National Center for Emerging and Zoonotic Infectious Diseases

Our Work, Our Stories

2011–2012

National Center for Emerging and Zoonotic Infectious Diseases

DEPARTMENT OF HEALTH & HUMAN SERVICES USA
CDC

You can download and print
NCEZID: Our Work, Our Stories 2011–2012
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▲ *Courtesy Olaf Hajek*

About our name

Infectious diseases are illnesses caused by germs (such as bacteria, viruses, and fungi) that enter the body, multiply, and can cause an infection.

- Some infectious diseases are contagious (or communicable), that is, spread from one person to another.
- Other infectious diseases can be spread by germs carried in air, water, food, or soil. They can also be spread by vectors (like biting insects) or by animals.

Emerging means infections that have increased recently or are threatening to increase in the near future. These infections could be

- completely new (like SARS).
- reappearing in an area (like dengue in south Florida).
- old infections that have become resistant to antibiotics (like staph and the deadly gram-negative infections that are cropping up in hospitals).

Zoonotic means infectious diseases of animals that are spread to humans by ticks, mosquitoes, or fleas or contact with animals; these diseases include

- Lyme disease (spread by ticks).
- West Nile virus disease (spread by mosquitoes).
- rabies (spread by mammals).

Letter from the Director

For the National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), the past 2 years have presented wide-ranging challenges as well as exciting new opportunities to maximize the health of people both in the United States and abroad. The Center's work during that period is bracketed by our response to large and devastating outbreaks— from cholera in Haiti in fall 2010 to West Nile virus disease and fungal meningitis that spread across the country in the summer and fall of 2012. Guided by the Center's vision to "prevent infections, protect people, save lives," we have made notable progress on many fronts in diminishing the burden of infectious disease.

National Center for Emerging and Zoonotic Infectious Diseases: Our Work, Our Stories 2011–2012 serves several purposes. First, it highlights major accomplishments from fiscal years 2011 and 2012 (October 1, 2010–September 30, 2012). NCEZID is CDC's newest national center, created during the organizational improvement initiative of 2009–2010. One of our overarching principles is to be transparent and accountable, and this first report (known by the shorter title *NCEZID: Our Work, Our Stories 2011–2012*) signals that we are committed to providing regular updates about our progress in protecting people from emerging and zoonotic infectious diseases. And finally, *NCEZID: Our Work, Our Stories 2011–2012* places NCEZID's accomplishments in the context of the larger public health missions of CDC and the Office of Infectious Diseases.

NCEZID's work overall directly reflects current CDC priorities to strengthen surveillance and epidemiology, enhance the agency's ability to support state and local public health, provide leadership in global health, promote effective public health policy, and address the leading causes of death, illness, and disability. And, as home to two of seven of CDC's domestic "winnable battles" (healthcare-associated infections and food safety), NCEZID is developing scalable strategies that will have a measurable and significant impact on public health. *NCEZID: Our Work, Our Stories 2011–2012* also shows how NCEZID priorities and achievements align with the principles guiding all infectious disease work throughout the agency, as described in *A CDC Framework for Preventing Infectious Diseases: Sustaining the Essentials and Innovating for the Future.* And, lastly, the review of achievements of the past 2 years helped inform the direction for the Center's future work, as outlined in the newly released *National Center for Emerging and Zoonotic Infectious Diseases Strategic Plan, 2012–2017*.

The prevention and control of emerging and zoonotic infectious diseases is arduous work, but we have made great strides since the fall of 2010. To provide a context for better understanding the significance of these accomplishments, this report begins with a section identifying NCEZID's core value to CDC and public health overall. *Our many roles* delineates the parts of the broader agency infectious disease mission that NCEZID is responsible for making happen— responding to outbreaks, managing world-class laboratories, ensuring public health preparedness, overseeing a unique portfolio of global activities, and investigating how diseases from animals are spread to people.

Continued on next page ►

These roles direct action on a variety of fronts. *Taking action* details the Center's work that focuses on healthcare-associated infections, antimicrobial resistance, foodborne disease and food safety, vector-borne diseases, high-consequence pathogens, global quarantine and migration, and waterborne disease and water safety. Most, but not all, of the Center's work falls within one of these areas. Absence from this report, however, does not signify lack of importance. *NCEZID: Our Work, Our Stories 2011–2012* is not a comprehensive summary of all Center activities of the past 2 years. Limited space dictates that it is more like a highlight reel of our most notable accomplishments.

NCEZID is committed to maximizing health by preventing and controlling emerging and zoonotic infectious diseases even in the face of projected economic constraints. That means finding better ways to perform world-class science; translate and communicate results in an accurate, timely, and effective manner; and promote fiscal and program efficiencies. Enhancing our ever-expanding extensive network of partnerships, both inside and outside CDC, is also critical to ensuring that more lives here and around the world are saved. Looking ahead, we will continue to strive and, when possible, redouble efforts to meet high-priority goals— expanding our portfolio of work on antimicrobial resistance, exploring innovative new approaches for detecting pathogens and diagnosing diseases, strengthening our foodborne disease surveillance and response capabilities, and bolstering the nation's preparedness for emerging infectious disease threats, to name just a few. Woven throughout all the work we do is our commitment to promote health equity, that is to identify ways we can reduce infectious disease disparities in vulnerable populations with distinct needs, such as racial and ethnic minorities, immigrants, and people who are economically disadvantaged.

But as we usher in a new year, NCEZID will be guided by a new strategic plan that has identified the essential activities and services related to the Center's mission that must be sustained— and where possible advanced— in the 5 years ahead. We in the NCEZID Office of the Director also understand that finding new and better ways to champion the professional growth and development of our close to 1,900-member workforce is inextricably linked to our success in reducing illness and death from infectious disease.

On behalf of the extraordinarily dedicated and talented staff of the National Center for Emerging and Zoonotic Infectious Diseases, I am pleased to present *NCEZID: Our Work, Our Stories 2011–2012*, a report of our accomplishments and activities during the past 2 years.

Beth P. Bell, MD, MPH
Director,
National Center for Emerging and Zoonotic Infectious Diseases

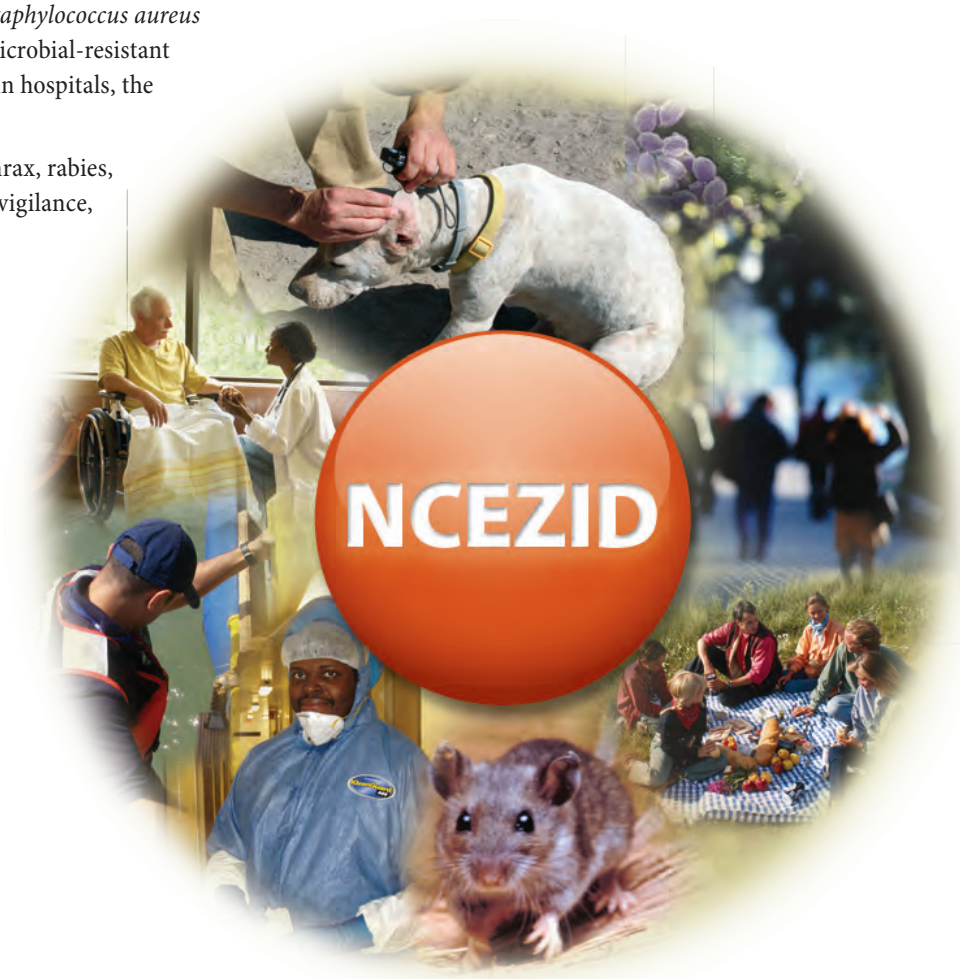
January 2013

Guarding against the gamut of infectious diseases— NCEZID's seven divisions

NCEZID is made up of seven divisions that work with partners throughout the United States and around the world to prevent illness, disability, and death caused by a wide range of infectious diseases— from the rare but deadly, like anthrax and Ebola hemorrhagic fever, to the more common, like foodborne disease and healthcare-associated infections. Because the diverse workforces of these seven divisions include an equally broad spectrum of infectious disease expertise, we are better able to identify mysterious— and sometimes very lethal— illnesses, contain outbreaks that sometimes span many states, and save lives.

Some of the challenges NCEZID's seven divisions face daily include

- **Foodborne illness.** One in six Americans gets sick each year from eating contaminated food. Illnesses caused by *Salmonella* and *E. coli* infections are costly and all too common.
- **Healthcare-associated infections.** At any given time, about 1 in every 20 patients has an infection related to their hospital care. Infections are popping up in hospitals, nursing homes, and other healthcare settings, like dialysis centers.
- **Antimicrobial resistance.** Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the more familiar types of antimicrobial-resistant infections, but many others are rapidly spreading in hospitals, the community, and even on the farm.
- **Deadly diseases.** Germs that cause smallpox, anthrax, rabies, Ebola hemorrhagic fever, and plague require 24/7 vigilance, especially because of the threat of bioterrorism.
- **Illnesses that affect immigrants, refugees, migrants, expatriates, and travelers.** Travelers can unknowingly pick up— and return with— infectious diseases, even some that we thought were no longer a threat, like measles.
- **Diseases spread by mosquitoes, ticks, and fleas.** Each year, scientists discover, on average, about two new mosquito-transmitted viruses that can make people sick.



The Center's seven divisions

Division of Foodborne, Waterborne, and Environmental Diseases

▲ CDC works to prevent diseases caused by contaminated food and water and dangerous fungal infections, usually found in soil. But in fall 2012, fungal-contaminated steroid injections caused a multistate outbreak of fungal meningitis and other infections.

Focus:

To prevent diseases caused by contaminated food or water or by animal contact, and detect and contain fungal infections.

Some key activities:

- Conduct surveillance of foodborne illnesses to track trends, identify risk factors, define the burden, find new drug resistance, and attribute illnesses to specific foods.
- Quickly detect, investigate, and control foodborne outbreaks, including those spanning multiple states like the outbreak of *Listeria* in cantaloupes that involved 28 states.
- Direct work in global water, sanitation, and hygiene (WASH)-related disease to identify new ways to reduce diarrheal diseases, such as cholera and typhoid.
- Use new communication and outreach to keep our domestic drinking water, swimming pools, lakes, and other water sources safe.
- Detect domestic and global fungal threats, such as candidiasis, cryptococcosis, and mucormycosis, so that they can be quickly contained before causing harm.

http://www.cdc.gov/ncezid/dfwed/

▲ CDC's Thomas George uses a Jacob's ladder to conduct an offshore boarding of a vessel with US Coast Guard and Customs and Border Protection partners. *Courtesy Gale Galland*

Division of Global Migration and Quarantine

Focus:

To protect the health of our communities in a globally mobile world by preventing the introduction, transmission, and spread of communicable diseases.

