PLANNING FOR THE UNTHINKABLE:

Preparation and Response in Public Health

02

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Thousands of public health professionals work to promote health and prevent disease and disability across the nation in every community every day. Although this guide primarily focuses on the federal public health response to terrorism and other public health emergencies, understanding how public health works at the local and state levels is critical to understanding how a public health response to an emergency event will take place in a given community.

The backbone of the nation's public health system is at the local (typically county, township, or city) level. Providing low-cost health care services in communities is what many people think of when they hear the term "public health," but those services are only a small fraction of public health activities. Public health also includes the following functions, many of which are relevant to a public health emergency:

- Preventing and controlling epidemics and the spread of disease
- Protecting against environmental hazards
- Preventing injuries and disabilities
- Promoting and encouraging healthy behaviors (e.g., exercise, good nutrition) and mental health
- Responding to disasters and assisting communities in recovery
- Assuring the quality and accessibility of health services
- Ensuring safe and effective medical products
- Ensuring the safety of food, blood, and biologics (vaccines) (Harrell & Baker 2004)

In a terrorist attack, epidemic, natural disaster, or major accident, state and federal public officials provide help, but local public health is in the forefront during the first critical minutes and hours after a major incident has occurred. In addition, even after federal assistance arrives, the public health response will be implemented and managed locally. For example, decisions about where a mass vaccination clinic should be held would be made by local health officials. While many health departments were preparing for handling a major incident in their communities before September 11, the tragic events of that day focused new attention and resources on emergency preparedness and response.

This guide does not go into detail about how local and state health departments will function in a public health emergency because every state and locality does things differently. Although all public health departments share similar functions and a philosophy about serving the public, the federal government does not mandate how state and local health departments are structured. All states have a state health department, but the exact services that are offered and how they are administered vary greatly across the country. For example, in South Carolina, the state agency is centralized and the state provides services in each of the state's 46 counties, whereas in Idaho, local public health districts are completely independent from the state health department.

These differences allow states and localities to focus specifically on the needs of their citizens in a way that makes sense for them. For example, the needs of people in New York City—a densely packed urban community where residents

DEFEATING DISEASES: THE CASES OF SMALLPOX AND POLIO

For many centuries, smallpox was a feared disease that killed many. In 1796, Edward Jenner conducted the first successful smallpox "vaccination" with cowpox virus, a virus related to smallpox. Through vaccination, particularly through the successful technique of "ring vaccination" (described later in this section), smallpox was controlled. Vaccine development techniques improved over the years and by the 1940s, a stable, freeze-dried vaccine was perfected and used throughout the world. The last case of smallpox in the United States was in 1949, and the last case in the world was in Somalia in 1977. In 1980, the disease was considered eradicated—the first time that mankind had successfully eliminated a disease.

Polio was one of the most feared childhood diseases of the early- to mid-20th century. The first polio outbreak occurred in 1916 and resulted in more than 27,000 reported cases and 7,000 deaths. The disease peaked in 1952, with about 60,000 new cases and 3,000 deaths. The polio epidemic effectively ended in 1955 with the introduction of the Salk vaccine. The incidence of polio decreased by 85–90 percent between 1955 and 1957. With the introduction of a second vaccine that had been developed by Albert Sabin, by 1962, the incidence of polio had declined by 95 percent and was effectively eradicated in the Americas.

UNDERSTANDING HOW PUBLIC HEALTH WORKS

at the local and state levels is critical to understanding how a public health response to an emergency event will take place in a given community.

speak scores of different languages—will vary greatly from the needs of people in a mostly rural state, like South Dakota. How these places structure their service delivery will be understandably different. Therefore, in order to understand how immediate response to an emergency will occur in a given community, one must know how the local health department functions in that area.

The main goal of the remainder of this section is to provide an overview of how federal government public health agencies would function in an emergency and, when applicable, how their actions would relate to those of state and local governments and to the private medical system. This section appears in the beginning of this guide to provide a framework and context that are critical to understanding the "big picture" as well as many of the programs and processes discussed later in this guide. For example, in order to understand how a smallpox attack could unfold, the "Biological Agents" section is a key resource, but it is also important to understand how a smallpox attack would be discovered, how it would be reported, how it might be contained, and how vaccines would be delivered to communities. These are the kinds of issues discussed in this section. Some of the specific topics covered here include:

- Syndromic surveillance systems
- The role of epidemiology
- Laboratory testing
- Information sharing in public health
- Strategic National Stockpile
- Vaccination strategies
- Isolation and quarantine
- National Disaster Medical System
- The threats of emerging infectious diseases and influenza pandemics

THE IMPACT OF PUBLIC HEALTH

During the 20th century, the lifespan of the average American increased by more than 30 years. Much of this increase can be attributed to improvements in public health. In 1999, the U.S. Department of Health and Human Services' (HHS) Centers for Disease Control and Prevention (CDC) compiled the following list of the 10 greatest public health achievements of the 20th century (not in order of importance):

- Vaccination—**Vaccine use assisted in the eradication of smallpox worldwide and the elimination of polio in the Americas**
- Motor-vehicle safety—**Engineering advances and changes in behaviors, such as the use of seatbelts and child safety seats, have reduced death and injury rates**
- Safer workplaces—**Changes have reduced injuries and deaths related to many industries, such as mining, manufacturing, and construction**
- Prevention and control of infectious diseases—**Improved sanitation has reduced cholera and typhoid, while the advent of antibiotics has helped to combat tuberculosis and other diseases**
- Decline in deaths from coronary heart disease and stroke—**Decreases in smoking and better blood pressure control have reduced death rates from coronary heart disease and stroke**
- Safer and healthier foods—**Decreases in food contamination and fortification of foods with nutrients to protect against rickets, goiters, and other diseases have resulted in fewer deaths and illnesses related to food and nutrition**
- Healthier mothers and their babies—**Better hygiene and nutrition, antibiotics, and technological advances have reduced death and illness**
- Family planning—**Access to family planning and contraceptives has resulted in fewer maternal and child deaths**
- Fluoridation of drinking water—**Addition of fluoride to water has resulted in less tooth decay**
- Recognition of tobacco use as a health hazard—**Understanding the risks of smoking has led many smokers to stop, which has reduced deaths from smoking**

ACRONYM LIST

You may find it helpful to refer to the following list of acronyms as you read this section.

ATSDR	Agency of Toxic Substances and Disease Registry
BSL	Biosafety Level
CDC	Centers for Disease Control and Prevention
DHS	U.S. Department of Homeland Security
Epi-X	Epidemic Intelligence Exchange
FBI	Federal Bureau of Investigation
HAN	Health Alert Network
HHS	U.S. Department of Health and Human Services
LRN	Laboratory Response Network
NDMS	National Disaster Medical System
NEDSS	National Electronic Disease Surveillance System
NIAID	National Institute of Allergy and Infectious Diseases
NIH	National Institutes of Health
RRR	Rapid Response Registry
SNS	Strategic National Stockpile; formerly NPS
WHO	World Health Organization

PUBLIC HEALTH RESPONSE TO TERRORISM

After the September 11 and anthrax attacks in 2001, strengthening the public health infrastructure, particularly in relation to terrorism, became a heightened national priority. In the past several years, HHS and the U.S. Department of Homeland Security (DHS) have substantially increased funding (primarily to local and state governments) to build capacity to prepare for and respond to future terrorism events and/or other potential public health emergencies (e.g., a SARS or major influenza epidemic).

The remainder of this section will be organized by three stages that are typical of any public health response to a health-related emergency, including one caused by terrorist activity:

- Detection
- Response
- Containment

DETECTION

It is likely that the initial recognition of a possible terrorism incident will be at the local level. Incidents may be:

- **Overt** or immediately obvious (e.g., a bomb, an envelope containing a suspicious powder along with a message saying the powder is a deadly substance)
- **Covert** or quietly conducted without an obvious beginning (e.g., transmitting a disease, like smallpox, to people without any distinct signals)

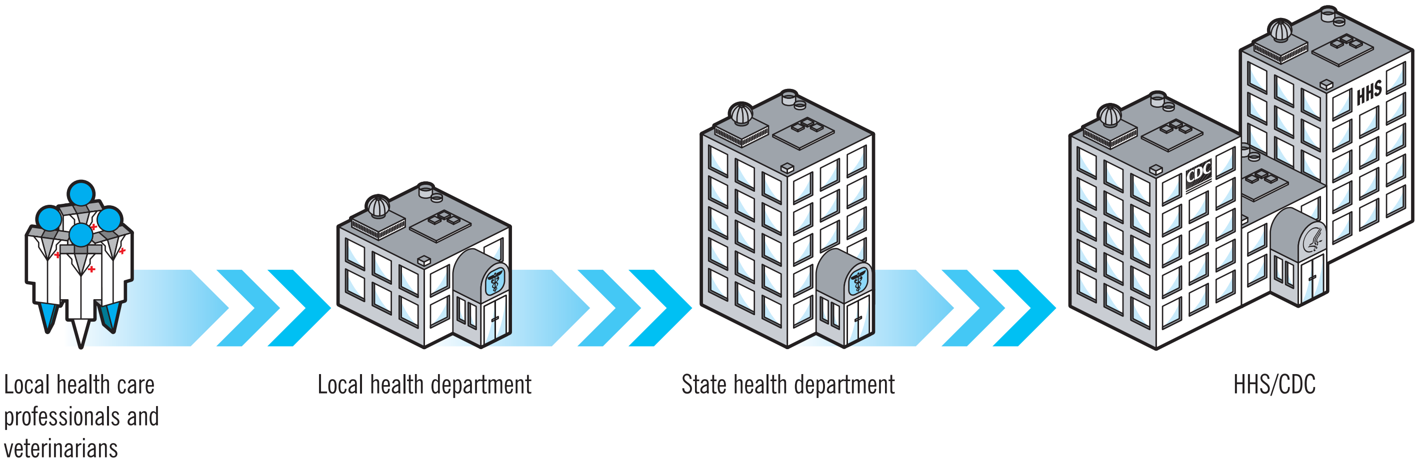
How each type of attack would unfold is quite different. An overt attack would be obvious and would immediately be responded to by local, state, and national law enforcement and public health officials. A covert attack would unfold more slowly and be harder to identify. It could be hours or days before officials would have any indication of the need for a response to such an attack.

Keeping Track of the Status of the Nation's Health

Domestic Systems

A covert attack is likely to be identified by the routine monitoring and analysis of data, called syndromic surveillance, on disease patterns and deaths that are performed in the public health and medical communities. As a result of concerns over the increased threat of terrorism and an increase in the use of electronic health information programs, health professionals can track and analyze data more easily and more quickly than ever before. The rapid availability of data increases the ability of public health officials to identify a large-scale terror attack in its early stages. For example, in late 2001, the New York City Department of Health and Mental Hygiene established a syndromic surveillance system to monitor

FIGURE 2–1: FLOW OF INFORMATION



emergency room visits. Symptoms, such as respiratory difficulties, fever, diarrhea, and vomiting, are tracked and information is transmitted electronically to the health department daily to be analyzed for unusual patterns that would warrant further investigation (Heffernan et al. 2004).

CDC and individual states have numerous surveillance policies and networks, some of which are fairly broad in scope and others which are focused on the tracking of specific diseases. Reporting at the local health department level is often electronic but is still done via paper forms in some places. Although data are entered into electronic systems, the transfer of the data is not always seamless or in real time. To address this issue, CDC is in the process of developing the National Electronic Disease Surveillance System (NEDSS) (http://www.cdc.gov/nedss/index.htm). NEDSS will create standards for the collection, management, transmission, analysis, access, and dissemination of data. The goal is to get data as close to real time as possible. Several pilot versions of NEDSS have been completed and are being used in some states, but the system is not yet fully operational.

