (alphaviruses [e.g., Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis])
- Water safety threats (e.g., *Vibrio cholerae*, *Cryptosporidium parvum*)

Category C

Third highest priority agents include emerging pathogens that could be engineered for mass dissemination in the future because of:

Availability

- Ease of production and dissemination
- Potential for high morbidity and mortality rates and major health impact.

Agents

- Emerging infectious diseases such as Nipah virus and hantavirus

As far as who is most likely to initiate an act of bioterrorism, Adalja divides the threat into two categories: state and non-state actors. State actors refer to a group of people working as part of a program that's run by a government, such as the former Soviet Union's offensive program, where they were preparing to make bombs and devices to disseminate biological weapons in a war setting. And then there are non-state actors, such as the terrorists responsible for 9/11 or the successive anthrax attacks; individuals leading an initiative on their own or as part of a non-governmental group.

Adalja believes the current risk rests primarily with non-state actors, which is conditioned, in part, by the fact that the independently initiated anthrax attack was successful using the mail, and also by the fact that there would be significant negative world pressure put on a government program using biological warfare today. Although suspect still exists, this pressure discourages the use of this method.

And although critics say this isn't accurate—that biological weapons aren't practical or reliable and are not a realistic choice for a low-budget terrorist group or individual—Adalja agrees this is a legitimate argument, but he disagrees.

"You do need tacit experience to do some of this work" he says, noting the concept of dual use research, which refers, for example, to a person who's a microbiologist by day and terrorist by night, such as the infamous Dr. Germ and Chemical Sally, who were both legitimate microbiologists working in the weapons program for the Iraqi government.

But formal training in microbiology isn't necessary required. "People do rudimentary experiments that can be useful in this context," he says. "Like making Ricin in their garages from castor oil." He notes that people can find cultures of biological agents in nature without a lot of effort, so if a person has some

basic knowledge, they may be able to make good effort at creating a biological weapon.

"Although synthesizing a virus is not necessarily accessible to the everyday person, there are other things that could be constructed from simple sources that don't require a degree in microbiology," he says.

As a result, federal, state, and local governmental agencies are preparing on an ongoing basis for an act of bioterrorism, as well as natural outbreaks and pandemics, focusing on the entire spectrum between prevention and treatment. There exists everything from comprehensive information on the CDC website about various pathogens to specific emergency response programs to research into vaccines and medicines that might be useful in treating diseases.

Many of these efforts intertwine, resulting in partnership projects. For example, at Colorado State University, the federal Department of Health and Human Services is partially funding a project between university researchers and a pharmaceutical company to investigate whether an experimental drug therapy may be used to effectively to treat *Burkholderia pseudomallei*, the highly infectious bacteria that causes melioidosis, a Category B agent of emerging concern.

So, how can individuals prepare for an act of bioterrorism, or even a natural outbreak? Is it possible to escape? Jim Cobb, owner of Disaster Prep Consultants and the author of *Countdown to Preparedness: The Prepper's 52 Week Course to Total Disaster Readiness* believes that preparedness, above all, begins with lifestyle. In order to protect yourself and your family, he suggests the following steps:

Avoid being in a target area. Cobb emphasizes that in the case of bioterrorism, the perpetrators' goal is to infect a high concentration of people, and person-to-person contact is often a major factor in spreading the illness.

"If you have a choice to live in the middle of Chicago, or the middle of Idaho, choose the rural setting," he says. For those who are forced who live in an urban area, Cobb recommends getting out of the region as soon as an emergency is announced and isolating yourself and your family as best as you can.

You can sign up for public safety emergency alerts in your area at Ready.gov/alerts or register for e-mail alerts or RSS feeds from the CDC's Health Alert Network at <http://emergency.cdc.gov/HAN/>.

Hunker down. In your house or apartment, have a bag ready with things like gloves and N95 surgical masks, which are effective against most viruses and can be found at everyday hardware stores. In addition, wash hands frequently and stay clean. Before the emergency occurs (i.e. now), it's important to begin stockpiling food and water.

Cobb emphasizes that you don't need to "panic and spend \$5,000 on a pallet of freeze-dried food," but rather start by gathering enough food and water in your home to feed your family for seven days. Then shoot for 2 weeks. And then, build up to a month. Increase your supply slowly over time so that you are ready when the time comes. For a comprehensive list of what to include in your preparedness kit, visit the CDC All Hazards Preparedness link at <http://emergency.cdc.gov/preparedness/kit/disasters/>.

Think beyond the infection. In the event of a widespread attack, it may take time for officials to get a handle on the situation. This may mean that businesses have to shut down, including grocery stores. Cobb suggests that self-sufficient skills will go a long way toward sustaining yourself and your family in the following days, weeks, or month after societal shutdown. Things to explore for your family include:

Learning to garden: "No matter where you live, you can grow something," Cobb says. Container gardening works well in an urban situation, and larger plots are doable in a rural space.

Knowing how cook from scratch. Without processed and prepared foods from a grocery store or restaurant, it's important to know how to take food out of your garden and prepare it in a healthful way.

Investing in alternative energy. Solar panels and wind turbines have come a long way in a short period of time. Purchasing solar panels is relatively inexpensive and can provide much of your energy needs.

Empowering your children. Cobb has three young boys at home, and although they are as locked into the internet as many modern-age kids, he and his wife have been working on other skills, taking them camping, having them help out in the garden, teaching them how to cook; helping them understand what it means to be self-sufficient, so they can grow up with this important life skill. ■■■



BE INFORMED

- > Follow CDC Emergency on Twitter for updated information and preparedness chats. <https://twitter.com/CDCemergency>.
- > Sign up for public safety emergency alerts in your area at Ready.gov/alerts.
- > Follow CDC Emergency Preparedness and Response on Facebook at [Facebook.com/cdcemergency](https://www.facebook.com/cdcemergency).
- > Visit CDC Emergency and Preparedness at <http://emergency.cdc.gov> for comprehensive information on bioterrorism and other potential disasters.