Some key activities:

- Manage programs to screen, diagnose, treat, and prevent infectious diseases in immigrants and refugees.
- Partner for health at airports, seaports, and land borders.
- Provide vital health information to help international travelers stay healthy before, during, and after their trips.
- Promote the safe importation of animals and animal products through enforcement of regulations.
- Respond to global public health emergencies to slow the introduction and spread of illness to US communities— for example, cholera in Haiti, the radiation disaster in Japan, H1N1 pandemic flu, and tuberculosis outbreaks near the US-Mexico border.

http://www.cdc.gov/ncezid/dgmq/

Division of Healthcare Quality Promotion

Focus:

To protect patients and healthcare workers and to promote safety in healthcare settings.

Some key activities:

- Investigate and respond to emerging infections and adverse events in healthcare facilities, including healthcare-associated infections; antimicrobial drug-resistant infections; adverse events from the use or misuse of a drug (like accidental overdoses); blood, organ, and tissue safety; and vaccine safety.
- Support the enhancement of state infrastructure for elimination of healthcare-associated infections.
- Develop and disseminate evidence-based guidelines and recommendations to prevent and control healthcare-associated infections, antimicrobial resistance, and medication errors.
- Provide healthcare facilities, states, and federal agencies with data for action through the National Healthcare Safety Network (NHSN), a tool for monitoring and preventing healthcare-associated infections, used by healthcare facilities in all 50 states.

http://www.cdc.gov/ncezid/dhqp/

▲ Healthcare-associated infections are also a problem for the millions of older adults living in nursing homes and assisted living facilities.

Division of High-Consequence Pathogens and Pathology

Focus:

To improve public health and safety domestically and globally by preventing illness and death caused by highly lethal or unexplained diseases.

Some key activities:

- Monitor, investigate, and study diseases caused by highly hazardous bacteria and viruses— such as those that cause anthrax and viral hemorrhagic fevers (like Ebola in Africa).

▲ In 2012, 10 confirmed cases of hantavirus infection were reported in people who had recently visited Yosemite National Park. Infection was caused by exposure to hantavirus-infected rodents such as deer mice (pictured).

- Investigate wildlife zoonoses and find new ways to prevent zoonotic infections (like rabies and leptospirosis) that spread from animals to people.
- Conduct investigations of unexplained critical illness and death and diseases of unknown origin and efforts to uncover new infectious diseases. This work contributed to the identification of SARS and hantavirus pulmonary syndrome.
- Develop better and faster diagnostic tests that help us improve our understanding of the impact of vaccines on human papillomavirus infection.
- Track specific prion diseases (diseases that attack the brain and central nervous system), such as Creutzfeldt-Jakob disease.
- Implement educational campaigns and outreach efforts on chronic fatigue syndrome, including diagnosis and intervention recommendations for physicians and coping/management options for patients.

http://www.cdc.gov/ncezid/dhcpp/

Division of Preparedness and Emerging Infections

Focus:

To assure that the public health system can detect and respond to infectious disease threats, with a special focus on emerging pathogens, biological warfare agents, and the diseases that are of particular concern to people living in Alaska and other Arctic regions.

Some key activities:

- Help prepare CDC and its partners to use vaccines, drugs, and diagnostic tests— countermeasures that would be critically important to saving lives during a large-scale public health emergency caused by bioterrorists.
- Collaborate with public health laboratories throughout the world to implement the quality standards necessary for effective disease detection and successful partnerships.
- Serve as an effective steward for the Emerging Infections Program and the Epidemiology and Laboratory Capacity for Infectious Diseases Cooperative Agreement to support infectious disease epidemiologic investigations, laboratory infrastructure and expertise, and surveillance for state and local health departments.
- Manage the Laboratory Response Network, which links 160 highly specialized laboratories, including health department laboratories, federal and military laboratories, environmental testing and diagnostic veterinary laboratories, as well as international laboratories. This unique network of laboratories is designed to respond to bioterrorism, chemical terrorism, and other public health emergencies.
- Target diseases that are a special problem for Alaska Natives, such as viral hepatitis and foodborne botulism.

http://www.cdc.gov/ncezid/dpei/

◀ Preparing CDC and its partners to use vaccines, drugs, and diagnostic tests would be critically important to saving lives during a public health emergency, such as the release of a biological agent like *Bacillus anthracis*, which causes anthrax.

Division of Scientific Resources

Focus:

To provide support to CDC laboratories in responding to public health needs through the supply of state-of-the-art technology and high-quality services and products.

Some key activities:

- Provide genomic sequencing, proteomics technologies, oligonucleotide and peptide synthesis, and bioinformatic support to aid the identification and characterization of bacteria, viruses, fungi, and other pathogens.
- Provide CDC laboratorians with high-quality laboratory products and services in compliance with US Food and Drug Administration regulations.
- Distribute investigational and licensed drugs and unique biologicals (antitoxins) to approved physicians for treatment of rare, tropical, or exceptional diseases.
- Provide accessioning services for specimens sent to CDC for reference and diagnostic testing and manage shipment of outgoing specimens, microbiologic organisms, and biologicals.

http://www.cdc.gov/ncezid/dsr/

▲ Providing laboratorians throughout CDC with state-of-the-art technology and high-quality products that they need to do their work.

Division of Vector-Borne Diseases

Focus:

To identify and respond to vector-borne disease that affects human health, domestically and globally.

▲ Checking dog's ears for ticks during an outbreak of Rocky Mountain spotted fever. *Courtesy Craig Manning*

Some key activities:

- Identify and respond to emerging and newly discovered pathogens.
- Improve diagnostic tests and serve as a reference laboratory for vector-borne pathogens.
- Investigate improvements to pesticides and repellents that target mosquitoes, ticks, and fleas.
- Develop and evaluate vaccines for dengue, Japanese encephalitis, and other vector-borne viruses and bacteria.
- Train domestic and global public health workers to prevent, diagnose, and control vector-borne diseases.
- Conduct surveillance and monitor impact and spread of vector-borne diseases.

http://www.cdc.gov/ncezid/dvbd/

About our partners

We would be able to accomplish little without the help of our many partners. We don't have enough space to list them all, but here are a few examples of notable work that would not have happened without their contributions:

- **The September 2011 outbreak of listeriosis**, the deadliest foodborne outbreak in nearly a century, was linked to a single cantaloupe farm in Colorado and is a textbook example of how coordinated public health partnerships save lives. It is estimated that up to twice as many people would have been infected had it not been for the quick work of alert Colorado public health officials, CDC's PulseNet laboratory analysis, and the US Food and Drug Administration's trace-back investigation. The outbreak was detected, its source identified, and a national warning issued— all in just a matter of days.
- **Although human rabies** has been virtually eliminated in the United States, globally the disease kills more than 55,000 people each year, mostly children, usually from dog bites. The Center's rabies group works closely with partners such as the World Health Organization and is engaged in several international collaborations, including an award-winning grassroots rabies control project in the Philippines. Despite major obstacles to rabies control in resource-poor countries, NCEZID has outlined steps for a way forward to work with partners to eradicate this horrific— and highly preventable— disease.
- **Epidemic cholera** emerged in Haiti in October 2010, and the disease spread rapidly throughout the country, sickening more than half a million people. NCEZID experts worked closely with many partners— including colleagues from CDC's Center for Global Health and other US agencies, the World Health Organization, international governments, and nongovernmental organizations— in an international response to assist Haiti. The effort is estimated to have saved at least 7,000 lives. NCEZID continues to focus on ways to improve water, sanitation, and hygiene systems as part of a strategy to prevent cholera-related illness and deaths in Haiti.

NCEZID 2011–2012: Highlighted accomplishments

- Reported substantial decreases in healthcare-associated infections. (pg 61)
- Developed one of the first dengue candidate vaccines to enter human clinical trials that will, if trials are successful, protect people from all four dengue viruses. (pg 75–76)
- Developed and disseminated a rapid, inexpensive bedside diagnostic dipstick test to reduce the time and cost of diagnosing plague. (pg 25)
- Integrated hygiene education into antenatal care clinics in Malawi that will help to improve hygiene to reduce illness and disease from diarrhea and other diseases transmitted through water. (pg 88)
- Published the first estimates of foodborne illness in a decade that also included estimates for hospitalizations and deaths caused by these illnesses. This complex analysis included 31 pathogens known to cause foodborne illness and unspecified agents that cause acute gastroenteritis illnesses. (pg 71)
- Developed a highly effective natural repellent and insecticide against mosquitoes and ticks and licensed it to commercial partners to develop products for consumer purchase. (pg 74)
- Completed successful trials for a vaccine against Rift Valley fever, an acute fever-causing viral disease, for use in livestock. Vaccinating livestock will eliminate one of the most significant sources of Rift Valley fever in people living in Africa and the Arabian Peninsula. (pg 79)
- Initiated an emergency response to a multistate outbreak of fungal meningitis and other infections among patients who received contaminated steroid injections; worked closely with state and local health departments to track down and contact more than 14,000 exposed patients; issued clinical diagnostic and treatment guidance; and rapidly developed a new laboratory test to help diagnose these infections. This effort illustrates the power of public health in action— quickly detecting a serious health problem, alerting the public, and leading a targeted response— to protect the country from infectious disease threats. (pg 99)

NCEZID 2011–2012: Highlighted accomplishments, continued

▲ Following CDC's guidance, healthcare workers at a clinic in a refugee camp in Thailand watch to make sure that refugees with tuberculosis are taking their medicine before they come to the United States.

- In collaboration with the Colorado Department of Public Health and Environment, quickly responded to a deadly outbreak of listeriosis in cantaloupes. The numbers of cases and deaths would have been 25% higher without this timely, effective public health intervention. (pg 71)

- Saved state public health departments millions of dollars through improved tuberculosis screening and treatment of immigrants and refugees prior to their arrival in the United States.(pg 84)

- Identified three new strains of germs that are difficult to treat because they have high levels of resistance to antibiotics. Better understanding of this family of germs, called carbapenem-resistant Enterobacteriaceae (or CRE), will help us more effectively diagnose and treat them. (pg 66)

- Provide healthcare facilities, states, and federal agencies with data for action through the National Healthcare Safety Network (NHSN), a tool for monitoring and preventing healthcare-associated infections, used by healthcare facilities in all 50 states. (pg 62)

- Investigated and provided laboratory testing through the Laboratory Response Network (LRN) for a case of inhalation anthrax in Minnesota. The LRN helps to quickly detect and respond to acts of chemical and biological terrorism and other high-priority public health emergencies. (pg 34)

- Released *A Public Heath Action Plan to Combat Antimicrobial Resistance* in collaboration with the federal Interagency Task Force on Antimicrobial Resistance. (pg 67)

- Discovered two new tick-borne pathogens in the United States. Further research into these pathogens will help us better understand their role in human illness and how to decrease it.(pg 75)

▲ A new *Ehrlichia* species was one of the two new tick-borne pathogens discovered. It causes ehrlichiosis, a bacterial disease commonly transmitted to people by the bite of an infected lone star tick (pictured).

▲ The 1,000 or more foodborne outbreaks that are reported annually reveal familiar culprits, like *Salmonella*.