CDC believes that NEDSS will offer significant improvements in the way public health surveillance is conducted at the local, state, and federal levels. The long-term vision for NEDSS is that of complementary Internet-based electronic information systems that:

- Gather health data automatically from a variety of sources on a real-time basis
- Facilitate the monitoring of the health of communities
- Assist in the ongoing analysis of trends and detection of emerging public health concerns
- Provide information for setting public policy

The data fed into the local systems are often the result of alert health care professionals. The following types of professionals may notice unusual disease patterns and deaths that will require further investigation:

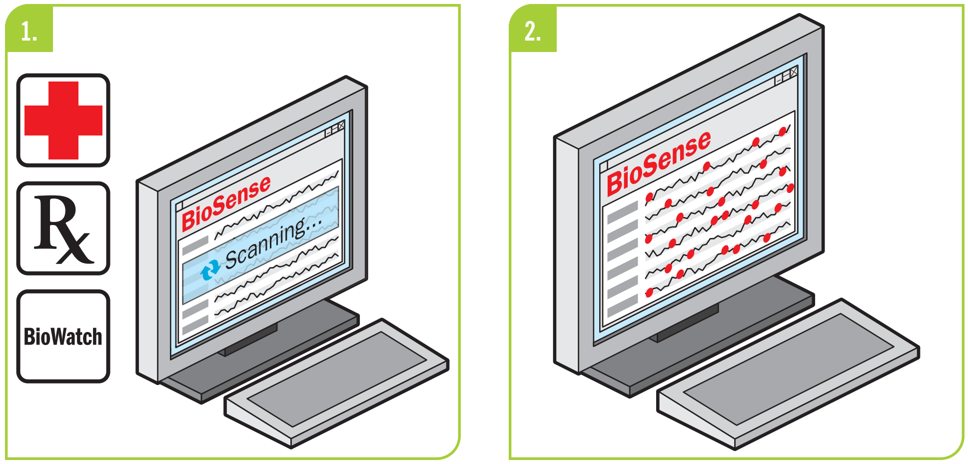
- Doctors, nurses, and others working in health care institutions and clinics
- Veterinarians and animal control personnel
- Medical examiners
- Pharmacists
- Laboratory scientists
- Epidemiologists

When health care professionals see atypical diseases, unusual patterns of diseases (e.g., large numbers of cases of disease not commonly seen in that part of the nation), larger than normal death rates from a disease, unusual rises or patterns in purchases of drugs, or uncommon test results, they contact local public health officials. These officials will start investigating and may contact state and federal officials, as well as law enforcement, depending on the situation. Figure 2–1 illustrates how information flows from individual health care professionals through the system to local, state, and federal officials.

For example, in August of 1999, an infectious disease specialist contacted the New York City Department of Health about two patients with encephalitis in Queens. Preliminary investigations at nearby hospitals identified six additional cases. After talking to the patients' families, it became clear that all of the patients had participated in outdoor activities around their homes in the evenings, such as gardening. Mosquito breeding sites and larvae were also found in their area. Medical professionals believed at first that the disease was St. Louis encephalitis. However, 4 weeks after the outbreak in humans, a flavivirus, later identified as West Nile virus, was isolated from specimens from crows and a flamingo nearby and was determined to be the source of the outbreak for both animals and humans. These were the first cases of West Nile virus ever seen in the Western Hemisphere (Nash et al. 2001).

Another example, with a different outcome, occurred in the winter of 2003 when a state medical examiner in Virginia noticed an unusual pattern of childhood (ages 2–7) deaths over a short time period from what appeared to be a flu-like illness in one region of the state. This observation prompted a full-scale investigation to quickly identify the exact cause of the deaths and determine if all of the children died of the same cause.

FIGURE 2–2: HOW BIOSENSE WORKS



1. BioSense scans data from hospitals, pharmacies, and BioWatch for:
- Common symptoms
- Increased medical visits
- Increased drug purchases

2. BioSense identifies clusters or patterns of suspicious activity that could signal a possible emergency.

In the end, health officials learned that the children had died of a variety of causes, including the flu, and although the deaths had occurred in a short timeframe, the total number of deaths was not unusual for a given flu season (Commonwealth of Virginia Department of Health 2003).

BioSense

Late in 2003, CDC began operating a high-tech bioterrorism detection program, known as BioSense. BioSense monitors and rapidly picks up on any possible health emergencies by constantly scanning medical information from hospital emergency rooms and pharmacies (http://www.syndromic.org/pdf/work3-JL-BioSense.pdf). BioSense also scans environmental data from Project BioWatch, which is described in detail in the "Environmental Safety and Testing" (see p. 135).

BioSense monitors enormous databases to find groups of common symptoms, such as fever, rash, diarrhea, and nausea. The system can assess whether there are any sudden increases in the number of visits to emergency rooms or whether there are sharp increases of prescription and over-the-counter medication purchases in any given location. By comparing these increases with the normal number of visits and medication purchases, analysts can determine whether there might be a cluster of symptoms or an unusual pattern of symptoms that could signal a terrorist attack or other unusual public health problem that could be brewing (e.g., SARS). Eventually, BioSense will expand to include information from ambulance dispatches, clinics, doctors' offices, school-based clinics, and worksites.

International Systems

In our modern world, where international travel is common and rapid, a disease can spread around the globe very quickly. On an international level, the World Health Organization (WHO) has developed and monitored International Health Regulations (with origins in the mid-19th century) to help prevent epidemics from spreading worldwide. The regulations are being revised to address bioterrorism as well as chemical and radiological threats.

In 1997, WHO established a mechanism to identify, verify, and respond to public health emergencies that may be of international concern, working closely with government agencies and other partners throughout the world. Reports of current outbreaks that are thought to have international significance are included in a weekly e-mail service that is distributed to public health professionals and partners worldwide. This information is also available to the public on the Internet at http://www.who.int/csr/don/en.

In 2000, WHO also created the Global Outbreak Alert and Response Network to help its member states better identify and manage outbreaks that are unintentional as well as intentional. The network is a collaboration of 120 international partners, including scientific institutions, laboratories, United Nations organizations, and humanitarian organizations as well as many others. The main goals of the network are to:

- Combat the international spread of outbreaks
- Ensure that appropriate technical assistance reaches affected areas rapidly
- Contribute to long-term epidemic preparedness and capacity building

In 2004, the Global Public Health Information Network, an electronic surveillance system developed and maintained by Health Canada for WHO, was expanded and enhanced. The system uses powerful search engines to actively trawl the World Wide Web looking for reports of communicable diseases in electronic discussion groups, on news wires, and elsewhere on the Web. The system also disseminates preliminary reports on public health threats on a "real-time, 24/7" basis. The Global Public Health Information Network now provides early warning in all official United Nations languages—Arabic, Chinese, English, French, Russian, and Spanish—allowing for speedier screening and sharing of information on both natural and manmade threats.

Additionally in 2004, WHO's Strategic Health Operations Center (SHOC) opened. SHOC features a communications system that allows the staff to closely monitor international public health response activities around the world. SHOC health experts, technical advisors, and logistics planners watch and assist their colleagues on the ground as they deal with crises ranging from SARS or Ebola outbreaks to tropical storms and tsunamis.

More information on the role of the WHO in international surveillance, preparedness, and response can be found at WHO's Communicable Disease Surveillance and Response program Web site (http://www.who.int/csr/en).

The Role of Epidemiology

This section provides an overview of the role of epidemiology, or disease investigation, in a public health emergency. The science of epidemiology is quite complex and epidemiologists often use highly technical language to explain their findings.

Epidemiologists at the local, state, and federal levels conduct investigations of suspected or confirmed disease or injury outbreaks. In some cases, an epidemiologist may even be the person who spots the outbreak by noticing unusual patterns for a disease in routine surveillance data (as described previously). Once a problem is identified through surveillance, epidemiologists will launch a more comprehensive investigation. Their findings are used to determine the source of an illness and make recommendations to guide public health intervention.

Steps for Investigating an Outbreak

Epidemiological investigations evolve through three phases: the preliminary phase, the analytic study phase, and the control and followup phase. Epidemiologists complete several steps within each of these phases to help them systematically collect information, test hypotheses, and communicate findings. Although these steps often occur simultaneously, they may be repeated as new information becomes available. The entire

A glossary of some commonly used epidemiology terms is included in appendix C of this guide as a reference.

“EPIDEMIOLOGY IS THE STUDY OF PATTERNS OF DISEASE:
who has the disease, how much disease they have, and why they have it.”

Daniel Wartenberg, “Epidemiology for Journalists”

investigation process is methodical but also needs to be rapid and responsive to stop the spread of the disease and treat those affected as soon as possible.

Preliminary Phase

- Work with lab data and disease tracking data to confirm the outbreak.
- Research the symptoms, causes, and routes of transmission of the disease.
- Assemble a multidisciplinary investigation team that includes experts in clinical medicine, environmental health, microbiology, behavioral science, and health education.
- Define what a case of the disease looks like so that cases can be accurately identified.
- Investigate medical records and conduct patient interviews to identify related cases.
- Summarize collected data by time, person, and place and tabulate.
- Take immediate control measures if an obvious source of illness is identified.

Analytic Study Phase

- Develop hypotheses about the cause of the outbreak, based on knowledge about the microbiology of a disease, background research, and patient interviews.
- Test hypotheses analytically with existing data.

Outbreak Control and Followup Phase

- Implement prevention and control measures to stop additional outbreaks by collaborating with government, industry, and health officials.
- Prepare health promotion messages for the public.
- Select a spokesperson to share health promotion messages with the media.
- Evaluate the short- and long-term effects of the investigation.
- Prepare a detailed summary of the investigation and recommendations for participants (FOCUS Workgroup 2003).

Interviewing and Contact Tracing

One of the key methods used to investigate an outbreak is the interviewing of patients. These interviews provide epidemiologists with some of the data needed to map the spread of an outbreak (i.e., where it came from and where it might be going). For example, by talking to patients, epidemiologists may learn that all of the patients attended the same event, which provides clues about how the outbreak started. Interviews may allow the epidemiologists to determine the index case (the first known case), which may be critical to determining the origin of the outbreak. Epidemiologists also use interviews to identify the close contacts of each patient (called contact tracing). Close contacts are those people who spend a lot of time in close, physical proximity to the patient (e.g., family members, office mates, significant others). In the case of a contagious disease, these people must be found and treated or isolated to prevent the spread of the illness.

THE BASIC STEPS OF AN OUTBREAK INVESTIGATION

1. **Verify the diagnosis and confirm the outbreak.**
2. **Define a case and search for cases.**
3. **Tabulate and orient data: time, place, person.**
4. **Take immediate control measures.**
5. **Formulate and test hypotheses for the cause of the outbreak.**
6. **Plan and execute additional studies, as needed.**
7. **Implement and evaluate control measures.**
8. **Communicate findings.**

Possible Indications of a Bioterrorism Event

Health professionals, including epidemiologists, will use the same methods to investigate a bioterror event that they would use to investigate any other outbreak. In many cases today, bioterrorism may be considered as the possible cause of an outbreak unless proven otherwise. In some cases, an attack may be suspected either because there is evidence of the agent (e.g., anthrax powder) or because of intelligence or claims of responsibility. In less obvious cases, there are also a few characteristics (see box on the right side of this page) that may indicate that an outbreak is intentional, particularly if several of these characteristics are true of the outbreak.

Even though these characteristics may point to bioterrorism, many of them may also be true in new and emerging naturally caused infectious diseases, like SARS or West Nile virus. Over the past 30 years, CDC has been involved in the discovery of many emerging naturally occurring infectious diseases that have the characteristics described here. For example, in 1993, there was an outbreak of Hantavirus Pulmonary Syndrome in the Southwestern United States. This severe pneumonia of unknown origin, which affected healthy adults, had never been seen in the United States before, which made the outbreak suspicious. Outbreaks of avian flu—bird flu not previously seen in humans—in China since 1997 are also examples of unusual but naturally occurring outbreaks. (More information on avian flu and animal diseases that may affect humans can be found at the end of this section.) Therefore, although the question of "Is it bioterrorism?" is likely to be asked in unusual situations, public officials will be careful not to prematurely assume that bioterrorism is the cause of an outbreak (Reynolds 2002).

RESPONSE

Laboratory Testing

Once a potential attack is identified, the public health response will immediately begin. Law enforcement, the Federal Bureau of Investigation (FBI), and local and state health and emergency officials will typically work together to determine if a suspicious outbreak is related to terrorism. Law enforcement and forensic scientists may actually begin work at any stage of the public health process, depending on the situation. If possible, the FBI will arrange for samples of the agent to be sent to a special laboratory for testing. It is likely that this lab would be a local or state lab that is a part of the national Laboratory Response Network (LRN), which is described in detail later in this section.

A positive result from an initial screening test, however, does not provide confirmation. Initial field testing (onsite) is considered presumptive, which means that additional tests must be performed to confirm the original test result (CDC 2004b). If a specific agent is suspected, tests may also be used that are specific to that agent (if any exist). For example, if anthrax is suspected, nasal swabbing may be done on people who were present in the environment where the suspected anthrax release took place. (However, it is important to note that nasal swabs are not used for diagnostic purposes; rather, they may provide information on whether a given environment has been contaminated. They do not indicate who will get anthrax illness.) If a chemical agent is suspected, blood or urine samples can be collected from people with suspected exposures.

CHARACTERISTICS OF OUTBREAKS THAT MAY INDICATE POSSIBLE BIOTERRORISM

- **A large number of cases appearing at the same time, particularly in a discrete population (e.g., people from the same town, people who attended the same event)**
- **A large number of cases of a rare disease or one considered a bioterrorism threat (e.g., plague, tularemia)**
- **More severe cases than typical for a given disease and/or an unusual route of exposure**
- **A disease that is unusual in a given place or is out of season (e.g., a flu outbreak in the summer in the United States)**
- **Multiple simultaneous outbreaks of the same disease or different diseases**
- **A disease that affects animals as well as humans**
- **Unusual disease strains or uncommon antibiotic resistance to an organism**

Although initial positive test results may begin the process of emergency and public health response (e.g., determining who may have been exposed, deciding who will need treatment), it can take up to a few days in some cases to confirm which agent is at work. Some of the time is needed to make sure that samples are collected properly and transported to labs with the ability to do the needed testing. More detailed information on diagnostic testing for specific biological agents can be found in the "Biological Agents" section (see p. 39).

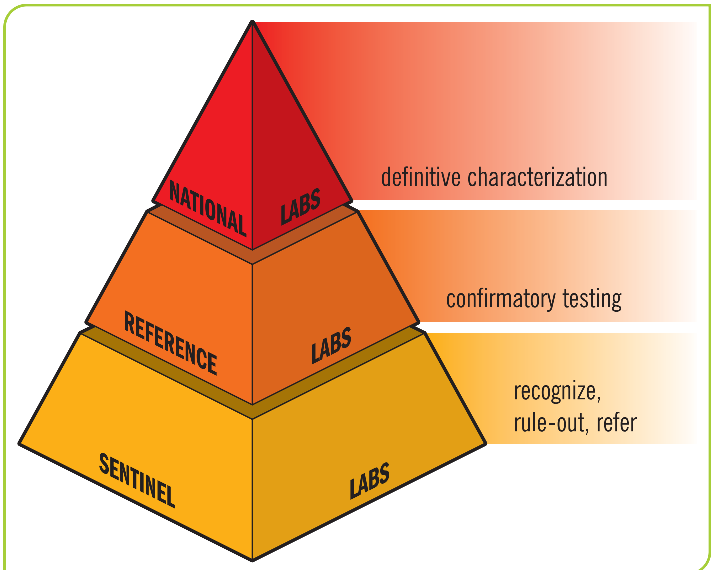
Laboratory Response Network

To make it easier for laboratories across the country to work together in the case of an act of terrorism or other public health emergency and to facilitate rapid identification of a bioterrorism agent, CDC, the Association of Public Health Laboratories (http://www.aphl.org), and the FBI formed the Laboratory Response Network (LRN) in 1999 (http://www.bt.cdc.gov/lrn/pdf/lrnfactsheet.pdf). The LRN currently has two major components: a well-developed network of public health laboratories dealing with biological agents and a newer network of public health laboratories dealing with chemical agents.

Bio-LRN

The Bio-LRN is a network of about 120 labs in all 50 states that include local, state, and federal public health labs as well as international, veterinary diagnostic, military, and other specialized labs that test environmental samples, animals, and food. The network is made up of three levels of labs that handle progressively more complex testing:

FIGURE 2–3: THE BIO-LRN



Source: Association of Public Health Laboratories. (2003). State public health laboratory bioterrorism capacity. *Public health laboratory issues in brief: Bioterrorism capacity*, 1–6. http://www.aphl.org/programs/emergency_preparedness/files/BT_Brief_2003--corrected.pdf.

Sentinel Labs

- Private and hospital labs that routinely process patient tests.
- May be the labs to first test and/or recognize a suspicious organism.
- Conduct tests to "rule out" less harmful organisms.
- Refer samples to a reference lab, if they cannot rule out that the sample is a bioterror agent.

Reference Labs

- Have specialized equipment and trained personnel.
- Perform tests to detect and confirm the presence of a bioterror agent.
- Are capable of producing conclusive, confirmatory results.
- Include local, state, and federal labs.

National Labs

- Include CDC, the U.S. Army Medical Research Institute for Infectious Diseases in Maryland, and the Naval Medical Research Center, also in Maryland.
- Perform highly specialized testing to identify specific disease strains and other characteristics of an investigated agent.
- Test certain highly infectious agents that require special handling.

The Bio-LRN has been involved in a number of major testing operations since it was established in 1999. In the 2001 anthrax attacks, Bio-LRN labs tested more than 125,000 samples by the time the investigation was completed. Bio-LRN labs are also involved in BioWatch, a program in selected American cities that uses air samplers to test for bioterrorism agents. (More information on BioWatch can be found in the "Environmental Safety and Testing" section [see p. 135].) Bio-LRN labs were also involved in developing tests and materials to support the DNA sequencing of the SARS virus, which was identified at the CDC (CDC 2004a).

Chem-LRN

The Chem-LRN is a network of 61 laboratories in all states and some territories and municipalities that test for chemical agents in human samples, such as urine or blood. The Chem-LRN member laboratories have three levels of activities. Each level builds on the activities of the preceding level.

- Every network member participates in Level 1 activities. These Level 1 laboratories work with hospitals in their jurisdiction and maintain competency in clinical specimen collection, storage, and shipment.
- Forty-one laboratories also participate in Level 2 activities, meaning that the laboratories are trained to detect exposure to a limited number of toxic chemical agents.
- Five laboratories participate in Level 3 activities. These laboratories are able to detect exposure to an expanded number of chemicals, including those analyzed by Level 2 laboratories, as well as analyses for mustard agents, nerve agents, and ricin.

Responding to an Event

- At the onset of an event, a state may request CDC's assistance. CDC may then deploy a Rapid Response Team to the affected state to assist with specimen collection, packaging, storage, and shipment.
- Representative samples from people who are suspected to be highly exposed, moderately exposed, and those thought to have low exposure are sent to CDC for analysis through the Rapid Toxic Screen, which can analyze people's blood or urine for a large number of chemical agents likely to be used by terrorists.
- Data produced from the Rapid Toxic Screen and the health implications associated with those exposures will be communicated in a secure, electronic manner to the affected state.
- Hospitals and laboratories may be dealing with many people concerned about exposure. There will be a need to respond to these concerns and determine whether an individual has been exposed and at what level. CDC will contact the appropriate LRN labs to help participate in the response.

Biosafety Level Classifications

All labs in the United States are rated according to a biosafety level (BSL) classification system. Levels range from 1 to 4. Biosafety levels are used to determine the types of agents scientists can work with in their labs. Scientists use a combination of critical principles, practices, and safety devices to work with infectious materials safely and effectively. Biosafety level classifications are designed not only to protect researchers and technicians from laboratory-acquired infection but also to prevent microorganisms from entering the environment. Many microorganisms may be studied at more than one level, depending on what kinds of activities are involved.

The four BSLs define proper laboratory techniques, safety equipment, and design, as described below:

BSL-1 LABS

These labs are used to study agents not known to consistently cause disease in healthy adults (e.g., *E. coli*). Researchers follow basic safety procedures and require no special equipment or design features.

BSL-2 LABS

These labs are used to study agents that pose a danger if accidentally inhaled, swallowed, or exposed to the skin (e.g., plague). However, diseases related to these agents can be treated through available antibiotics or prevented through immunization. Safety measures include the use of gloves, eyewear, and lab coats as well as hand washing sinks, methods of waste decontamination, and safety equipment.

BSL-3 LABS

These labs are used to study agents that can be transmitted through the air and cause potentially lethal infection (e.g., West Nile virus). Researchers perform lab manipulations in a gas-tight enclosure. Other safety features include personal protective equipment, clothing decontamination, sealed windows, and specialized ventilation systems.

BSL-4 LABS

These labs are used to study agents that pose a high risk of life-threatening disease for which no vaccine or therapy is available (e.g., Ebola). Lab personnel are required to wear full-body, air-supplied suits and to shower when exiting the facility. The labs incorporate all BSL-2 and BSL-3 features. In addition, BSL-4 laboratories are negative-pressure rooms that are completely sealed and isolated to prevent release of viable agents into the environment (National Institute of Allergy and Infectious Diseases 2004a; Richmond 2000).

All labs participating in the Bio-LRN are BSL-3 or BSL-4 labs.

SELECT AGENT PROGRAM

As a safeguard against the accidental or intentional exposure of dangerous agents outside of laboratories, CDC developed the Select Agent Program in 1996 to control the possession, packaging, labeling, and transport of certain agents that are capable of causing substantial harm to human health and safety. The program requires that facilities that work with such agents, including government agencies, universities, research institutions, and commercial entities, register with CDC. In addition to tracking and safeguarding the use of these agents, the Select Agent Program established systems for alerting authorities if unauthorized attempts are made to acquire these agents by terrorists or others. These requirements are outlined in the Select Agent Regulation, which was officially published in 2002. The regulation includes a list of dozens of agents to which it applies, including viral hemorrhagic fevers (like Ebola), smallpox, plague, ricin, anthrax, and avian flu. More detailed information on the Select Agent Program and the Select Agent Regulation can be obtained on the program's Web site (http://www.cdc.gov/od/sap/index.htm).

Expansion of the Current Laboratory System

The National Institute for Allergy and Infectious Diseases (NIAID), of HHS' National Institutes of Health (NIH), is funding extensive research on new and improved medical countermeasures—diagnostic tests, drugs, and vaccines to detect, treat, and prevent illness from potential agents of bioterror. Much of the research to develop medical countermeasures for potential agents of bioterror needs to be conducted in BSL-3 or BSL-4 laboratories. Many institutions and companies with infectious disease research programs have BSL-3 laboratories, but many are small, need modernization, or are dedicated to a specific use. There is currently a limited number of BSL-4 labs operating in the United States in the following locations:

- CDC in Atlanta, GA
- U.S. Army Medical Research Institute of Infectious Diseases at Fort Detrick, near Frederick, MD
- Southwest Foundation for Biomedical Research in San Antonio, TX
- University of Texas at Galveston, TX

NIAID is funding the construction of four new laboratories that will have BSL-2 to BSL-4 capabilities as well as the construction or renovation of some facilities with BSL-2 and BSL-3 capabilities. In addition to advancing research, these labs may also expand the LRN and/or supplement the current LRN labs in responding to a public health emergency. The four new laboratories include facilities at the following locations:

- NIH headquarters in Bethesda, MD
- NIAID at Fort Detrick, near Frederick, MD
- NIAID's Rocky Mountain Laboratories in Hamilton, MT
- University of Texas Medical Branch at Galveston, TX

More information on the new laboratories can be found on the NIAID Web site (http://www.niaid.nih.gov/factsheets/facility_construction.htm).

It should be noted that HHS is not funding research on bioweapons. Such research is prohibited by international law. To identify treatments and ways to prevent epidemics, however, scientists sometimes need to work with small quantities of the actual microbes or toxins in extremely well-controlled protected facilities.