NCEZID 2011– 2012: Highlighted accomplishments, continued

- Improved methods to more quickly detect and respond to multistate outbreaks of foodborne illness that will help us respond even faster to future outbreaks. (pg 71)

- Worked in collaboration with Oxford University Press to develop a mobile app of *CDC Health Information for International Travel 2012 (The Yellow Book)*. This collaboration demonstrates the benefits of public-private partnerships. (pg 84)

- Reported that higher rates of "water-washed disease," caused by inadequate hand or body hygiene, are linked directly to an inadequate supply of clean water in rural Alaska Native households. Better understanding of the health impact of the lack of running water in nearly one-quarter of rural Alaska Native homes is the first step in reducing disease. (pg 46)

CDC's laboratories at Fort Collins, Colorado, helped develop vaccines to prevent dengue. *Courtesy Judith Lavelle* ▶

CDC responded to an outbreak of dengue in the Marshall Islands. Here a rapid diagnostic test that detects the presence of dengue virus in people with dengue-like symptoms is being demonstrated. *Courtesy Tyler M. Sharp*

Our many roles

Supporting CDC's infectious disease mission by…

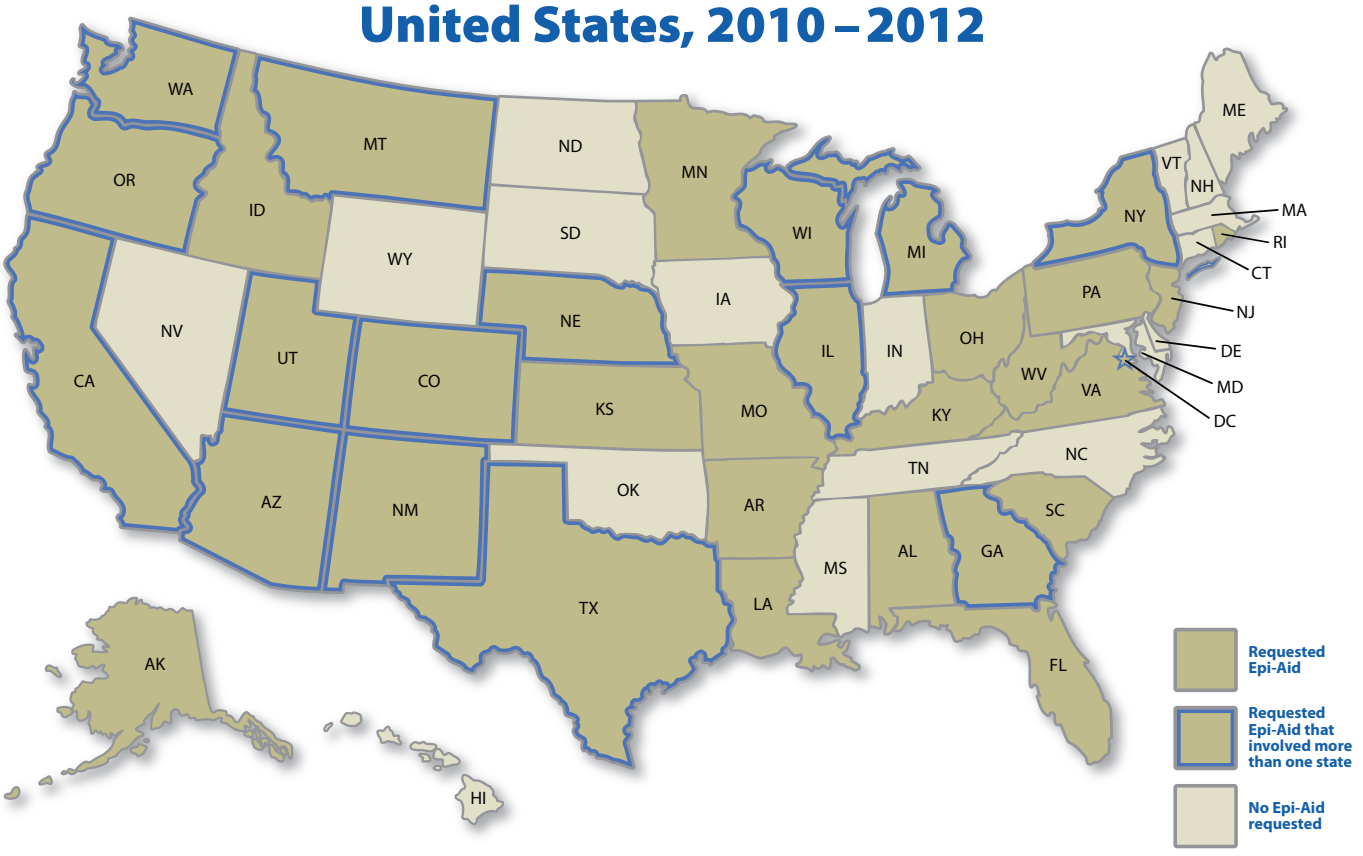
Responding to outbreaks

CDC plays a critical role in the investigation of local, state, national, and international outbreaks of diseases, such as a group of people who get sick from contaminated food or a cluster of hospitalized patients acquiring an infection. Since 1946, CDC has provided rapid assistance to states, federal agencies, international organizations, and ministries of health, often through formal requests for epidemic-assistance investigations, called Epi-Aids. The Epi-Aid mechanism provides CDC with the agility to respond rapidly to serious and urgent public health crises, and NCEZID conducts more Epi-Aid investigations of outbreaks each year than any other Center at CDC. From October 2010 to September 2012, we responded to more than 100 Epi-Aid requests (domestic and worldwide) for assistance with outbreaks of infectious diseases.

NCEZID responds to outbreaks of infectious diseases at the request of a state health department or other countries. We work in close collaboration with the health department to ensure a rapid and coordinated investigation and response. We augment varied state and local capacity through technical assistance, epidemiologic investigation, and laboratory support. NCEZID experts are also involved when the source of infection is very uncommon, new, or complex. For example, we recently identified a new tick-borne pathogen, an *Ehrlichia muris*-like agent, in Missouri in collaboration with the state health department. We seek to identify and stop emerging problems before they can spread and endanger public health.

Outbreaks often cross state borders. In these instances, NCEZID leads coordination across health departments, including communication and epidemiologic investigation, to enable more rapid identification and elimination of the source of disease during an outbreak. Our response to an outbreak does not end once the source of the outbreak has been identified and stopped. We use the information gathered during the investigation to work with health departments, partners, other federal agencies, and policymakers to implement strategies to prevent future outbreaks. NCEZID's response to outbreaks of infectious disease along with a thoughtful evaluation of strategies to prevent further outbreaks continues to improve public health.

Selected NCEZID Epi-Aid investigations, United States, 2010 – 2012



Selected NCEZID Epi-Aid investigations, United States, October 2010 – September 2012

State	
AL	Investigation of an outbreak of a bacterial infection (*Serratia* spp. bacteremia) in patients being fed through an IV
AK	Investigation of an outbreak of CA-MRSA (community-associated methicillin-resistant *Staphylococcus aureus*) skin infections in the Yukon-Kuskokwim Delta region
AZ	Investigation of a cluster of cases of a suspected, rare disorder (Guillain-Barré syndrome) in residents of the border area of Arizona and Sonora, Mexico
AZ	Evaluation of dogs as indicators for human risk for tick-borne disease (Rocky Mountain spotted fever)[1]
AZ	Evaluation of a tick-borne disease (Rocky Mountain spotted fever) prevention program on the San Carlos Apache Reservation[2]
AZ	Multistate investigation of suicide among Bhutanese refugees in the United States
AZ	Multistate assessment of risk for a tick-borne disease (Rocky Mountain spotted fever) in the Navajo Nation[3]
AZ	Investigation of a fatal case of a tick-borne disease (Rocky Mountain spotted fever) and a dog serosurvey (blood survey) in the Hopi Tribe[4]
AZ	Survey of a dog serosurvey (blood survey) in the Tohono O'odham Nation[1]

Selected NCEZID Epi-Aid investigations, United States, October 2010 – September 2012

State	
AR	Investigation of an outbreak of foodborne illness (from *Salmonella*) at two prisons
CA	Investigation of human rabies
CA	Investigation of hantavirus pulmonary syndrome (a sometimes deadly disease spread by infected mice and rats) in visitors to Yosemite National Park
CA	Multistate evaluation of the mental and physical health of Iraqi refugees resettled in the United States
CA	Multistate investigation of fungal eye infections after eye surgery
CO	Investigation of an outbreak of foodborne illness (from *Listeria*) among pregnant women exposed to contaminated cantaloupe
CO	Investigation of a cluster of invasive pneumococcal disease, which can result in pneumonia or other serious infections, in an assisted living facility
CO	Investigation of an outbreak of healthcare-associated infections (from *Clostridium difficile*) in pediatric cancer patients
CO	Multistate assessment of risk for a tick-borne disease (Rocky Mountain spotted fever) in the Navajo Nation[3]
DC	Multistate investigation of an outbreak of bacterial infections (from *Salmonella* Bareilly)
DC and international	Multistate investigation of a suspected cluster of venous thromboembolism (VTE) and pulmonary embolism (PE), which may be life-threatening, among government workers
FL	Investigation of an outbreak of drug-resistant bacterial infections (carbapenem-resistant *Klebsiella pneumoniae*) in a long-term acute care hospital
FL	Investigation of a tuberculosis outbreak associated with homelessness
FL	Investigation of a cluster of surgical site infections in patients undergoing heart surgery
FL	Investigation of an outbreak of bacterial infections (Legionnaires' disease) associated with travel on a cruise ship
GA	Investigation of an increase in the number of eye infections caused by *Acanthamoeba* keratitis
GA	Investigation of hepatitis C infections at an outpatient facility
GA	Assessment of the need for rabies treatment after exposure to a bat during an airline flight
GA	Investigation of an outbreak of bacterial infections (from group A *Streptococcus*) among residents of a nursing home
GA	Investigation of a viral infection (lymphocytic choriomeningitis virus) in mice shipped from a commercial facility
GA	Multistate investigation of mosquito-borne disease (dengue) among Georgia and Nebraska travelers returning from Haiti
GA	Multistate investigation of suicide among Bhutanese refugees in the United States
ID	Evaluation of the mental and physical health of Iraqi refugees resettled in the United States
IL	Investigation of human cowpox, a rare disease that usually resolves but occasionally causes death, in a laboratory researcher
IL	Multistate survey of NICUs reporting to the National Healthcare Safety Network
KS	Investigation of a cluster of bacterial infections (from *Burkholderia cepacia*) in patients in an acute care hospital
KY	Assessment of potential human exposure to rabies from bats in the sleeping areas of a rural learning center
LA	Investigation of an outbreak of bacterial infections (from *Francisella novicida*) among inmates at a prison

Selected NCEZID Epi-Aid investigations, United States, October 2010 – September 2012