HHS Support for Hospital Preparedness

To strengthen local response, in 2002, HHS' Health Resources and Services Administration started the National Bioterrorism Hospital Preparedness Program. The program is helping to improve hospital capabilities and surge capacity (the ability of a hospital to handle a large influx of patients at one time, often requiring specialized medical equipment and treatment), staff training, and the building of specialized facilities, such as decontamination areas.

To receive funding through the program, states must enter into cooperative agreements with the Health Resources and Services Administration, agreeing to use the funds for certain activities. In 2002, activities focused on needs assessments and planning for state agencies, hospitals, and other health care facilities, such as outpatient centers, emergency medical services, and poison control centers. All states were required to make plans with their hospitals for dealing with an epidemic involving 500 or more patients in their state or region. Other topics that the response plans cover include:

- Communication between hospitals and emergency responders
- Procedures for receipt and distribution of vaccines, antibiotics, and supplies from federal sources (like the Strategic National Stockpile)
- Quarantine, isolation, and decontamination
- Hospital lab capacity
- Personal protective equipment
- Emergency drills
- Personnel training

Local and state governments are actively working with their hospitals to implement the elements outlined in the plans to enhance local preparedness.

Information Sharing In the Public Health Community

Once lab tests confirm the presence of a terrorism agent, information will need to be distributed throughout the medical community quickly to facilitate identification of additional patients and advise health care providers about treatment. Over the past several years, CDC has been developing several national networks to encourage and facilitate the sharing of information within the public health community. The networks are designed to help health officials and hospitals around the country share information both before and during public health emergencies.

Health Alert Network

The Health Alert Network (HAN) (http://www.phppo.cdc.gov/HAN/Index.asp), which was introduced by CDC in 1998, is a nationwide, integrated electronic information and communications system for the distribution of health alerts, prevention guidelines, national disease surveillance, and laboratory reporting. HAN is a collaboration between CDC, local and state health agencies, and national public health organizations. It allows for the sharing of information between state, local, and federal health agencies as well as hospitals, laboratories, and community health providers. There is also a distance-learning component to allow network users to continually increase their knowledge of bioterrorist threats via satellite and the Internet.

HAN is designed to assist public health and emergency response *during* a terrorism event as well as any public health emergency. It provides early warnings by broadcast fax and e-mail to alert officials at all levels about urgent health threats and appropriate actions. There are three categories of HAN messages:

HEALTH UPDATE

Provides updated information regarding an incident or situation; unlikely to require immediate action.

HEALTH ADVISORY

Provides important information for a specific incident or situation; may not require immediate action.

HEALTH ALERT

Conveys the highest level of importance; warrants immediate action or attention.

These messages can be viewed over the Internet on the HAN Web site (http://www.phppo.cdc.gov/HAN/Index.asp).

HOW ONE STATE'S HEALTH AND HUMAN SERVICES SYSTEM USES HAN

States have taken many different approaches to creating their own HANs. One state developed a HAN home page on its HHS Web site. In the future, health professionals will be able to register online to be a part of the state HAN network and gain access to secure Web pages. The state's HHS Web site provides links to the HAN, emergency contact numbers, and other terrorism information. It also has a link to a list of news releases on HAN-related issues. The state also has special emergency Web pages ready to activate in the event of a public health emergency.

In addition to the national HAN network that is led by CDC, CDC has encouraged states to develop their own HAN networks and is providing funding and technical assistance in conjunction with other health organizations, such as the National Association of County and City Health Officials and the Association of State and Territorial Health Officials.

Epidemic Information Exchange

The Epidemic Information Exchange (Epi-X) is a secure, Web-based communication network that was created in 2000 to connect CDC and other federal health agencies, state and local health departments, poison control centers, laboratories, and other public health professionals in the United States and neighboring countries. Since 2000, Epi-X (http://www.cdc.gov/mmwr/epix/epix.html) has posted over 4,000 reports of disease outbreaks and other health threats, and has grown to include more than 3,000 public health professionals nationwide. To protect health on the U.S. border, senior health officials in Mexico and Canada also share information on Epi-X.

In contrast to the fairly open membership structure of HAN, health agencies authorize certain officials to participate on Epi-X and share provisional technical information. Peers contribute information to CDC, monitor the network 24 hours a day, and typically post reports within minutes to hours of submission. Epi-X staff also send out daily e-mails to users about new reports and events. Staff can also notify users immediately by e-mail, pager, and telephone if a situation is deemed an emergency. In addition to near daily use during the response to routine disease outbreaks, Epi-X has been used for a number of major public health crises, including the outbreaks of West Nile virus, SARS, and monkeypox. Figure 2–4 illustrates the operation of Epi-X in both normal and emergency situations.

CONTAINMENT

Once an attack has been confirmed, public health officials may use a variety of tactics to control its effects, ranging from distributing antibiotics to using quarantine strategies. This section describes several methods that might be used for containment.

Strategic National Stockpile

What SNS Is

The Strategic National Stockpile (SNS) (formerly the National Pharmaceutical Stockpile) (http://www.bt.cdc.gov/stockpile/index.asp) is a national repository of critical medical supplies designed to supplement and resupply state and local public health agencies in the event of a national emergency anywhere and at anytime within the United States or its territories. The goal of the SNS program is to provide rapid delivery of SNS lifesaving pharmaceuticals to any location within all U.S. states and territories within 12 hours or less from the federal decision to deploy. The SNS program is managed by CDC and is carried out in conjunction with state and local communities who have responsibility for developing their own local plans for the receipt and distribution of SNS supplies. SNS distributes medical supplies and provides technical assistance to states in their planning efforts related to the receipt and distribution of SNS assets. SNS only distributes medical supplies—it does not operate mass casualty centers or clinics.

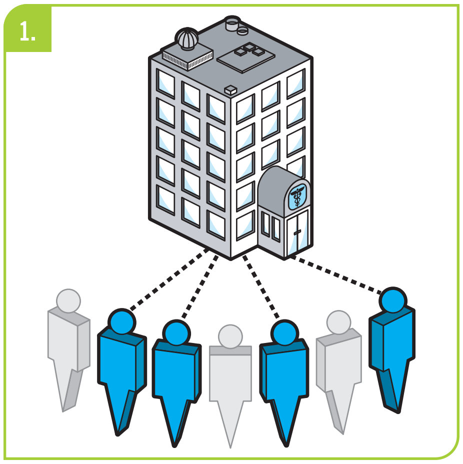
What SNS Includes

Items included in SNS are based upon current terror threats, the vulnerability of the U.S. civilian population, and availability and ease of distribution of supplies. SNS contains multiple caches of medical supplies stored in warehouses in different regions across the country. These caches include antibiotics, chemical antidotes, antitoxins, life-support medications, intravenous (IV) administration, airway maintenance supplies, and medical/surgical items.

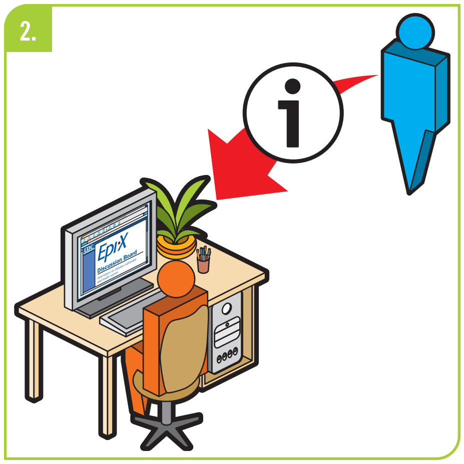
How SNS Is Activated

- The affected state's Governor's office requests SNS materials from HHS or CDC.
- HHS assesses the situation and determines prompt and appropriate action. This assessment could include consultation with other federal agencies and entities (e.g., DHS).
- Supplies are sent in what are called "12-hour Push Packages," which contain a broad range of products that may be needed in the early hours of an emergency and are ready to be loaded on trucks or aircrafts. These supplies would go directly to predesignated sites, depending on the situation and the plans made by the affected community.

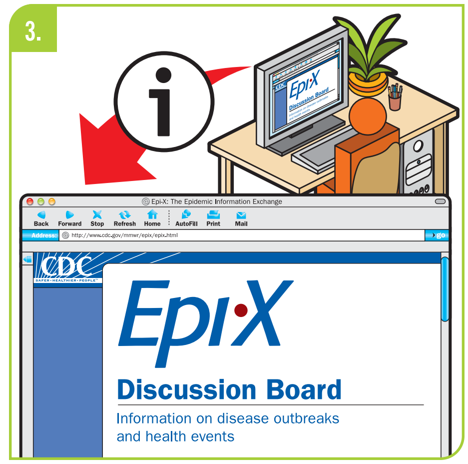
FIGURE 2–4: EPI-X NORMAL OPERATION



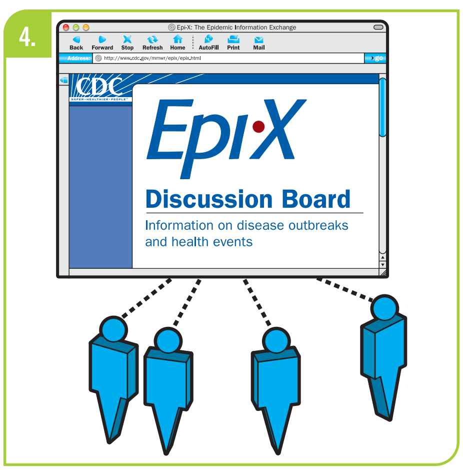
State health agencies select Epi-X members.



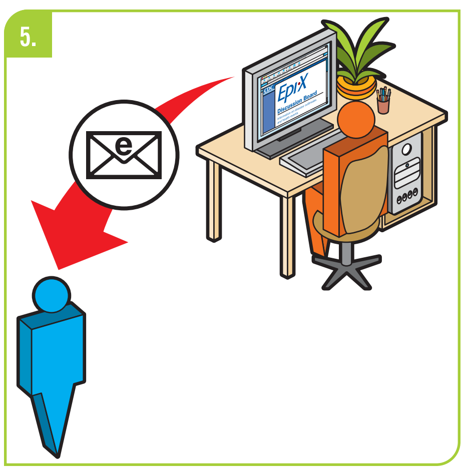
Members send important information to Epi-X staff.



Epi-X staff edit and post information from members on discussion board.

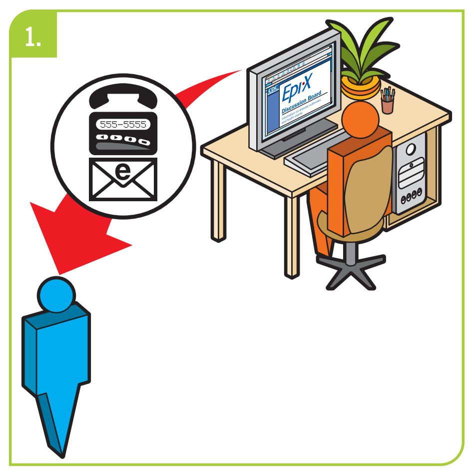


Epi-X members can access discussion board to get information.



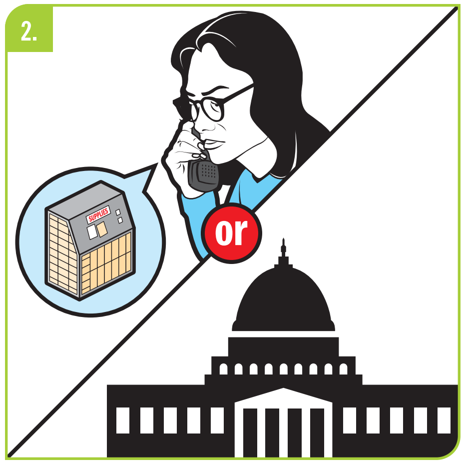
Epi-X staff also send out daily e-mails to users about new reports and events.