State	
MI	Evaluation of the spread of and risk factors for a drug-resistant bacterial infection (from vancomycin-resistant *Staphylococcus aureus*) and its precursor organisms
MI	Investigation of a bacterial infection in dogs (from *Leptospira*) and evaluation of public health risk among humans
MI	Evaluation of community preparedness for emergencies
MI	Multistate evaluation of the mental and physical health of Iraqi refugees resettled in the United States
MI and international	Multistate investigation of a group of wedding attendees who were possibly exposed to foodborne illness-causing bacteria (*Listeria monocytogenes*)
MN	Investigation of a vitamin B12 deficiency in resettled Bhutanese refugees
MO	Investigation of a cluster of cases of bacterial meningitis among patients at an outpatient clinic
MO	Investigation of severe fungal soft tissue infections after a tornado
MO	Investigation of an outbreak of *E. coli* O157 infections
MT	Multistate investigation of an outbreak of bacterial infections (from Q fever) associated with a goat farm
NE	Multistate investigation of mosquito-borne disease (dengue) among Georgia and Nebraska travelers returning from Haiti
NJ	Investigation of rabies in humans
NM	Multistate assessment of risk for a tick-borne disease (Rocky Mountain spotted fever) in the Navajo Nation[3]
NY	Multistate investigation of suicide among Bhutanese refugees in the United States
NY	Multistate investigation of the persistence of eye infections caused by *Acanthamoeba* keratitis following an outbreak of *Acanthamoeba* keratitis in 2007
OH	Monitoring of human contacts and adverse health events associated with the distribution of a new oral rabies vaccine for wildlife
OR	Multistate investigation of fungal infections (from *Cryptococcus gattii*) in the Pacific Northwest
PA	Investigation of an outbreak of bacterial infections (from group A *Streptococcus*) in a skilled nursing facility
PA	Investigation of infections with a new strain of influenza (H3N2)
RI	Investigation of a cluster of bacterial infections (from *Streptococcus pneumoniae*) among children living at a psychiatric facility
SC	Identification of opportunities to prevent people from exposure to rabies in residential structures
TX	Investigation of an outbreak of bacterial infections (from *Herbaspirillum* spp.) in cancer patients
TX	Investigation of an outbreak of West Nile virus infections
TX	Evaluation of the impact of adult mosquito control during a West Nile virus outbreak
TX	Multistate investigation of suicide among Bhutanese refugees in the United States
TX	Multistate evaluation of the mental and physical health of Iraqi refugees resettled in the United States
TX and Kenya	Multistate assessment of the need for rabies treatment after exposure to a rabid zebra at a travel lodge
UT	Investigation of pruno culture (homemade wine) in a prison and its association with botulism
UT	Multistate assessment of risk for a tick-borne disease (Rocky Mountain spotted fever) in the Navajo Nation[3]
VA	Investigation of intestinal tissue death (necrotizing entercolitis) in infants receiving feeding thickening agents

Selected NCEZID Epi-Aid investigations, United States, October 2010 – September 2012

State	
WA	Investigation of intestinal tissue death (necrotizing entercolitis) in infants receiving feeding thickening agents
WA	Multistate investigation of fungal infections (from *Cryptococcus gattii*) in the Pacific Northwest
WA	Multistate investigation of an outbreak of bacterial infections (from Q fever) associated with a goat farm
WV	Investigation of a cluster of bloodstream infections (from *Tsukamurella* spp.) at an outpatient cancer clinic
WI	Multistate investigation of an outbreak of bacterial infections (from *Salmonella* Typhimurium) associated with exposure to microbiology laboratories

[1] Epi-Aid investigation was requested by the Tohono O'odham Nation, a federally recognized tribe located in Arizona.

[2] Epi-Aid investigation was requested by the San Carlos Apache Tribe, a federally recognized tribe located in Arizona.

[3] Epi-Aid investigation was requested by the Navajo Nation, a federally recognized tribe located in Arizona, Colorado, New Mexico, and Utah.

[4] Epi-Aid investigation was requested by the Hopi Tribe, a federally recognized tribe located in Arizona.

Investigation requests received by CDC's Emergency Operations Center

Multistate investigation of cholera cases in US residents associated with a wedding in the Dominican Republic
Multistate investigation of the incidence of diarrhea in US medical personnel working with cholera patients in Haiti

Investigations requested by US territories and freely associated states

Territory	
Marshall Islands	Investigation of an outbreak of mosquito-borne disease (dengue)
Guam	Assessment of communicable disease surveillance, including evaluation of surveillance in mobile populations
Puerto Rico	Investigation of cases of a fatal bacterial infection (from *Leptospira*)
US Virgin Islands	Investigation of an outbreak of gastrointestinal illness associated with a hotel

"Controlling outbreaks is the most immediate way we prevent disease and save lives."

Benjamin Silk, Lt. Cmdr., US Public Health Service

Dr. Benjamin Silk presents key information on listeriosis in the aftermath of the large 2011 outbreak as part of the CDC Expert Commentary in Partnership with Medscape series. ▶

Benjamin Silk, CDC disease detective

Fresh out of college, Benjamin Silk served in the Peace Corps in El Salvador in the 1990s, working on rural water sanitation. Now Dr. Silk applies his idealism to his work at CDC, where he played a key role in CDC's response to the deadliest foodborne disease outbreak in the United States in nearly a century. In 2011, a new source of *Listeria* infection— cantaloupe— was identified, and the outbreak stopped quickly. As tragic as this outbreak was (33 people died), swift and coordinated public health actions, starting in Colorado, saved lives.

Dr. Silk, who has 16 years of experience in public health disease tracking, investigation, and research as well as service as a CDC Epidemic Intelligence Service officer from 2008 to 2010 reflected, "This historic outbreak will also allow us to learn more about how to investigate *Listeria*, and especially how to prevent contamination of cantaloupes and other foods in the future. These lessons will be very valuable to the public health and regulatory officials who are working constantly to prevent *Listeria* outbreaks."

Fighting a real-life "contagion" in the Marshall Islands

The whole thing unfolded as if it were a movie. An outbreak of dengue fever, the mosquito-borne illness that occurs in tropical climates. The setting— a small island chain in the Pacific. A local government requesting assistance to control the outbreak. Tyler M. Sharp, Epidemic Intelligence Service (EIS) officer at the CDC Dengue Branch, was assigned to head to the middle of the Pacific (4½ hours by plane west of Honolulu) and remembers thinking, "I certainly didn't want to end up like Kate Winslet's character in the Hollywood blockbuster *Contagion*."

There was lurking concern about the possibility of dengue activity in the Marshall Islands, so sporadic testing of patients with fever was being done using rapid diagnostic tests for dengue. Indeed, the outbreak began with three children showing up in a hospital in Majuro, the capital of the Republic of the Marshall Islands, with the same symptoms: fever, headache, and body pain. The astute clinical team who attended all three children connected the dots, "This is dengue." Positive rapid tests on these children launched recognition of the outbreak and triggered the response. By the time the CDC team arrived in Majuro, the city teemed with dengue. Mosquito experts from CDC surveyed the local community and found mosquitoes that transmit dengue virus everywhere they looked.

CDC, along with the US Department of Defense; the World Health Organization; the Department of State and USAID; governments of Taiwan, Japan, and Australia; and the local government and community worked together on many fronts. Local healthcare professionals were trained in best methods to diagnose and treat dengue. Surveillance was established to identify cases throughout the island-country that extends 1,000 miles from the northernmost to southernmost point. Teams began wide-scale mosquito control efforts to reduce, and where possible, eliminate mosquito-producing sites in the two major population centers of Majuro and Ebeye. As it turned out, not only did EIS officer Sharp survive, but so did each of the nearly 1,300 people who had come down with dengue during the roughly 2-month-long outbreak.

▲ To keep dengue patients in an area where nurses and doctors could keep a close eye on them, a dengue ward was established in what had been the gym in Majuro Hospital. Hospitalized patients were asked to stay under mosquito nets to prevent mosquitoes from feeding on them, an attempt to reduce the risk of hospital workers and other patients becoming infected. *Courtesy Tyler M. Sharp*

Tornado survivors battle deadly fungus in Joplin, Missouri

On May 22, 2011, an EF5 tornado— the highest classification for a twister— ripped through the heart of Joplin, Missouri, killing 161 people and leveling homes, buildings, and trees. The tornado damaged or destroyed more than 8,000 structures, one-third of the city.

When people sustain massive traumatic injuries, their natural defenses are weakened, paving the way for pathogens (germs) to enter the body and cause infection. Some injured survivors in Joplin began showing signs of an unusual wound infection, and it was several days before it was diagnosed as a serious fungal infection. When the news of a potential outbreak of fungal infections reached the community, there was a lot of fear and concern, especially for relief workers who worried they might also be at risk.

CDC sent a team to Missouri to help with the investigation. The local laboratories in Missouri were quickly able to identify the infection as mucormycosis so that the medical teams could begin the correct treatment. When the first samples arrived at CDC from Joplin, the type of fungus had not been confirmed. The laboratory team identified the type of fungus causing the mucormycosis skin infections as a type found in soil and water around the world and known occasionally to cause the same type of skin infections in people who had been involved in motor vehicle crashes or other disasters. Epidemiologists, however, are still trying to identify exactly how people were exposed to the fungus.

▲ This photo, taken approximately 5 weeks after the tornado, shows the remains of a mucormycosis case-patient's home that was destroyed.

Nothing can prepare an investigation team for the emotional interviews with trauma survivors. As one reflected, "Every disaster is different, and probably whether you witness one or a hundred, every single one of them is going to leave a lasting impression. I will never, ever forget some of those stories or the devastation that we saw in Joplin."

Oh, give me a home where brown dog ticks don't roam

Rocky Mountain spotted fever (RMSF) emerged in eastern Arizona in 2003. It causes moderate to severe illness, but when treatment is delayed, it can develop into severe illness, even death. In this region, the descriptively named brown dog tick is the vector for transmission. An unchecked dog population plays an important role, because dogs serve as hosts to these ticks in each life stage. But preliminary findings from a 2012 pilot project in a neighborhood on the San Carlos Apache Reservation are causing optimism among scientists working to reduce RMSF. Improving people's health, it turns out, has everything to do with improving the health of pets.

From 2003 to 2012, several factors converged to cause a regional RMSF epidemic that extended across four reservations. An absence of organized animal control programs, compounded by limited access to veterinary care, resulted in an ever-increasing dog population, with tick-infested stray dogs roaming freely. Each year, large numbers of puppies are born, providing a ready and sustained source of hosts from which ticks may feed.

In 2012, CDC worked with tribal, public, private, and academic partners to launch the "RMSF Rodeo," a pilot project on the San Carlos Apache Reservation. One of the neighborhoods on the reservation was selected for the project. About 95% of homes in the neighborhood participated in the pilot. In the spring-summer months, neighborhood yards were sprayed for ticks four times, instead of just once. Every dog received a free collar and license and an 8-month tick collar from Bayer Chemical Company Healthcare/Animal Health Division. Free spay and neuter services were offered. Residents were encouraged to restrain free-roaming dogs by tether or fence. The project proved highly successful; 99% of dogs in the RMSF Rodeo community were tick-free by the project's conclusion. By designing a small and well-scaled pilot project that the tribe could expand to the entire reservation, it is hoped that Rocky Mountain spotted fever in eastern Arizona will be significantly reduced.

One & Only—Preventing injection errors in healthcare settings

"One and only" refers to using needles and syringes only once. They should not be used for more than one patient or reused to draw up additional medication. Unfortunately, Dr. Evelyn McKnight, mother of three, learned the hard way that this practice was not always followed. Dr. McKnight was infected with hepatitis C virus (HCV) while battling a recurrence of breast cancer in 2000. In total, 99 patients at the same oncology clinic became infected with HCV when their provider failed to follow safe injection practices. This was one of the largest healthcare-associated outbreaks of HCV infections in US history.

Since 2001, at least 150,000 US patients have been negatively impacted by unsafe medical injections. In response, CDC and the Safe Injection Practices Coalition (SIPC) are leading the One & Only Campaign to raise awareness among patients and healthcare providers about safe injection practices. The campaign aims to eradicate outbreaks resulting from unsafe injection practices and has developed the following "3 Things Every Provider Should Know":

- **Needles and syringes are single-use devices.** They should not be used for more than one patient or reused to draw up additional medication.
- **Do not administer medications** from a single-dose vial or IV bag to multiple patients.
- **Limit the use of multi-dose vials** and dedicate them to a single patient whenever possible.

◀ Injection safety is part of the minimum expectation for safe care anywhere healthcare is delivered. But CDC has had to investigate numerous outbreaks of life-threatening infections caused by injection errors. Since 2001, at least 150,000 US patients have been negatively impacted by unsafe medical injections.