EPI-X EMERGENCY OPERATION

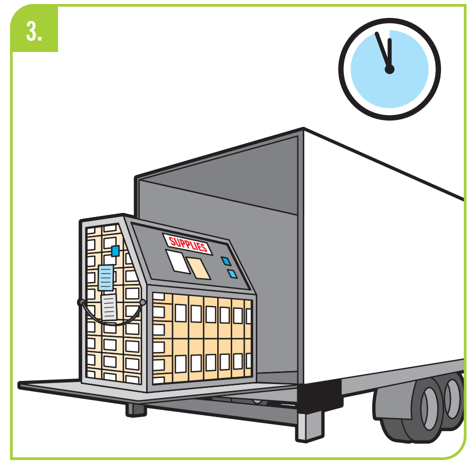


Epi-X staff notifies members immediately via e-mail, pager or telephone.

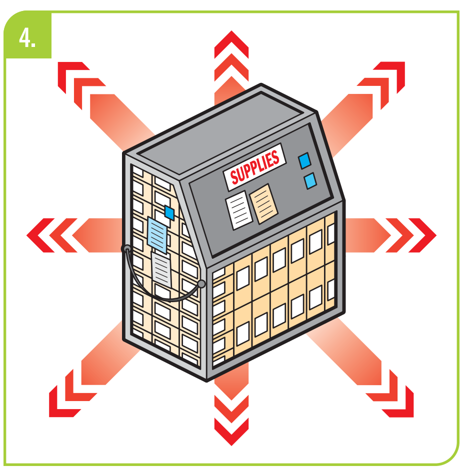
FIGURE 2–5: SNS ACTIVATION



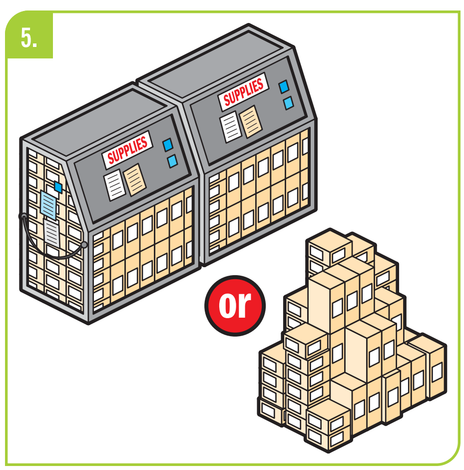
Either the state requests SNS supplies or the federal government determines there is a need.



SNS supplies arrive within 12 hours anywhere in the United States or its territories.



State and local officials distribute supplies according to their SNS distribution plans.



Additional supplies may be sent directly from Vendor Managed Inventory or Stockpile Managed Inventory, or in lieu of Push Packages.

- If an incident requires additional pharmaceuticals and/or medical supplies, additional shipments of supplies through Vendor Managed Inventory and Stockpile Managed Inventory will be shipped to arrive within 24–36 hours. These shipments can be tailored to provide pharmaceuticals, supplies, and/or products specific to the suspected or confirmed agent(s) in addition to or instead of the 12-hour Push Packages.
- CDC is also funding the Cities Readiness Initiative, a pilot program to direct funding to targeted cities to increase their capacity to deliver medicines and medical supplies during a large-scale public health emergency. This program helps ensure state and local partners have effective plans for receiving, storing, and dispensing medication to large populations when needed.

How SNS Is Managed

- The SNS program helps support state and local governments, health care providers, and first responders in the development of plans and capabilities to receive, secure, distribute, and dispense SNS supplies. With SNS program assistance, state and local officials develop, train, and exercise state-specific plans for utilizing SNS.
- Local and state officials are responsible for the distribution of SNS supplies once they arrive at agreed upon receiving sites.
- While SNS supplies are being transported, the SNS program will deploy its Technical Advisory Response Unit. The unit's staff will coordinate with state and local officials so that SNS supplies can be efficiently received and distributed upon arrival at the site.
- The SNS program ensures that medical supplies are rotated and kept within potency shelf life limits. This involves quarterly quality assurance/quality control checks on all 12-hour Push Packages; a full inventory conducted annually of 12-hour Push Package items; and inspections of environmental conditions, security, and overall package maintenance.

Figure 2–5 illustrates how SNS is activated.

HOW A VACCINATION CLINIC OR SNS DISTRIBUTION SITE MIGHT FUNCTION

Although most communities have done advance planning in terms of where clinics and dispensing sites may be held and how they will work, the exact location and setup will be incident specific. As a result, the local media would be heavily relied on to get information out about who should go to one of these sites and where and when they will be open.

HHS has also recommended that, if a clinic or dispensing site needs to be used, the center should be open for the local media to tour before it is officially opened so that local media can provide information to the public about what to expect when they arrive at the site.

Public health officials will request that people bring the following information to receive appropriate treatment:

- **Photo identification (driver's license, military ID, company badge)**
- **Medical records, including previous immunizations, current medications, and allergies**
- **Current age and weight of children**

It is helpful for people to gather this information before the emergency and keep in a safe, but easily accessible, place.

This information would be requested strictly for medical reasons. Anyone who needs treatment will be able to get treatment free of charge and regardless of immigration and residency status.

Vaccination Strategies

One method that public health officials may use to control an outbreak of some diseases caused by bioterrorism is vaccination. Vaccines cause the body to produce antibodies, which protect the body against later infection by a particular agent. However, vaccines are not available for many diseases and not all vaccines work the same way. Smallpox vaccine, for example, provides almost immediate immunity and can be beneficial even if someone is vaccinated a few days after exposure. Other vaccines, such as the anthrax vaccine, may require a number of doses over time before the recipient builds up immunity. Therefore, vaccines may or may not be helpful in a sudden outbreak, depending on the disease and incident.

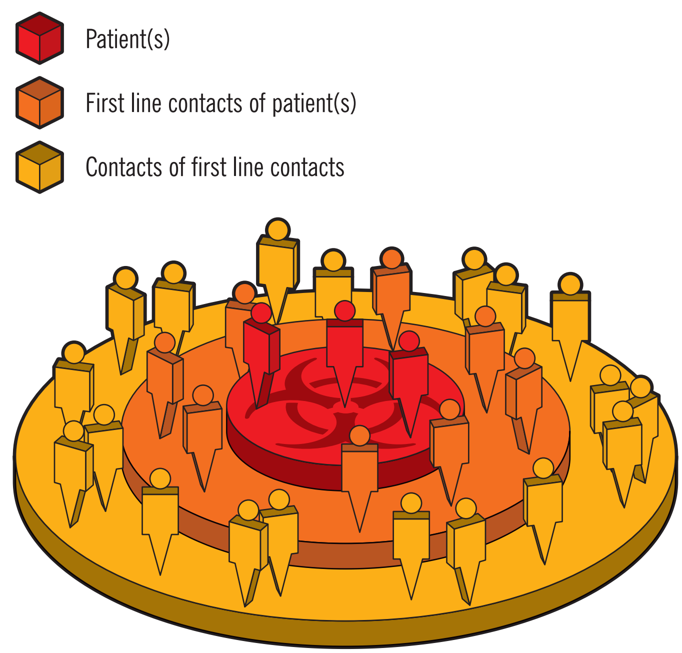
Scientists are currently doing research on vaccines to combat various bioterror agents, but currently, the only major bioterror agents for which vaccines are available in case of an attack are smallpox and anthrax. Although these vaccines may be used in case of an attack, they are not currently available to the general public due to potential vaccine side effects and other issues. However, these vaccines may become available in the case of an attack. In fact, in October 2004, HHS awarded a contract to VaxGen, Inc., to produce 75 million doses of a new anthrax vaccine for the SNS. Additional details on vaccines can be found in the "Biological Agents" section (see p. 39) and on NIAID's Web site (http://www2.niaid.nih.gov/biodefense).

Smallpox Vaccination

Although vaccination before a smallpox event has been a hotly debated topic over the past several years due to potential side effects of the vaccine, in the case of a smallpox "outbreak," it is likely that public health officials would turn to vaccination because the risks associated with the smallpox illness would be much higher than the risks of the possible vaccine side effects. There are two main ways to conduct vaccination for smallpox:

- Ring vaccination
- Mass vaccination

FIGURE 2-6: RING VACCINATION



Source: CDC & WHO. (2003). Course: "Smallpox: Disease, prevention, and intervention." Day 2, Module 4: Vaccination strategies to contain an outbreak. PowerPoint presentation. http://www.bt.cdc.gov/agent/smallpox/training/overview.

Ring Vaccination

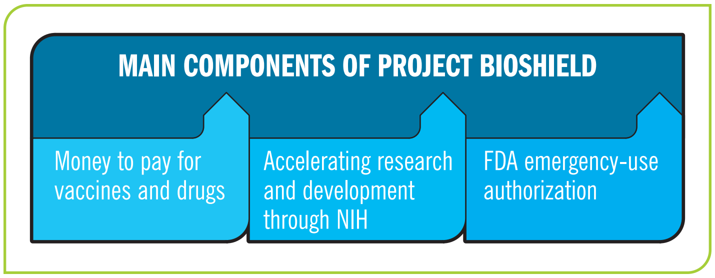
Ring vaccination was the primary strategy that was used to control smallpox outbreaks and led to the complete eradication of the disease worldwide by 1980. It involves finding and vaccinating the contacts of smallpox patients. First line contacts are those who have had face-to-face contact (6 feet or less; for example, at school or the workplace) and those living in the same household as the person who has smallpox. Then, close contacts of the first line contacts are vaccinated to make sure to break the chain of transmission. For the contacts of contacts, those who have what are called contraindications (medical conditions that may cause adverse reactions to the vaccine; for example, eczema or immune deficiencies) are not typically vaccinated.

Ring vaccination is typically effective if the outbreak appears to be small and contacts can be identified quickly. It minimizes the number of people who will need to be vaccinated and who may have reactions to a vaccine. (Note: Someone cannot contract smallpox from the smallpox vaccine.)

Mass Vaccination

Depending on the nature of the outbreak, public health officials may decide to use a mass vaccination strategy. Some reasons that a mass vaccination may be used include: if the number of cases is high, if outbreaks occur in a number of locations, and/or if the outbreaks continue to grow despite the use of ring vaccination. Since routine vaccination for smallpox in the United States ended for the general public in 1972 and there are large numbers of Americans who are susceptible to the virus, mass vaccination would be strongly considered for a smallpox outbreak. If mass vaccination were indicated, supplies from SNS would be used, and it is planned that vaccine clinics would be set up to vaccinate people quickly and efficiently.

FIGURE 2–7: BIOSHIELD



Project BioShield

Project BioShield was signed into law in July 2004. The program is designed to provide incentives for the pharmaceutical and medical technology industries to develop and make available modern, effective drugs and vaccines to protect the population against attack by biological and chemical weapons or other dangerous toxins (http://www.hhs.gov/news/press/2004pres/20040721b.html). Many existing medications, such as vaccines or other drugs, are 20 or 30 years old and are available in limited supply or may have significant side effects (e.g., smallpox vaccines). Recommended decontamination procedures and other treatments for chemical and radiation exposure have not changed much since the 1970s (National Memorial Institute for the Prevention of Terrorism 2004). For many biological and chemical agents, no specific vaccines or treatments have been developed yet, based in part on the absence of a market and thus reduced financial incentives for industry to develop new products and devices (Gottron 2003) as well as a variety of liability concerns.

Project BioShield allows the federal government to buy improved vaccines and other drugs for smallpox, anthrax, and botulinum toxin for SNS. It will also speed up the product development and approval cycle for new countermeasures against other dangerous pathogens, such as Ebola and plague, as soon as scientists verify their safety and effectiveness, by authorizing HHS and DHS to buy drugs, vaccines, medical devices, and other supplies up to 5 years before the products would normally be expected to come to market. To help make new treatments available to the public in an emergency, a new law guarantees a government market for otherwise experimental drugs and medical treatments.

How BioShield Works

Project BioShield has three main components:

- Ensuring that resources are available to pay for vaccines and other drugs
- Speeding up NIH research and development by authorizing NIAID to accelerate the normal contracting, scientific peer review, and approval processes
- Providing new emergency-use authorization for the Food and Drug Administration (FDA) for medical treatments that have not been formally approved and licensed

HHS will have new funding authority to identify and include medical countermeasures in SNS. Products in development include new smallpox vaccines as well as treatments for botulism, plague, Ebola, and other diseases. HHS would coordinate SNS purchasing decisions with DHS and the Office of Management and Budget.