Paralysis in the desert— An unprecedented binational outbreak of Guillain-Barré syndrome

On June 17, 2011, CDC was contacted by the Arizona Department of Health Services regarding an unusual number of Guillain-Barré syndrome (GBS) cases in the Yuma area, near the US-Mexico border. GBS is a disease that affects the nervous system and can cause paralysis and, in some cases, death. Nearly all cases of GBS are sporadic, and clusters of several people in one area coming down with GBS are extremely rare. *Campylobacter jejuni* is a bacterium that often causes diarrhea, and the infection (called campylobacteriosis) is a common precursor to GBS in North America. At the same time as the cluster of GBS cases had been reported, routine surveillance noted an increase in *Campylobacter jejuni* infections.

Within 2 weeks, federal, state, and local epidemiologists met with their Mexican counterparts in San Luis Rio Colorado to fully investigate the outbreak. The binational team, including Arizona's Office of Border Health, ultimately classified 26 patients with GBS, 8 cases in Arizona and 18 cases in Mexico. This unprecedented GBS cluster, 26 times the expected rate in a 3-month period, was likely caused by a large outbreak of waterborne campylobacteriosis that affected the region's water supply. CDC conducted an environmental health investigation to better understand the local water systems and establish relationships with water managers to improve water treatment and disinfection practices.

The number of people who live, work, and travel between the United States and Mexico has led to a sharing of culture and commerce as well as health issues, including infectious diseases. As this response to the outbreak of GBS demonstrates, CDC's strong relationships with border health partners and Mexican public health officials is essential for rapid and targeted response to binational outbreaks of infectious diseases. To that end, HHS Secretary Kathleen Sebelius and Mexico Secretary of Health Salomón Chertorivski signed a US-Mexico declaration on May 22, 2012, which formally adopted guidelines for both countries to follow when responding to public health events affecting both countries.

▲ Neuroepidemiologists Dr. Jim Sejvar (CDC) and Dr. Francisco Arzate (DGE Dirección General de Epidemiología) evaluate one of the patients recovering from GBS in his home in San Luís Río Colorado, Sonora. The patient had recently begun to be able to stand up on his own after battling GBS for over a month. *Courtesy Maureen Fonseca-Ford*

Supporting CDC's infectious disease mission by…

Karen Miernyk, an Alaska Native Tribal Health Consortium employee, works in the Arctic Investigations Program lab, which features outstanding diagnostics, facilities, and scientists.▲

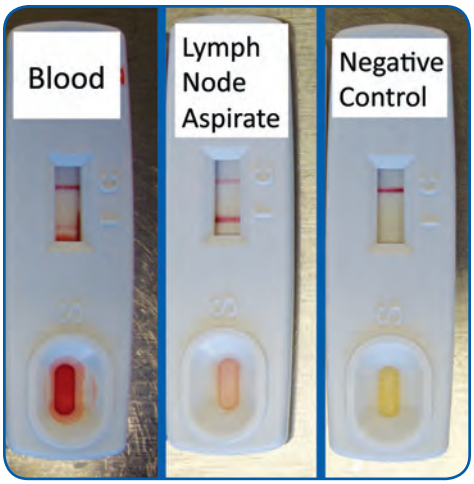
Providing laboratory science

NCEZID provides high-quality laboratory science to protect the public from infectious diseases and other health threats. Our laboratories maintain unique and critical capacities, including serving as reference labs, conducting tests on or identifying pathogens in samples from around the world, evaluating pathogens from outbreaks of infectious disease, providing reagents for use in laboratory work, developing diagnostic tests to more quickly and easily identify new diseases, and researching a wide range of pathogens to understand better the nature of significant and emerging pathogens. State health departments' laboratories and other laboratories rely on NCEZID's labs for assistance with rare and complex pathogens and other issues. Research conducted by our laboratories has been used to develop prevention strategies and technology to reduce the burden of infectious diseases.

The enormous diversity of microbes— combined with their ability to evolve and adapt to changing populations, environments, practices, and technologies— creates ongoing threats to health and continually challenges CDC's ability to prevent and control disease. CDC must always be prepared for the unexpected. That means continuing to build state and local public health laboratory capacity throughout the United States and strengthening CDC's core infectious disease laboratories.

In all we do, NCEZID relies on collaborations with other federal agencies, state and local public health agencies, healthcare organizations, and many other domestic and international partners. This is equally true of our laboratories— a central element of the nation's public health laboratory system and of the global public health laboratory system as well. CDC laboratorians partner closely with various federal agencies, the World Health Organization, ministries of health in many countries, and with industry and non-governmental organizations.

The plague dipstick—Bringing the laboratory to the bedside



Healthcare workers can be quickly trained to apply blood or lymph node aspirate to the dipstick, which yields results in 15 minutes. The dipsticks do not require electricity or refrigeration— important in an environment where electricity is sporadic. *Courtesy Martin Schriefer*

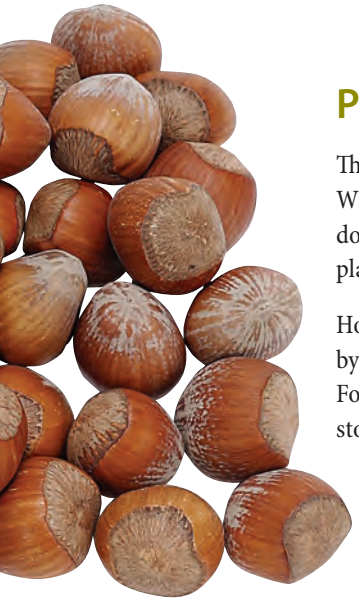
Now rare in the United States, plague remains a real threat to human health in sub-Saharan Africa and Madagascar. These regions account for more than 95% of the world's reported plague cases. Fatality rates for untreated infections range from 50% to 60% for bubonic plague to nearly 100% for pneumonic infections.

The most common form of plague is bubonic plague, characterized early by high fever, and later by painful lymph node swellings called "buboes." Additionally, the infection can spread to the patient's lungs, resulting in pneumonic plague, which may be spread to others via infectious respiratory droplets.

Unfortunately, early clinical diagnosis of plague is difficult and can delay effective treatment. Sending samples away for laboratory verification can take weeks. Overcoming these barriers to effective diagnosis and timely treatment has been a priority for CDC laboratorians. Researchers recently developed, manufactured, and field-tested a rapid, affordable diagnostic tool— the plague dipstick. The point-of-care plague dipstick brings the laboratory to the bedside.

Dipsticks provide significant improvement in terms of time, ease of use, storage, and handling. Healthcare workers can be quickly trained to apply blood or lymph node aspirate to the dipstick, which yields results in 15 minutes. The dipsticks do not require electricity or refrigeration— important in an environment where electricity is sporadic. Each test costs less than 50 cents to produce. The plague dipstick is now being submitted to the US Food and Drug Administration for final clearance.

In October 2012, this Ugandan farmer (third from left) had symptoms of plague. He was immediately tested with the rapid plague dipstick test and learned in 15 minutes that he had tested positive. He was treated with antibiotics, fully recovered, and was back working in 3 days. Also pictured: Ugandan clinical coordinator, Dr. Titus Apangu (center, wearing a tie) and NCEZID Director Dr. Beth P. Bell (far right).



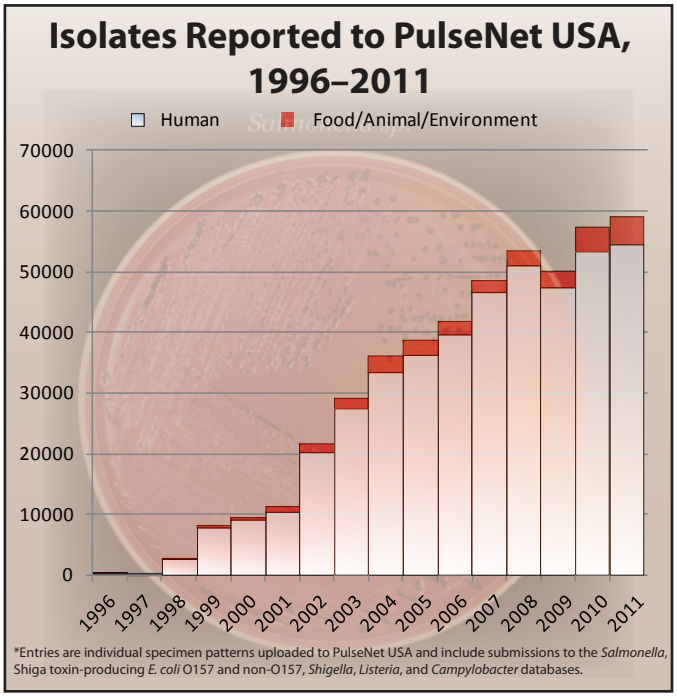
PulseNet at work— Detecting hazardous hazelnuts

They're usually in bowls of mixed nuts that are a holiday staple. But for 8 people who lived in Michigan, Wisconsin, and Minnesota, the 2010 holidays weren't so merry. Beginning in late December, they all came down with a rare and serious illness caused by *Escherichia coli* O157:H7 (*E. coli*) that was lurking in, of all places, hazelnuts.

How was this outbreak confined to only eight people? PulseNet, a national network of laboratories coordinated by CDC consisting of state and local health departments and federal agencies (US Department of Agriculture/ Food Safety and Inspection Service, US Food and Drug Administration), quickly identified that the type of *E. coli* stood out from other cases of *E. coli* infection that were occurring at the same time. Without PulseNet's ability to match up bacteria from sick people in many locations, this outbreak would not have been caught.

So how does PulseNet really work? John Besser, CDC microbiologist, explains, "PulseNet tracks foodborne illness like the FBI tracks criminals. It compares the 'DNA fingerprints' of bacteria from patients to find clusters of disease that might represent unrecognized outbreaks. Health officials can't stop an outbreak, and industry and regulatory agencies can't make changes to our food and water delivery systems, if they don't know that outbreaks are occurring. That's where PulseNet comes in. Public health laboratories in all 50 states and food regulatory and agriculture agencies across the United States use PulseNet to track foodborne diseases within their jurisdictions and compare their findings to those from laboratories across the network through a central database at CDC in Atlanta. Because food is truly an international commodity, PulseNet International also has been established in 82 countries around the globe."

In less than 3 months, and with only eight illnesses, the outbreak and food source were identified, the product recalled, and no one died. CDC and its food safety partners also discovered a new food vehicle for *E. coli* O157:H7 infections— hazelnuts.



PulseNet tracks what is being reported to CDC today compared with what was reported in the past to look for changes. Since 1996, PulseNet has built a database that contains nearly half a million isolates of bacteria from food, the environment, and human foodborne illness. ▶

What is this? NCEZID's "Path Lab" helps find the answer

When public health specialists are having a hard time while investigating unusual infectious diseases, they often call on CDC's Infectious Diseases Pathology Branch for help. The unique expertise of the "Path Lab" often enables CDC to respond rapidly to public health threats posed by various infectious disease agents, some of which are previously unknown or highly lethal.

In the early 1990s, the Path Lab, working closely with other public health investigators, identified and characterized a previously unrecognized type of hantavirus that was causing severe respiratory illness and death among residents of the southwestern United States. The branch's work was also central to CDC's success in responding to outbreaks of Ebola hemorrhagic fever in several African nations between 1995 and 2002, leptospirosis in Nicaragua in 1996, Nipah virus encephalitis in Malaysia and Singapore in 2000, and West Nile virus infection in the United States in 2000 and 2002.

During the anthrax crisis in the United States in 2001, the Infectious Diseases Pathology Branch provided expert diagnostic support and consultation to emergency response teams in different US cities. In 2003, the branch's contribution was instrumental in CDC's success in identifying and characterizing a new coronavirus that was causing SARS. More recently, the path lab has investigated various novel transplant-associated infections in addition to characterizing the pathology and pathogenesis of pandemic influenza and, in 2012, fungal meningitis and other fungal infections.

The Infectious Diseases Pathology Branch's talented staff stays on the cutting edge of innovation by continually refining testing methods to produce greater precision and faster results, supporting field investigations to strengthen connections between science in the lab and on the ground, and developing models for vaccines and drug therapies.