The HHS Secretary will play a critical role in authorizing the use of not yet approved and unlicensed products and technologies in an emergency. The routine development and approval processes for drugs, devices, and biological products are designed to provide safe and effective products to protect and enhance the public health. However, conducting thorough safety and effectiveness studies for submission to HHS and the Food and Drug Administration often takes the industry several years—too long for emergency situations. If the need arises, the HHS Secretary could issue an emergency authorization to use an investigational treatment after determining that there were no other alternatives available and that the known or potential benefits would outweigh the known or potential risks.

Isolation and Quarantine

To protect the public in the case of an outbreak of a highly contagious infectious disease, such as smallpox or plague, public health officials may decide to employ quarantine and isolation strategies, separately or together, depending on the situation. These practices can reduce the public's exposure to an illness by separating and restricting the movements of persons known to be infected or who are suspected of infection. Both practices may be carried out voluntarily, but, ultimately, government officials have the authority to impose quarantine and isolation, if necessary, to protect the public welfare.

Isolation removes people who are ill with contagious diseases from the general public and restricts their activities to stop the spread of a disease. *Isolation* is not required for patients with noncontagious diseases, such as anthrax. *Isolation:*

› Confines infected persons to their homes, hospitals, or designated health facilities

› Allows health care providers to provide infected persons with specialized care

› Is commonly used in hospitals for people with certain diseases, such as tuberculosis

› Is initiated mostly on a volunteer basis, but government officials at all levels have the authority to enforce it (CDC 2004c)

Quarantine separates people who have been potentially exposed to a contagious disease and may be infected but are not yet ill to stop the spread of that disease. *Quarantine:*

› Confines persons to their homes or community-based facilities

› Can apply to a group that has been exposed at a public gathering

› Can apply to persons who are believed to have been exposed while traveling, particularly overseas

› Can apply to an entire geographic area, in which case a community may be closed off by sealing its borders or by a barricade, known as a "cordon sanitaire"

› Is enforced at the state level and/or by CDC's Division of Global Migration and Quarantine

Although quarantine and isolation policies are commonly put into emergency plans, public health and government officials have not needed to use widespread quarantine and isolation measures in recent years in the United States. The last large-scale quarantine measures that were imposed in this country were used in the early 20th century to contain outbreaks of plague, yellow fever, and smallpox. Other countries have successfully used quarantine measures recently to control SARS. However, how quarantine is managed is unique to each country.

Legal Authority Related to Isolation and Quarantine

All levels of government have the legal authority to issue orders for isolation and quarantine. Generally, however, if an outbreak of an infectious disease occurs in a specific location, the authority for quarantine falls to the local authorities that govern that area. If the outbreak affects more than one community or has the potential to cross local boundaries, authority is passed on to the state. The federal government is primarily responsible for preventing diseases from being introduced and spread in the United States from foreign countries as well as interstate and national outbreaks.

The Division of Global Migration and Quarantine at CDC (http://www.cdc.gov/ncidod/dq/mission.htm) enforces regulations that are intended to prevent the introduction, transmission, and/or spread of communicable diseases from foreign countries into the United States. They operate eight full-staffed Quarantine Stations in international airports in the United States. These stations are responsible for monitoring all ports, seaports, and international airports for a given region. Officers at these stations also train immigration, customs, and agriculture inspectors to watch for ill persons and imported items that may have public health significance. During the SARS epidemic in 2003, quarantine officers took a number of actions to protect the health of the public, ranging from distributing health notices to air travelers with information about SARS to boarding planes to see if ill travelers had symptoms of SARS.

More detail on the legal authority related to isolation and quarantine can be found in "The Role of the Federal Government" section under the "Public Health Sources of Authority" heading (see p. 153).

National Disaster Medical System

The National Disaster Medical System (NDMS) is a federally coordinated system that provides medical services to help local and state agencies respond to major emergencies and disasters, including acts of terrorism. This system is made up of medical professionals who are specially trained and volunteer their services in case of an emergency as a supplement to local hospital systems. Some people describe the system as the "National Guard for Medicine."

NDMS (http://ndms.dhhs.gov) operates as a part of DHS, in partnership with HHS, the U.S. Department of Defense, and the U.S. Department of Veterans Affairs. The system is made up of specialized teams and a network of hospitals. In addition to assisting communities in disasters, NDMS also supports military medical systems and U.S. Department of Veterans Affairs facilities in caring for casualties that are evacuated back to the United States from overseas conflicts. NDMS is operational in two situations: (1) if a National Emergency is declared, or (2) at the request of a state or local government.

The five types of NDMS teams are:

- Disaster Medical Assistance Teams
- Disaster Mortuary Operational Response Teams
- Veterinary Medical Assistance Teams
- National Nursing Response Teams
- National Pharmacy Response Teams

Each of these teams will be described in turn.

Disaster Medical Assistance Teams

- Eighty teams across the country comprised of local professional and paraprofessional medical personnel and logistical staff.
- Include four National Medical Response Teams, which are especially equipped and trained to deal with Weapons of Mass Destruction, and other specialized teams available to handle specific medical needs, such as burn and mental health emergencies.
- Designed as rapid-response units to supplement local services (e.g., triage, emergency care) until a situation is resolved or until additional resources—federal or private—can be activated.
- Deployed to affected areas with enough supplies to last 72 hours.
- May work at fixed or temporary medical sites.
- Each team managed by a sponsoring organization, such as a public health agency or a nonprofit group, that operates under a Memorandum of Agreement with DHS.
- Sponsor recruitment and organization of team members, arrange training, and coordinate the deployment of the team.
- Although designed to supplement services at the local, state, or regional level, may be used on a national basis.

Disaster Mortuary Operational Response Teams

- Ten regional teams formed to provide help to local officials in tasks relating to the recovery, identification, and burial of victims.
- One national team is specially trained to handle events involving Weapons of Mass Destruction.
- Members are private citizens with specialized expertise.
- Examples of types of team members include: funeral directors, medical examiners, coroners, and pathologists.
- Include two Disaster Portable Morgue Units, which are complete morgues that can be deployed to an affected site.

Veterinary Medical Assistance Teams

- Five nationally deployable teams of private citizens who provide veterinary care following major emergencies.
- Examples of tasks include the following:
  - Medical treatment for rescue animals, farm animals, and pets
  - Tracking and assessment of disease in animals
  - Animal decontamination
- Examples of types of team members include:
  - Clinical veterinarians
  - Veterinary pathologists
  - Veterinary technicians
  - Microbiologist/virologists
  - Epidemiologists
  - Toxicologists

National Nurse Response Teams

These teams are currently being formed to assist with mass vaccinations and provide specialized services in case the nation's supply of nurses is overwhelmed during a major emergency. There will be 10 regional teams, which will each consist of approximately 200 civilian nurses.

RAPID RESPONSE REGISTRY

As part of the response to an emergency event, CDC's Agency for Toxic Substances Disease Registry (ATSDR) may establish and maintain a Rapid Response Registry (RRR) of people exposed to a terrorist or other emergency event affecting public health within the United States and its territories. RRR will follow up with registrants over time to determine if there are any health problems that can be linked to the event.

ATSDR has been identified as the lead agency in establishing an event-related registry of victims and exposed population and will initiate RRR within 8–12 hours after an event. ATSDR will deploy field supervisors and data collection teams to the site of the event, and begin enrolling on an urgent basis all people who were exposed or potentially exposed. RRR can respond to any size and type of agent.

National Pharmacy Response Teams

Ten regional teams are being formed to help with emergency situations that may require the assistance of large numbers of pharmacy professionals, such as mass vaccination. Members will be sponsored by the Joint Commission of Pharmacist Practitioners and work in partnership with DHS.

Administration of Teams

When activated, members of NDMS teams are considered federal employees and are paid for their service. They are required to maintain the appropriate licensures for their disciplines, and some are required to stay current in treatment recommendations for diseases related to Weapons of Mass Destruction and to complete Web-based training in disaster and terrorism response.

Federal Coordinating Centers

In addition to the five types of teams, NDMS also coordinates a network of approximately 2,000 hospitals to assist in a disaster. NDMS relies on the voluntary assistance of accredited hospitals across the country—usually those with more than 100 beds and located in large metropolitan areas. Federal Coordinating Centers recruit these hospitals to commit a number of their acute-care beds for NDMS patients, if needed. If a hospital admits NDMS patients in an emergency, it is guaranteed reimbursement by the federal government.

In the case of a major disaster, the Federal Coordinating Centers may coordinate the evacuation or transport of patients to NDMS network hospitals in unaffected areas. These activities are coordinated with the U.S. Department of Defense, which would be responsible for transporting patients over long distances.

Other Supplementary Personnel and Resources

In response to a public health emergency, the federal government may dispatch personnel from the Epidemic Intelligence Service (EIS), the Commissioned Corps Readiness Force, or the Medical Reserve Corps.

EIS (http://www.cdc.gov/eis) is a 2-year postgraduate program of service and on-the-job training for health professionals interested in epidemiology. EIS, which is managed by HHS/CDC, was developed more than 50 years ago to defend the nation against biological warfare but also provides surveillance and response units for all types of outbreaks. Medical doctors, researchers, and scientists work in a range of subject areas, including infectious diseases, and are supervised by experienced epidemiologists at CDC and local and state health departments.

The Commissioned Corps of the U.S. Public Health Service (http://www.usphs.gov) is a uniformed service with a number of programs to help promote the health of the nation. It includes a variety of health professionals, including physicians, dentists, pharmacists, nurses, veterinarians, and other scientists and professionals. The Commissioned Corps Readiness Force is a subset of the Commissioned Corps that may be sent to respond to public health emergencies.

The Medical Reserve Corps (http://www.medicalreservecorps.gov) are teams of local volunteer medical and public health professionals who have offered to contribute their skills and expertise during times of community need. The Medical Reserve Corps program office is within the HHS Office of the Surgeon General, but the volunteer teams are operated out of local Citizen Corps, a national network of volunteers concerned with preparing their communities for disasters of all kinds.

Red Cross

The Red Cross (http://www.redcross.org) is another key player in responding to a public health emergency. The Red Cross is a nonprofit humanitarian organization led mostly by volunteers and has been providing disaster recovery assistance to Americans since the 1880s. Although not a government organization, the Red Cross was given authority through a Congressional Charter in 1905 to provide assistance in disasters, both domestically and internationally. As a result, Red Cross Chapters work closely with federal, state, and local governments to respond to disasters. The following are some of the services offered by the Red Cross in a disaster:

- Emergency first aid
- Health care for minor injuries and illnesses in mass-care shelters or other sites
- Supportive counseling for victims and those affected by the event
- Personnel to assist in the temporary infirmaries, immunization clinics, morgues, hospitals, and nursing homes
- Assistance with meeting basic needs (e.g., food, shelter)
- Provision of blood products

THE THREAT OF EMERGING INFECTIOUS DISEASES

With the development of antibiotics, other drugs and vaccines, vastly improved sanitation, and better control of insects and other animals that can harbor and spread disease, great strides have been made in public health over the last century. In the 1960s, it was even thought that the long era in which infectious diseases inflicted high mortality might be drawing to a close. But increases in international travel, the number of people living in urban areas, and the adaptability of microbes have given cause for increased concern in recent years.

Also of increasing concern to scientists and the medical community are infectious diseases that have previously infected only animals but are now infecting humans. Because such diseases are relatively unstudied in humans, these species-jumping or zoonotic infections have the potential to become serious problems quite rapidly. In addition, it is difficult to predict when or where such a disease might emerge. Many factors may cause these jumps, including contact between animals and humans, mutations of a microbe, and changes in the environment. The recent increase of these sorts of infections may be due to many factors, including that increasingly larger numbers of people and animals are coming into contact with each other and that modern transportation allows people to quickly travel around the globe and rapidly spread infections widely (Murphy 1998). As mentioned previously, many of these outbreaks have characteristics similar to bioterror attacks and may be investigated as such in their beginning stages.