▲ Dr. Sherif Zaki, chief of the Infectious Diseases Pathology Branch. The Branch collaborates broadly with other infectious disease groups at CDC to conduct laboratory studies and investigations of infectious diseases of unknown cause or origin. The branch also works to identify new or emerging pathogens.

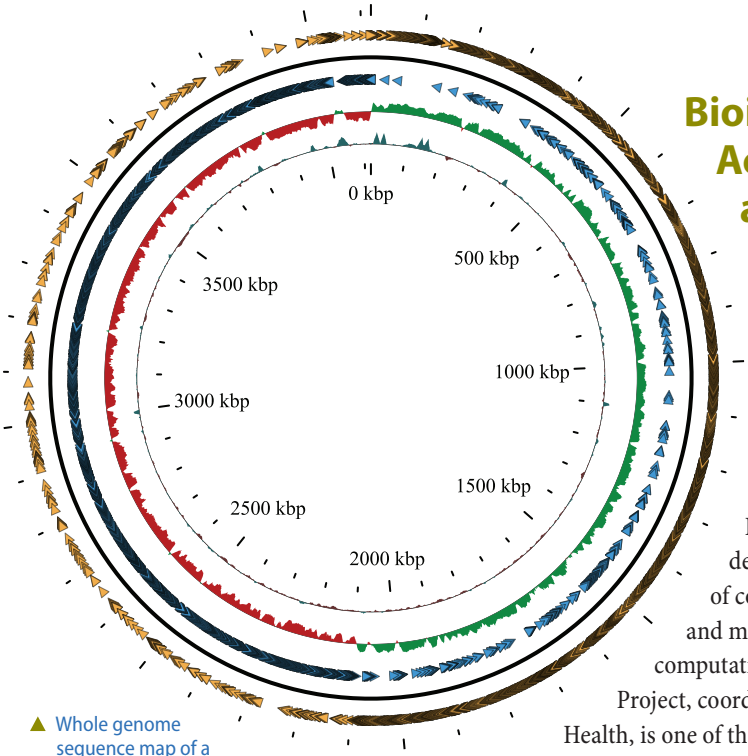
Leading the hunt for antimicrobial resistance

Antibiotics and similar drugs, together called antimicrobial agents, have been used for the last 70 years to treat patients who have infectious diseases. However, these drugs have been used so widely and for so long that the infectious organisms the antibiotics are designed to kill have adapted to them, making the drugs less effective. People infected with antimicrobial-resistant organisms are more likely to have longer, more expensive hospital stays and may be more likely to die as a result of the infection.

▲ CDC scientists, like Dr. Brandi Limbago pictured here, track antimicrobial-resistant pathogens around the globe.

In an effort to combat antimicrobial resistance, CDC's laboratories are at the forefront of efforts to identify newly emerging antimicrobial resistance in the United States. The laboratories have identified E. coli and Klebsiella pneumoniae, common bacteria that can cause severe healthcare-associated infections, including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis, that are resistant to nearly all antibiotics.

The laboratories use cutting-edge susceptibility testing methods to detect emerging resistance to antibiotics. CDC labs also evaluated antimicrobial susceptibility testing methods commonly used in hospital labs around the country in developing guidance for frontline laboratory detection to ensure that laboratories throughout the country are able to detect these resistant pathogens.



▲ Whole genome sequence map of a major strain of *Clostridium difficile*, a serious healthcare-associated infection that causes diarrhea and accounts for 14,000 deaths in the United States each year.

Bioinformatics—Accelerating detection and analysis in the laboratory

An attendee at the 2012 Association of Public Health Laboratories annual meeting in Seattle was so impressed with a demonstration of CDC's MicrobeNet that he proclaimed over Twitter that it was "a hit" and "an excellent resource" for labs. MicrobeNet is one of the many bioinformatics core support activities conducted by CDC. The agency has placed a high priority on strengthening its bioinformatics capacity.

For more than 15 years, NCEZID has played an important role in the development of bioinformatics at CDC. Bioinformatics is the application of computer science and information technology to the fields of biology and medicine. Bioinformatics generates new knowledge as well as the computational tools needed to create that knowledge. The Human Genome Project, coordinated by the US Department of Energy and the National Institutes of Health, is one of the best-known examples of bioinformatics at work. The project involved the identification and mapping of the approximate 25,000 genes of the human genome.

CDC's MicrobeNet, another important bioinformatics project, is a reference database for genetic identification of infectious pathogens that will link CDC laboratories with state and local laboratories. The MicrobeNet platform will allow laboratorians throughout the world to browse and match against isolates in CDC's reference collections, using a variety of data types and sources. It will connect them with the appropriate CDC subject matter expertise and provide detailed information about the organism, complete with pictures, protocols, and expected test results. Other recent bioinformatics projects include the sequencing and analysis of 250 different strains of the foodborne pathogen Shiga toxin-producing *Escherichia coli* (called STEC) for the development and validation of next-generation PulseNet methods. CDC's PulseNet is a national network of public health and food regulatory agency laboratories that perform standardized molecular subtyping ("fingerprinting") of foodborne disease-causing bacteria. Another prime example of bioinformatics at work, this sequencing and analysis project will help PulseNet more quickly detect and define, and in so doing reduce, outbreaks of foodborne disease.

"CDC's laboratory scientists are at the heart of our work to protect America on a 24/7 basis. CDC could not succeed without them."

Thomas Frieden, MD, MPH, Director, Centers for Disease Control and Prevention

Multitasking in the lab—Equipment that diagnoses flu can now be used to diagnose dengue

In 2012, CDC laboratories developed a new diagnostic test to detect the presence of dengue virus in people with symptoms of dengue fever or dengue hemorrhagic fever. Dengue is a painful and sometimes deadly viral disease transmitted by mosquitoes that threatens more than 3.5 billion people worldwide, and it is a major public health problem in the tropics and subtropics where *Aedes aegypti* mosquitoes are mainly found. Large numbers of travelers return from dengue-endemic areas to the United States each year, increasing the possibility of introducing the virus to those parts of the United States where the mosquitoes capable of transmitting dengue still thrive.

The new test will help diagnose dengue within the first 7 days after symptoms appear, which is when most people are likely to see a healthcare professional and the dengue virus is likely to be present in their blood.

The test can identify all four dengue virus types. This is the first US Food and Drug Administration-approved molecular test for dengue that detects evidence of the virus itself. One of the new test's most important features is that it can be performed using existing equipment and supplies that many public health laboratories already use to diagnose influenza.

A CDC scientist who works with dengue explained the potential value of such a test: "Patients will be diagnosed sooner than before, and public health laboratories will have a clearer picture of the true number of dengue cases." New dengue test kits were made available for distribution in July 2012.

Providing essential support to laboratories throughout CDC

If CDC's laboratory scientists are, in the words of CDC Director Thomas Frieden, "…at the heart of our work to protect America on a 24/7 basis," then NCEZID's Division of Scientific Resources (DSR) functions a bit like oxygen, providing laboratorians throughout CDC with state-of-the-art technology and high-quality products that they need to do their work. DSR provides essential support to the public health efforts of CDC laboratorians and CDC's emergency preparedness and response activities, including work in next-generation genomic sequencing and bioinformatics analyses for fungal, viral, and bacterial pathogens.

As the primary laboratory support infrastructure for the agency, DSR performs many roles. They supply the nuts and bolts needed for laboratory research— everything from supplies and glassware to mammalian tissue cultures to peptides and custom reagents. They provide resources and technological services to support mission-critical diagnostic, reference, and research laboratory programs. They support laboratory investigators in their work involving protein and DNA synthesis and sequencing, proteomics, and molecular modeling. DSR is also responsible for training the next generation of laboratory animal veterinarians who are needed to support work performed in high-containment laboratories.

Supporting CDC's infectious disease mission by…

Improving public health preparedness

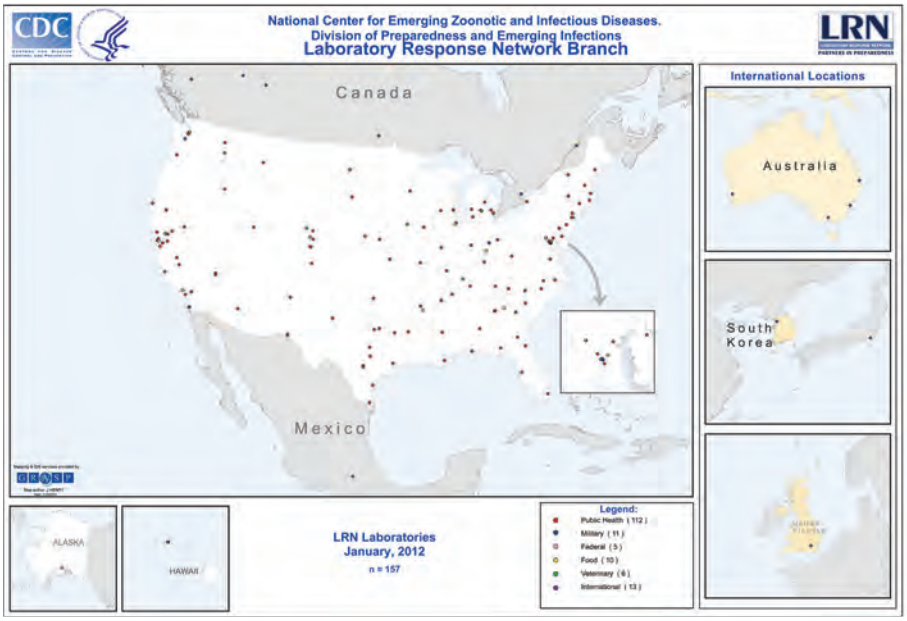
NCEZID plays a significant role in rapidly detecting and responding to infectious disease threats and emergency situations. We work to prevent, identify, and control infectious diseases from spreading— whether they are naturally occurring, unintentional, or the result of terrorism. We focus our preparedness activities on emerging and zoonotic infectious diseases— working closely with partners in and outside the government to provide strategic vision in preparing the United States to respond to threats posed by deadly pathogens that cause smallpox, anthrax, Ebola hemorrhagic fever, Marburg hemorrhagic fever, Rift Valley fever virus, and hantaviruses. NCEZID has the world's leading experts in a number of these viral and bacterial pathogens, and, therefore, plays a critical role in preparing the country against biological threats by providing expertise, capacity, and planning.

Our Center has unmatched laboratory capacity and epidemiological resources to respond to infectious disease threats. The ability to diagnose disease and identify risk factors for infection is critical to preparing properly for an unknown scenario. For example, NCEZID coordinates the Laboratory Response Network (LRN), which maintains an integrated network of state and local public health, federal, military, and international laboratories that are prepared to detect and respond to bioterrorism, chemical terrorism, and other public health emergencies. Since its creation, the LRN has played an instrumental role in improving the public health infrastructure by helping to boost laboratory capacity across the United States.

NCEZID and its partners produce guidelines on how to diagnose, treat, and prevent the spread of infectious diseases when a public health crisis occurs. NCEZID staff support state, local, tribal, and territorial partners by providing a comprehensive and standardized set of protocols, plans, and procedures for use during an infectious disease emergency. This advance planning and preparation saves lives during responses and emergency situations.

A powerful network of laboratories to detect and respond to threats

In the late 1990s, most Americans were more concerned about a computer bug than a biological one. While the nation's collective attention was fixed on the prophesized Y2K apocalypse, a small group of CDC staff and their colleagues at the Federal Beaureau of Investigation (FBI), Department of Defense, and Association of Public Health Laboratories were quietly piecing together a network of public health laboratories that would later become a model for laboratory preparedness around the globe.



▲ The Laboratory Response Network is a unique asset in the nation's growing preparedness for biological and chemical terrorism. The linking of state and local public health laboratories, veterinary, agriculture, military, and water- and food-testing laboratories is unprecedented.