The following emerging diseases (all of which are thought to have animal origins) are among those that the public health community continues to try to understand and manage.

EBOLA (A VIRAL HEMORRHAGIC FEVER)

Ebola is highly contagious and usually fatal. Most cases have occurred in Central Africa. The first Ebola epidemics occurred in Zaire and Sudan in 1976 and outbreaks have occurred in the last decade in Cote d'Ivoire, Zaire, Gabon, Uganda, the Congo, and Sudan. According to WHO, 257 deaths were reported between December 2002 and 2003. Outbreaks are thought to begin with human contact with an infected animal. Once the first person is infected, the disease can then be spread from person to person through infected blood or secretions, or via contaminated objects, such as needles. Researchers continue to try to pinpoint which animals act as hosts to this virus. Knowledge about the host and about how Ebola spreads will help prevent future outbreaks. Researchers are alsocurrently working on developing a vaccine and possible antiviral drug treatments for Ebola.

In 2001, at the time of an active Ebola outbreak in Uganda, Africa, there was a “false alarm” concerning a suspected viral hemorrhagic fever case in Ontario, Canada. A patient who had traveled from Africa by plane was hospitalized with an infectious disease that had symptoms consistent with those of a viral hemorrhagic fever. If this diagnosis had been confirmed, this would have been the first viral hemorrhagic fever case ever seen in North America. Health Canada and CDC worked together on the case and quickly coordinated their public health messages and recommendations. Fortunately, the test results were negative for any viral hemorrhagic fever, but this case illustrates the potential global threat of newly emerging infectious diseases.

More detailed information on viral hemorrhagic fevers, like Ebola, can be found in the “Biological Agents” section (see p. 39).

SARS

SARS (severe acute respiratory syndrome) is a viral respiratory illness caused by a coronavirus. The first confirmed cases occurred in Guangdong Province in China in November 2002. These 11 independent cases appear to have resulted from human consumption of wild animals. The virus quickly evolved to a form that could be transmitted among humans. In the 2003 outbreak, a total of 8,098 people worldwide contracted SARS and 774 died. Most SARS cases were in Asia. There were eight lab-confirmed cases of SARS in the United States, but none of these individuals died from the disease. Those affected had all traveled to parts of the world where SARS outbreaks were occurring. By late July 2003, no new cases were being reported and WHO declared that the global outbreak was over. In April 2004, there were several cases of SARS in China that were laboratory acquired infections. CDC now has a plan in place to respond quickly if SARS recurs. Tremendous progress has been made in the development of experimental SARS vaccines. For more information on SARS, including current information on SARS transmission throughout the world, see CDC’s SARS Web site (http://www.cdc.gov/ncidod/sars) or WHO’s SARS Web site (http://www.who.int/csr/sars/en/).

WEST NILE VIRUS

West Nile virus (WNV) is transmitted by mosquitoes from birds to humans or other animals. Humans, horses, and some species of domestic and wild birds are susceptible to WNV. The most serious form of the disease is viral encephalitis, which is an inflammation of the brain. In 2003, 2.6 percent of infected humans developed severe symptoms. No human-to-human transmission has been reported.

The first known occurrence of WNV in humans was in the West Nile District in Uganda in 1937. There was an outbreak among the elderly in Israel in 1957, and horses were stricken in Egypt and France in the early 1960s. WNV first appeared in North America in 1999. According to CDC, in 2003, 9,862 cases were documented in humans in the United States and 264 people died. Efforts are now underway to develop specific treatments and different vaccine approaches to manage WNV.

In 2002 and 2003, a small number of cases of WNV were acquired through blood transfusions. Tests were developed to screen blood for WNV and as of July 2003, every blood bank in the United States was screening donated blood for WNV. In addition, blood banks started screening out donors with recent possible symptoms of WNV (i.e., fever, headache). However, since the current testing procedures cannot catch every infected blood donation, scientists continue to work on better tests and testing procedures.

More information on WNV can be found at http://www.cdc.gov/ncidod/dvbid/westnile/index.htm.

BOVINE SPONGIFORM ENCEPHALOPATHY (“MAD COW” DISEASE)

Bovine spongiform encephalopathy (BSE), which is commonly known as “mad cow” disease, was a concern in the United States in the winter of 2003–2004 after the discovery of a single dairy cow in Washington state with BSE. This cow’s birth was traced to a farm in Alberta, Canada. BSE is a progressive neurological disorder that is typically spread in cows when they eat animal feed containing neural tissue (e.g., spinal cords, brain tissue) of BSE-infected cows. Feed bans were implemented in North America in 1997, which prohibited the use of this kind of cattle feed. The majority of BSE cases have appeared in Great Britain, peaking in the mid-1990s. The concern about BSE is that it appears linked to a neurological disease in humans called variant Creutzfeldt-Jackob disease (vCJD). It is thought that humans may be exposed in a way similar to cows’ exposure—if they eat meat products that contain contaminated bone, spinal cord, or brain tissues. In a few cases, people have been infected by contaminated blood transfusions or tissue or organ transplants.

The BSE risk to humans, particularly in the United States, is considered low. As of December 1, 2003, there had been 153 vCJD cases reported worldwide—143 of them in Great Britain (CDC 2003a). CDC has increased surveillance, however, to monitor for cases of vCJD in the United States and the U.S. Department of Agriculture has enhanced regulations, inspections, and surveillance related to BSE.

THE THREAT OF PANDEMIC INFLUENZA

Influenza or flu viruses routinely cause epidemics of disease every winter that can cause illness in about 10–20 percent of the population in the United States. Although these routine influenza epidemics cause an average of 36,000 deaths and 200,000 hospitalizations per year in the United States, healthy adults are usually not at high risk for complications. The groups that are at risk for complications include the very young, pregnant women, older adults, and those with chronic medical conditions. Typically, flu shots are available and effective against these types of influenza outbreaks that occur each winter, although persuading people most at risk to get annual vaccinations remains a challenge. Flu viruses are continually circulating around the world and mutate or change over time. This is the reason that the vaccine is updated to include current viruses each year and that people who want to be protected against the flu need to get a new flu shot each year.

Pandemics of influenza are explosive global events in which most, if not all, persons worldwide are at risk for infection and illness. In past pandemics, influenza viruses have spread worldwide within months. With increased globalization, a new pandemic could cross the globe within weeks or perhaps even days. Pandemic viruses have historically infected one-third or more of large populations and have led to tens of millions of deaths.

Pandemics occur when there is a major change in an influenza virus, resulting in a new strain that most of the world has never been exposed to, therefore leaving most individuals susceptible to infection. Unlike the gradual changes that occur in the influenza viruses that appear each year during flu season, a pandemic influenza virus is one that represents a major, sudden shift in the virus' structure that increases its ability to cause illness in a large proportion of the population. This kind of change is called an "antigenic shift."

There are two types of influenza viruses: type A and type B. Type A viruses can be found in many types of animals, while type B viruses circulate only among humans. While a routine epidemic can involve either type of virus, antigenic shift can only occur with influenza A viruses. One way that an antigenic shift can occur is through pigs. Pigs can be infected with both avian and human influenza viruses. If pigs are infected with viruses from different species at the same time, it is possible for the genes of these viruses to mix and create a new virus. Humans would not have any immune protection to such a virus and could be infected in large numbers (CDC 2004d) The rare appearance of a flu pandemic virus would likely be unaffected by currently available flu vaccines that are modified each year to match the strains of the virus that are known to be in circulation among humans around the world.

During previous influenza pandemics, large numbers of people were ill, sought medical care, were hospitalized, and died. Three major influenza pandemics occurred during the 20th century. The most deadly influenza pandemic outbreak was the 1918 Spanish flu pandemic, which caused illness in roughly 20–40 percent of the world's population and more than 50 million deaths worldwide. Between September 1918 and April 1919, approximately 675,000 deaths from the Spanish flu occurred in the United States alone (HHS 2004a). In 1957, the Asian flu pandemic resulted in about 70,000 deaths. The most recent influenza pandemic occurred in 1968 with the Hong Kong Flu outbreak, which resulted in nearly 34,000 deaths in the United States. Although the virus involved in the 1968 outbreak was a dangerous virus, experts believe that fewer deaths occurred in the United States than in previous outbreaks for several reasons:

- The virus was similar to the virus that appeared in the 1957 outbreak, and some people already had immunity
- The peak of the outbreak occurred during December when children were out of school, so the virus was not widely transmitted among school-aged children
- Medical care and available treatments for complications had improved since the 1957 outbreak (HHS 2004b)

Although no one can predict when the next pandemic will occur, public health scientists believe that the risk of an influenza pandemic is greater now than it has been in decades.

AVIAN INFLUENZA

One type of influenza A virus that is of concern to many public health officials is often called avian flu or bird flu. Both the 1957 and 1968 pandemics are thought to have had avian origins. Avian flu is caused by a group of influenza viruses that circulate among birds. Avian flu is highly contagious among birds, particularly domesticated birds, such as chickens. It is thought that human cases have resulted from contact with infected birds. In the past, quarantine and depopulation (or culling) and surveillance around affected flocks have contained outbreaks. Among humans, symptoms range from conjunctivitis to a flu-like illness that includes severe respiratory distress and pneumonia. There has been no evidence of sustained human-to-human transmission of avian flu, although there have been a few isolated cases of transmission between family members. However, because influenza viruses have the potential to change and gain the ability to spread easily between people, monitoring for human infection and person-to-person transmission is important.

Several humans have been infected with avian flu since 1997. The first documented human case was identified in 1997 in Hong Kong. Both humans and chickens were infected. Eighteen people were known to be infected and six died. To prevent further spread of the disease, public health authorities killed more than a million chickens. A second outbreak occurred in Hong Kong in 1999; two children were infected but both recovered. Three outbreaks occurred during 2003. Two separate cases in Hong Kong and a third outbreak occurred among poultry workers and their families in the Netherlands. Eighty-four people were infected and one died. Avian flu is a continuing threat. In early 2004, a new outbreak of avian influenza occurred in humans in Thailand and Vietnam. It also appears that cats may become infected from infected birds and that those cats may then transmit the disease to other cats.

During 2004, avian flu cases were spread to unprecedented levels in both poultry and humans in several countries in Asia. The threat to the United States is considered uncertain at this time. While poultry imports from Asia are limited (mostly feathers or processed or cooked products, which are considered to be low risk), it is possible that in the future an individual infected with a new avian influenza virus that is able to spread from person to person could travel to the United States (Center for Emerging Issues 2004).

One important reason for the current heightened concern about influenza viruses is that avian influenza has become endemic in many species of birds throughout Asia. Therefore, the threat of an avian flu pandemic is not diminishing. Scientists will need to continue to carefully monitor avian flu epidemics in Asia each year to make sure that they remain contained and that the virus has not transformed into a virus that can be easily transmitted from person to person.

Preparing for a Pandemic

Prepandemic planning is essential to minimize the effects should an influenza pandemic occur. Although some of the planning activities for terrorism and other public health emergencies are relevant to an influenza pandemic (e.g., strengthening surveillance systems), planning is also underway that is more specific to influenza. HHS' current Pandemic Influenza Preparedness and Response Plan (http://www.hhs.gov/nvpo/pandemicplan) (HHS 2004c) provides guidance to national, state, and local policymakers and health departments for public health preparation and response in the event of a pandemic influenza outbreak.

At the federal level, health officials are also conducting a number of other activities in preparation for the next pandemic, including international surveillance activities, vaccine development and research, and antiviral drug stockpiling and research. Among other activities, resources are being allocated to expand vaccine production as needed and add influenza antiviral drugs to SNS. Research is also being conducted on new influenza vaccines, more effective antiviral drugs, and ways to rapidly sequence the genes of influenza viruses.