This forward-looking team created the Laboratory Response Network (LRN), a diverse network of domestic and international laboratories that can spring into action to identify harmful biological and chemical agents. Approximately 160 LRN laboratories located in all 50 US states provide diagnostic capacity to identify agents that may be connected to biological or chemical terrorism events and infectious diseases. That extensive network provides access to rapid laboratory testing throughout the nation, with approximately 90% of people in the United States living within 100 miles of an LRN laboratory.

Just 2 years after it was created in 1999, the LRN played a pivotal role in identifying *Bacillus anthracis* in the first victim of the 2001 anthrax attacks. Since then, the LRN has played a key role in preparedness and response activities, including those related to a mysterious new form of pneumonia now known as SARS, monkeypox, *E. coli* food contamination, ricin toxin, and H5N1 (avian influenza). The LRN provided laboratory testing for anthrax cases identified in drummers in the Northeast in 2010 and a naturally occurring case of inhalation anthrax in the Midwest in 2011. Routinely, the LRN is called upon to provide laboratory services for threat letters containing white powders and during major sporting events, national political conventions, and other high-profile events that attract large crowds and international media attention.

CDC and the FBI— A partnership to combat bioterrorism

Public health and law enforcement agencies have different mandates and, consequently, different ways of looking at and investigating biological incidents. In the past, they often conducted separate investigations, but now they have recognized the potential to improve effectiveness by working more closely together. To promote collaboration between public health and law enforcement personnel, CDC and the Federal Bureau of Investigation (FBI) developed the Joint Criminal and Epidemiological Investigations Workshop.

The 2-day workshop, facilitated by CDC and FBI instructors, emphasizes the need for a joint response to biological incidents, using lectures to provide an overview of investigative methods and information sharing practices along with case studies and exercises to reinforce joint investigation principles and techniques. Implementing joint investigation methods can help improve response to naturally occurring or intentionally produced biological incidents by mutually supporting the investigative goals of both public health and law enforcement.

Since 2004, CDC and the FBI have conducted 32 workshops, training over 2,900 staff at the federal, state, and local levels. As a result, several state and local jurisdictions have used joint investigation methods to successfully respond to biological incidents. For example, local public health officials in North Carolina contacted the FBI about a case of potential ricin poisoning possibly due to the illicit manufacturing of ricin. The FBI special agents assigned to the case had attended the workshop and recognized the need to quickly coordinate with public health officials to begin an investigation, including a joint interview of a patient using techniques learned in the workshop. The joint investigation determined that the individual was not manufacturing ricin, as first reported, but rather ingested several castor beans in a possible suicide attempt. FBI officials believe that the efficient and coordinated response by public health officials and law enforcement staff was due to the training received in the Joint Investigations Workshop.

What's in the water? "Water Lab's" ultrafiltration technique helps ensure safety

In the wake of 9/11 and the anthrax letter attacks, CDC researchers and laboratorians worked to develop a protocol to rapidly sample drinking water for unidentified biothreat agents. They used a technique called ultrafiltration that can simultaneously concentrate viruses, bacteria, parasites, and even some large toxins in water all from a single water sample instead of having to use a different sample and method for each desired microbe. In 2007, the ultrafiltration-based water processing protocol was posted as an official Laboratory Response Network (LRN) method. Approximately 160 LRN laboratories located in all 50 US states provide diagnostic capacity to identify agents that may be connected to biological or chemical terrorism events and infectious diseases.

Environmental Microbiology Laboratory— the "Water Lab," as it is known, is leading efforts to establish this water processing protocol. In 2011, Water Lab staff began working with the US Environmental Protection Agency to train new LRN member labs to perform the protocol. In 2012, Water Lab staff led a hands-on laboratory workshop at CDC to train laboratorians from 14 state public health labs on the water processing protocol. Recent preparedness exercises confirmed that participants would know how to implement the protocol in case of an emergency.

A medical victory remains a medical mystery

Something rather remarkable happened to a 61-year-old retiree from Florida who took a 3-week vacation with his wife to visit the national parks of Wyoming, Montana, and the Dakotas. He acquired— but survived— a rare and extremely deadly type of anthrax infection that he may have acquired from exposure to natural sources on his road trip.

When he arrived at a friend's home in Minnesota on August 2, 2011, he was feeling a little "punky." Two days later, on August 4, he was admitted to the hospital and treated for what was thought to be community-acquired pneumonia. But he did not improve.

The next day (August 5), the hospital lab identified the bacteria from a culture they had taken as a type of *Bacillus* and alerted the Minnesota Department of Health laboratory, part of the Laboratory Response Network (LRN). Following LRN protocol, the state lab identified and then confirmed that it was the highly lethal *Bacillus anthracis* (that causes anthrax) and notified CDC. Because this was inhalation anthrax, the deadliest type that produces toxins that can quickly cause multisystem organ failure, CDC rushed in a specialized antitoxin (anthrax immunoglobulin) and sent two medical officers to study the case and monitor the treatment. CDC also coordinated with FBI staff who, with public health epidemiologists, determined that it was not an act of bioterrorism.

Fortunately, the Florida retiree made a full recovery and was discharged in good condition on August 29. That he survived this deadliest form of anthrax is due, in part, to alert medical staff and an LRN protocol that guided rapid, and it turns out life-saving, diagnosis and initiation of treatment. Afterwards, CDC and state and federal partners combed through data and examined potential exposures encountered on his trip— from rocks he collected for making jewelry to bison herds he and his wife drove through— but were never able to identify the source of his exposure to anthrax. Just why he— and not his wife— got the deadly infection remains a mystery.

◀ CDC investigated many potential sources in trying to determine how the Florida retiree contracted inhalation anthrax. Had he inhaled dust (containing anthrax spores) stirred up by hooved animals, such as the bison pictured here, during travel? No anthrax cases, however, were reported in domestic or wild animals in 2011 prior to August.

Supporting CDC's infectious disease mission by…

Extending our reach around the globe

Because pathogens can quickly spread across our borders from anywhere on the globe, NCEZID works to protect the United States and other countries from infectious diseases. We provide technical expertise to enhance public health capacity, increase health security, and reduce the spread and importation of disease. Our partners include ministries of health and multinational organizations, such as the World Health Organization, the US Agency for International Development, and the Bill & Melinda Gates Foundation.

▲ Researchers from the Uganda Ministry of Health, African Field Epidemiology Network, Makerere University, and CDC interview the husband of the suspected first case-patient in the 2012 Ebola outbreak, hoping to learn how the spread of disease began. Looking on is Dr. Richard Besser, ABC News, who was embedded with the CDC team during the Ebola investigation. *Courtesy Justin Williams*

CDC has staff members in outposts around the world. Uganda, considered a "hot zone" for emerging infectious diseases that have the potential for far-ranging impact, is one such outpost. NCEZID has helped build, staff, and train the first functioning laboratories at the Uganda Virus Research Institute for the diagnosis of vector-borne viruses, plague, and hemorrhagic viruses. CDC helps local public health authorities in Uganda and other countries in Africa recognize and respond to deadly infectious diseases, such as Ebola hemorrhagic fever, monkeypox, plague, and Marburg hemorrhagic fever. CDC Director Thomas Frieden was clear when he explained the mission of CDC's work in Uganda and around the world: "We are building systems [abroad] so we don't have to be there forever. It's very similar to what CDC has done over the past 50 years in the United States…. It's a lot cheaper to identify something at its source before it comes to our shores."[1]

Selected NCEZID Epi-Aid investigations, worldwide, October 2010– September 2012

Each year NCEZID responds to numerous requests for assistance in response to international outbreaks of infectious diseases, often through formal requests for epidemic-assistance investigations, called Epi-Aids. Many international Epi-Aid investigations are done in collaboration with and support from other CDC centers, in particular the Center for Global Health.

Country	
Chad	Investigation of an outbreak of a parasitic disease (Guinea worm disease)
Democratic Republic of Congo	Training of health workers for enhanced surveillance due to widespread outbreaks of a rare viral disease (monkeypox) related to smallpox
Democratic Republic of Congo	Investigation of an outbreak of an often-deadly viral illness (Ebola hemorrhagic fever)
Egypt	Evaluation of the first surveillance system for healthcare-associated infections
Federated States of Micronesia	Investigation of a mosquito-borne disease (dengue)
Georgia	Investigation of an outbreak of anthrax in humans and animals
Haiti	Investigation of an outbreak of cholera
Haiti	Assessment of deaths from cholera at hospitals and cholera treatment centers
Jamaica	Investigation of a fungal infection (from *Trichosporon*) among patients at a hospital
Kenya	Surveillance for illness and death in Somali refugees
Kenya	Surveillance and response for bacterial infections (cholera and shigellosis) in Somali refugees
Kenya	Surveillance and response for cholera in Somali refugees
Kenya and US multistate	Assessment of the need for rabies treatment after exposure to a rabid zebra at a travel lodge
Kenya	Rapid field assessment of polio surveillance
Kenya	Investigation of an outbreak of canine-associated human rabies
Panama	Investigation of drug-resistant bacterial infections (from carbapenem-resistant *Klebsiella pneumoniae*) at a hospital
Peru	Investigation of an outbreak of vampire bat-associated human rabies
Sierra Leone	Development of an integrated disease monitoring system, focusing on diseases such as meningitis, viral hemorrhagic fevers, and cholera
Sierra Leone	Investigation of an outbreak of cholera
South Sudan	Investigation of nodding syndrome outbreak, which causes uncontrolled head nodding, seizure-like activity, and in many cases, death
Tanzania	Survey of nodding syndrome
Uganda	Investigation of an outbreak of disease of unknown cause associated with high death rates
Uganda	Investigation of an outbreak of bacterial infections (typhoid fever) characterized by intestinal perforations (holes)
Uganda	Investigation of an outbreak of an often-deadly viral illness (Ebola hemorrhagic fever)
Zambia	Investigation of an outbreak of anthrax in humans and animals
Zambia	Investigation of an outbreak of bacterial infections (typhoid fever)
Zimbabwe	Investigation of an outbreak of bacterial infections (typhoid fever)
International	Multistate investigation of a group of wedding attendees who were possibly exposed to foodborne illness-causing bacteria (*Listeria monocytogenes*)
International	Multistate investigation of a suspected cluster of venous thromboembolism (VTE) and pulmonary embolism (PE), which may be life-threatening, among government workers

Sharing expertise to eliminate rabies abroad

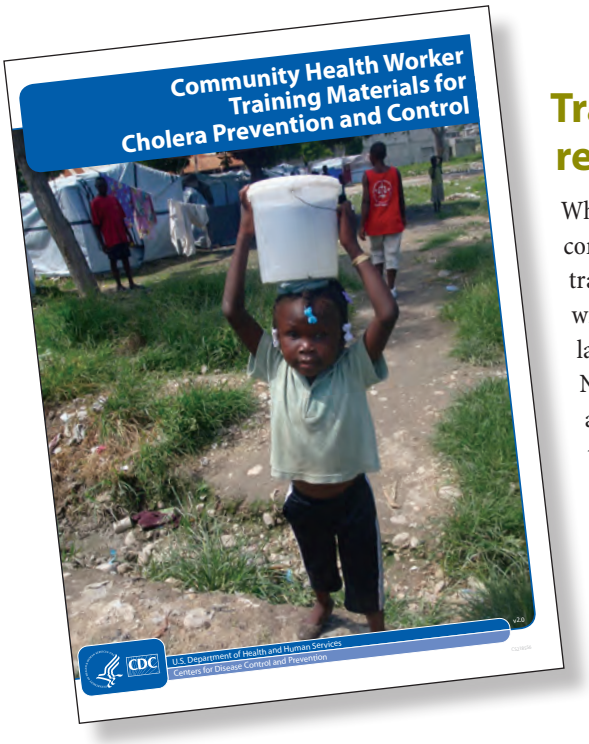
One of the oldest described infectious diseases, "mad crazy dog disease" (as it is known in China) or rabies, as it is called in this country, has been known for more than 4,000 years. Because of the remarkable success of public health interventions, such as vaccination of people and dogs, human rabies cases in the United States are now rare, though still deadly and tragic when they do occur, typically due to bites of infected bats. Globally, each year, rabies kills more than 55,000 people, mostly children, usually from dog bites. In fact, worldwide, 99% of human rabies deaths are from dogs.