If a pandemic were to occur, the federal response activities would depend to an extent on the stage of the pandemic. For example, the activities are different if scientists have discovered a new influenza strain in one person in another country than if a number of people in the United States are ill with a new strain of influenza. The kinds of activities that the federal government might be involved in include:

- National and international surveillance to identify people who have the virus and where outbreaks are occurring
- Rapid development, licensure, and production of new vaccines
- Implementing of programs to distribute and administer vaccine
- Determining how antiviral drugs could be used to combat the current flu strain and target drug supplies

- Implementing control measures to decrease the spread of the disease (e.g., infection control in hospitals, screening travelers from affected areas)
- Communicating with the public, health care providers, community leaders, and the media about the status of the pandemic and the response

States are also expected to develop their own plans to deal with the local aspects of planning for and response to a potential influenza pandemic. Some examples of what these plans would include are the state and local perspective on:

- Surveillance activities
- Vaccine management (distribution and administration)
- How to acquire and use antiviral agents
- How to implement community control measures (e.g., school closings, isolation and quarantine)
- Emergency response (e.g., delivery of medical care, maintenance of essential community services)

Local preparedness will be an essential determinant of how communities do in the early months of a pandemic. Communities are encouraged to plan now for the crucial period when a pandemic has stuck, but when there are not yet adequate supplies of vaccines or antivirals. Three tasks should be considered by communities in this process:

1. Reducing social contact to slow the spread of the virus
2. Treating those who become ill
3. Sustaining civic life in the face of greatly increased morbidity, mortality, and fear

Examples of the many issues a community should consider are: how to use volunteers, especially people who have recovered and are, therefore, immune; how to educate children if schools were closed; and how essential businesses would operate.

More detail on possible federal and state preparedness and response activities can be found in HHS' Pandemic Influenza Preparedness and Response Plan (http://www.hhs.gov/nvpo/pandemicplan).

SOME DIFFERENCES BETWEEN TYPICAL INFLUENZA OUTBREAKS AND PANDEMIC INFLUENZA OUTBREAKS

TYPICAL INFLUENZA	PANDEMIC INFLUENZA
Yearly occurrence.	Rare occurrence (last one was in 1968).
Virus undergoes gradual change from previous years.	Major, sudden virus shift in virus structure (antigenic shift).
Previous exposure to similar viruses may provide some protection.	Little or no previous exposure in the population to similar viruses.
Healthy adults usually not at high risk for complications.	Entire population may be at risk for complications.
Vaccines may be developed in advance to combat the virus.	Vaccines cannot be developed until virus strain appears. Some antiviral medications may be effective.
Approximately 5–20 percent of Americans get the flu each year and approximately 36,000 die from the disease.	Percentages of the population that would be infected by a pandemic influenza virus and die from it are hard to predict ahead of time but would be significantly higher than a typical flu season.
Symptoms include fever, cough, runny nose, and muscle pain.	Symptoms could be more severe, including shortness of breath, acute respiratory distress, pneumonia, and organ failure.

A JOURNALIST'S GUIDE
To Communicating Health Risk Numbers Effectively *by Vincent T. Covello, Ph.D.*

ESSAY

Introduction

There are many ways to use numbers to help explain public health risks. For example, numbers can be used to explain:

- Concentrations—such as parts per million or billion
- Probabilities—the likelihood of an event
- Quantities—such as how many spores of anthrax were in a letter
- Comparisons—such as comparing how dangerous something is compared to something else (e.g., twice as deadly…)

But unfortunately, numbers can also be very confusing and can sometimes be misinterpreted or presented in ways that inadvertently raise levels of concern and alarm. For example, if a substance is described as being "twice as deadly as cobra venom," that is not the same thing as "like being bitten by two cobras." Why not? Because the first comparison is about how lethal or poisonous the substance is, and the second is about the amount of poison someone might be exposed to.

Here are some other issues to be aware of when using numbers to help describe public health risks.

Framing. The impact of a health risk number changes depending on how the risk number is framed, or positioned. For example, describing "lives lost" versus "lives saved" can have a profound effect on how people respond to the information. In one classic study, doctors were presented with a hypothetical choice between two cancer therapies with different probabilities of success and failure. Half were told about the relative chances of dying while the rest had the same information presented in terms of survival rates. The change in framing—even though the results were the same—more than doubled the number of doctors choosing one alternative.

Absolute Versus Relative Risk. Responses to risk messages—especially when communicating increases or decreases in risk—depend critically on whether probabilities are presented in absolute terms ("the probability was 2 percent and is now 4 percent") or relative terms ("the probability has doubled" or "this group suffers twice the normal risk of …"). The latter can be seriously misleading. Information about relative risks can result in misperceptions if information about baseline probabilities is not made clear.

Scale. Scales can also radically change perceptions of risk numbers. For example, in communicating concentrations, the expression "6 parts per billion" sounds a great deal larger than 0.006 parts per million, even though they are the same. Scale is also a factor in communicating probabilities. For example, a risk agent that is expected to result in the death of 1.4 people in 1,000 can equally be expressed as:

- The risk is 0.0014.
- The risk is 0.14 percent.
- In a community of a thousand people, we could expect 1.4 to die as a result of exposure.

Although these alternatives are equivalent, their meaning to, and effect on, audiences are not. The first term may make the risk seem smaller, whereas the last term may make the risk seem larger. Confusion can often be avoided by embedding risk numbers in words that help clarify their meaning or translating the numbers into a comparison that people can imagine. For example, "a risk of 0.047" is comprehensible to only a few people. By comparison, it is much easier to understand that roughly 5 people in an auditorium of 100 would be affected. This embedding process can also be accomplished through visuals, including graphs, charts, animation, and pictures. But as mentioned earlier, embedding must be done carefully so that appropriate and accurate comparisons are made.

Estimates. Many risk numbers—for example, risk probabilities and mortality rates—are estimates based on modeling and not real life experience. Because they are based on models, many risk numbers often have substantial uncertainties and margins of error. In some cases, uncertainties in risk estimates arise from the use of different assumptions and extrapolations. In other cases, uncertainties arise because the risk is very low, because data are still preliminary, because diagnosis is difficult, or because measurement is difficult.

Because of uncertainties, one approach to communicating risk numbers is to report the most likely estimate of risk.

A second approach is to report the upper-bound, "worst case," or maximum estimate of risk. A third, and more complete approach, is to report the most likely estimate, along with the highest and lowest estimates. For example:

"Our best estimate is *a*. Our cautious, worst-case estimate is *b*. The highest estimate we have heard, from scientists at University X, is *c*."

Context. In presenting risk numbers, it is often useful to explain how the risk numbers were obtained. For example, it is often useful to explain how mortality rates and probabilities (1 in a million) are calculated. Demystifying the risk assessment process has several benefits. Perhaps most importantly, it enables the presenter to make points that may be important for people to understand. For example, it allows the presenter to make the point that the presence of a risk agent does not necessarily signify a significant health risk. This point is often extremely difficult to communicate. For a risk agent to pose a risk, *an exposure must occur.* There must be a way for the risk agent to get from where it is to where people or the things they value are.

A second critical point for the public to understand about risk assessment is that after a route of exposure is established, the next important question is the concentration of the risk agent that may reach people. Concentration amounts of exposure are typically far lower than the concentration amounts at the source. Moreover, they often become even lower with the passage of time and distance. Risk assessors consider not only *whether* a risk agent is present but also *how much* is present.

Comparisons. Risk numbers are often communicated as part of a comparison. The goal of comparisons is to make the original risk number more meaningful by comparing it to other numbers. For example, small probabilities are often difficult to conceptualize: just how small, really, is "1 in 10 million" or "a probability of 0.00015"?

Comparisons, although useful for putting numbers in perspective, can create their own problems. For example, use of the concentration comparisons found in table 2 can lead to disagreements. The statement that 1 part per million of a contaminant is equal to one drop in an Olympic-size swimming pool or one drop of vermouth in a million-gallon martini is typically intended to help the reader understand how "small" an amount exists. However, for some individuals, such comparisons represent a subtle way of trivializing the problem and prejudging acceptability. Furthermore, concentration comparisons can sometimes be misleading because risk agents vary widely in terms of the amount of the agent needed to sicken or kill someone.

Risk Comparisons. Comparing one risky thing to another helps people grasp how likely something is to cause harm compared to something else. Probabilities are only one of many kinds of information on which people base decisions about risk acceptability. Risk numbers cannot preempt those decisions. *No explanation of a risk number will be successful if it appears to be trying to settle the question of whether a risk is acceptable*.

Although more research is needed, the most effective comparisons appear to be:

› Comparisons of the same risk at two different times

› Comparisons with a regulatory standard

› Comparisons with different estimates of the same risk

› Comparisons of the risk of doing something versus not doing it

› Comparisons of alternative solutions to the same problem

› Comparisons with the same risk as experienced in other places

All of the types of comparisons have some claim to relevance and legitimacy.

The least effective comparisons appear to be those that disregard the risk perception and outrage factors that people consider important in evaluating risks. The most important of these include voluntary versus coerced, natural versus human-made, familiar versus unfamiliar, not memorable versus memorable, dreaded versus not dreaded, chronic versus catastrophic, knowable versus unknowable, individually controlled versus controlled by others, fair versus unfair, ESSAY (cont.)

morally irrelevant versus morally relevant, trustworthy sources versus untrustworthy sources, and responsive process versus unresponsive process.

Conclusion

In conclusion, as with any information contained in a news story, only health risk numbers that can be supported by reliable data should be selected. Some of the data manipulations discussed in this article are just simple transformations of the same number. However, other transformations can radically affect the way the audience hears, understands, and remembers the number.

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TABLE 1: VARIOUS ANNUAL AND LIFETIME RISKS (U.S. POPULATION ONLY)*

CAUSE OF DEATH OR HARM	ANNUAL RISK	LIFETIME RISK
Heart disease	1 in 300	1 in 4
Cancer (all forms)	1 in 510	1 in 7
Pneumonia	1 in 4,300	1 in 57
Plague	1 in 19,000,000	1 in 240,000
Anthrax (2001)	1 in 56,000,000	1 in 730,000
Suicide	1 in 9,200	1 in 120
Criminal homicide	1 in 18,000	1 in 240
Motor vehicle	1 in 6,700	1 in 88
Commercial aircraft	1 in 3,100,000	1 in 40,000
Passenger train	1 in 70,000,000	1 in 920,000
On the job	1 in 48,000	1 in 620
Accidental electrocution	1 in 300,000	1 in 4,000
Lightning	1 in 3,000,000	1 in 39,000
Shark attack	1 in 280,000,000	1 in 3,700,000

* These numbers vary from country to country. Individual risks vary.

Source: Ropeik, D. & Gray, G. (2002). *Risk: A practical guide to what's really safe and what's really dangerous in the world around you*. Boston, MA: Houghton Mifflin.

TABLE 2: CONCENTRATION COMPARISONS

UNIT	1 PART PER MILLION	1 PART PER BILLION	1 PART PER TRILLION
Length	1 in./16 mi.	1 in./16,000 mi.	1 in./16,000,000 mi. (a 6-in. leap on a journey to the sun)
Time	1 min./2 years	1 sec./32 years	1 sec./320 centuries (or 0.06 sec. since the birth of Jesus Christ)
Money	1 cent/$10,000	1 cent/$10,000,000	1 cent/$10,000,000,000
Weight	1 oz./31 tons	1 pinch salt/10 tons of potato chips	1 pinch salt/10,000 tons of potato chips
Volume	1 drop vermouth/80 "fifths"of gin	1 drop vermouth/500 barrels of gin	1 drop of vermouth in a pool of gin covering the area of a football field 43 ft. deep
Area	1 square ft./23 acres	1 square in./160-acre farm	1 square ft./the state of Indiana; or 1 large grain of sand on the surface of Daytona Beach
Action	1 lob/1,200 tennis matches	1 lob/1,200,000 tennis matches	1 lob/1,200,000,000 tennis matches
Quality	1 bad apple/2,000 barrels	1 bad apple/2,000,000 barrels	1 bad apple/2,000,000,000 barrels

Source: Rowe, W.D. & Hageman, F.J. (1984). *Evaluation methods for environmental standards*. Boca Raton, FL: CRC Press.

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