Fortunately, rabies is a vaccine-preventable disease. The most cost-effective strategy for preventing rabies in people is eliminating rabies in dogs through vaccination. Recent CDC collaborations with international partners in Asia and South America have been successful. For example, a collaboration with the Pan American Health Organization on canine vaccination has drastically reduced human rabies cases throughout the Americas. More recently, a grassroots rabies management project in the Philippines focused at the community level led to elimination of cases on the island of Bohol and may help the country obtain a "rabies-free" designation. Projects such as these use a multifaceted approach to reduce rabies, including high-level advocacy to make rabies control a priority for leadership, aggressively pursuing canine rabies elimination, expanding laboratory diagnostics and training, and promoting innovative approaches to responsible dog ownership (like the use of a canine rabies vaccine that also induces a contraceptive immune response).

In addition to helping implement interventions to better control rabies, in 2012 CDC researchers published an important discovery about the disease. Their survey of people living in a remote section of the Peruvian Amazon offered strong evidence that an immune response to rabies may develop in some people in certain communities where outbreaks caused by vampire bat bites have occurred regularly over the past 2 decades. Several of these people who were previously exposed to rabies virus survived without vaccination.

So, it is theorized that under very unique circumstances, certain people regularly exposed to the virus might have an enhanced immune response that could prevent onset of clinical illness. Nevertheless, the lead researcher of the study advised, "a series of injections following exposure remains the best way to protect people against rabies" until new paradigms, such as improved housing to prevent bat access into dwellings and inclusion of rabies vaccine in local childhood immunization programs, are implemented.

▲ A common vampire bat (*Desmodus rotundus*) captured in the Peruvian Amazon in Madre de Dios. As part of a collaborative longitudinal capture-recapture study between CDC and the University of Georgia, bats have been uniquely banded and serosurveyed for exposure to rabies since 2007. *Courtesy D. Streicker*



Training trainers in Haiti to respond to cholera

When epidemic cholera appeared in Haiti in October 2010, the medical community there had virtually no experience with the disease and needed rapid training as the epidemic spread throughout the country. CDC, including staff within NCEZID, developed a set of training materials specific to Haiti and launched a cascading training effort. Through a training-of-trainers course November 14–15, 2010, and department-level training conducted in French and Creole over the following 3 weeks, 521 persons were trained and equipped to further train staff at the institutions where they worked. After the training, the hospitalized cholera patients' case-fatality rate dropped from 4% to less than 2% by mid-December and was less than 1% by January 2011. Continuing in-service training, monitoring, evaluation, and integration of cholera management into regular clinical training will help sustain this success.

Improving health for Kenya's refugees by building laboratory capacity

Not far from the Somalia border in Kenya lies the town of Dadaab, the largest refugee camp in the world. Refugees in the camp are faced with a host of medical problems, which are compounded by overcrowded conditions and limited access to care. It's easy for infectious diseases to spread quickly in such conditions.

CDC works with many partners to offer a wide range of health services to refugees living in Dadaab, and from the beginning, one of the more pressing concerns was the extremely limited laboratory capacity. Determining the pathogen associated with an outbreak of watery diarrhea or the cause of someone's pneumonia could take several weeks because specimens had to be transported to a laboratory in Nairobi. And there are only two flights out of Dadaab each week.

▲ Before and after views of Dadaab's laboratory. Today, the lab contains state-of-the-art equipment to better diagnose common pathogens.

In September 2010, NCEZID, in collaboration with other offices at CDC, the United Nations, and the Kenya Medical Research Institute set up a functioning laboratory at a site where access to water, electricity, space, and staff are significant challenges. The laboratory serves approximately 1,000 people a month from the camp and surrounding community. It has been a long road, but with strong partnerships and continued dedication, this project will improve the lives of those seeking refuge in Kenya and beyond.

Defeating diarrheal disease— A leading killer of adults and children in India

Public health scientists have measured the disproportionate amount of illness and death caused by diarrheal disease in India, compared with the rest of the world. But what is still unknown and has not been measured is how much of this illness— which includes cholera, salmonellosis, and shigellosis, also called dysentery— is caused by food. Isolating the foodborne causes is a critical step toward defeating a disease that is common, costly, but largely preventable.

In 2011, CDC's Global Foodborne Infections Network (GFN), a World Health Organization-sponsored program, began working with partners in India to separate the primary culprits of diarrheal disease— water and food. Their aim was to focus on the disease caused by contaminated food and to encourage partnerships among microbiologists and epidemiologists so they could take the important next step. They needed to move beyond simply identifying clusters of diarrheal disease (syndrome-based surveillance) to finding the infections that were causing the diarrheal disease (case-based surveillance).

In March 2011, microbiologists from 16 states in India traveled to Kolkata to attend GFN's inaugural workshops focused on the foodborne germs that cause a lot of the illness and death— *Salmonella* and *Vibrio cholerae*. Another GFN workshop was held in New Delhi in early 2012, and sparked enthusiastic discussion among Indian colleagues about next steps needed to reduce foodborne disease outbreaks. GFN's overarching goal is to work with partners to strengthen the food safety network throughout India and extend it to the larger South Asia region.

To reduce typhoid fever in the developing world, safe water teams from CDC use bleach models such as these to help people purify their drinking water. *Courtesy CDC Foundation*

Answering a call for help from Zambia

Beginning in early 2012, an outbreak of febrile (fever) illness sickened more than 2,500 people across three regions in Zambia. The illness was consistent with typhoid fever, a life-threatening illness caused by the bacterium *Salmonella* Typhi that is still common in the developing world, where it affects about 21.5 million persons each year. The illness is difficult to diagnose on clinical grounds alone and can be confused with common diseases like malaria. The best way to confirm typhoid fever is with a blood culture, which is often beyond the capacity of local laboratories.

In February 2012, the Zambia Ministry of Health requested CDC's assistance, and in early March two Epidemic Intelligence Service officers departed to assist local health officials in an Epi-Aid investigation. The team assisted the Ministry in conducting an outbreak investigation and strengthened laboratory capacity to diagnose typhoid with a new rapid test. It is likely that contaminated water supplies were responsible for the outbreak, consistent with other typhoid outbreaks in sub-Saharan Africa.

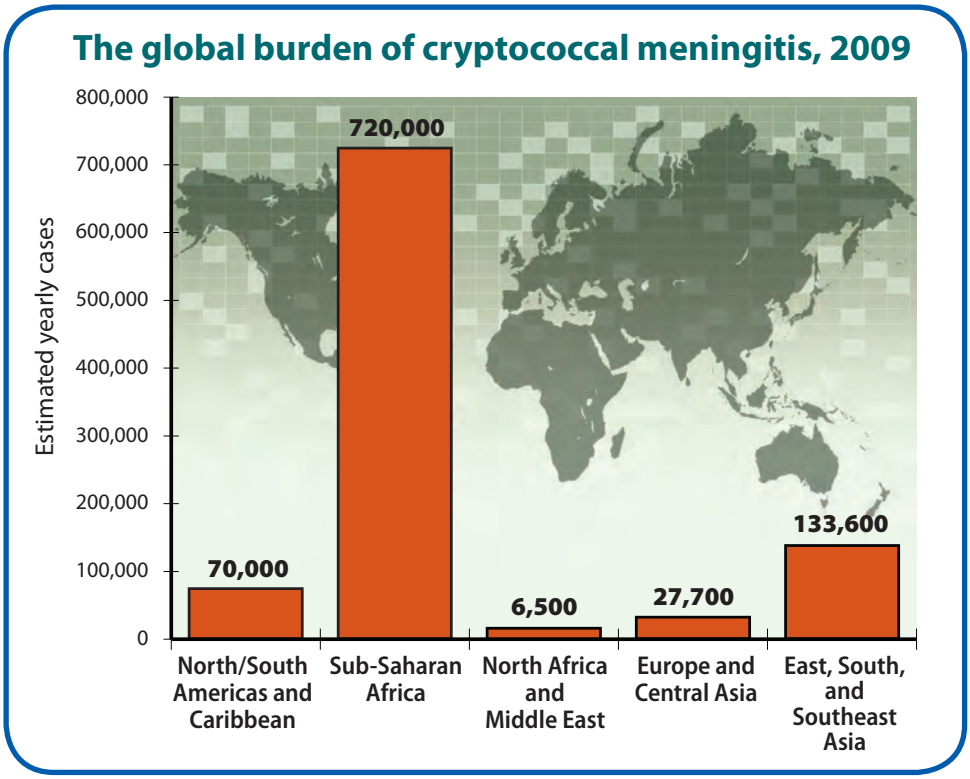
The investigation further underscored that outbreak control depends on successful water, sanitation, and hygiene interventions. Future plans for reducing typhoid fever also include evaluating the cost-effectiveness of typhoid immunization, as well as continuing to work with partners to strengthen Zambia's epidemiologic and laboratory surveillance and diagnostic capacity.

A new strategy to reduce deaths due to *Cryptococcus*

Each year, the fungus *Cryptococcus neoformans* causes life-threatening meningitis in almost 1 million people with weakened immune systems (like people who have advanced HIV/AIDS). The fungus is found in the soil and produces spores that can be inhaled. People can inhale spores early in life but never know it. In healthy people, the fungus usually does not cause serious illness because the immune system can fight off the infection. However, in people with weakened immune systems, the fungus can stay hidden in the body and later reactivate, spreading to other parts of the body and causing serious disease.

In sub-Saharan Africa, cryptococcal meningitis (when the infection has spread from the lungs to the brain) is one of the leading causes of death among HIV/AIDS patients; it may kill more people each year than tuberculosis. Although it is not possible to prevent the initial infection, a blood test can catch the infection before meningitis develops.

CDC has worked with other public health partners to perform "targeted screening" in HIV clinics, using a point-of-care dipstick screening test that is simple, quick, and effective. The test can be performed in the clinic, so it can be used by people who live in remote rural areas where there are no laboratories nearby. If screening detects the presence of *Cryptococcus*, beginning treatment before meningitis develops is affordable— the medication is sometimes free or only $1 to $2 dollars per month. CDC's call to action is to equip half of all HIV clinics in Africa and Asia to perform *Cryptococcus* screening and treatment by 2015, which could save 50,000–100,000 lives every year.



▲ The burial team from the Uganda Ministry of Health putting on personal protective equipment. During an Ebola outbreak, unexplained community deaths are treated with caution. *Courtesy Justin WIlliams*

Using disease prevention know-how to reduce deadly Ebola

In July 2011, when a patient in Uganda fell ill with deadly Ebola hemorrhagic fever (or Ebola), the diagnosis was made in about 8 days, far shorter than previous diagnoses, which took several weeks. And, largely because of that quick diagnosis, CDC Director Thomas Frieden explained, "You didn't read about it in the papers because for the first time ever we identified a single case, not an outbreak."[2]

Ebola hemorrhagic fever is a severe, often fatal disease in humans and nonhuman primates (monkeys, gorillas, and chimpanzees) that has appeared sporadically since its initial recognition in 1976, when there were more than 600 cases and 400 deaths reported. The disease is caused by infection with Ebola virus, named after a river in the Democratic Republic of the Congo (formerly Zaire) in Africa, where it was first recognized.

As the single case from 2011 suggests, there has been progress in stemming the tide of this horrific disease. In recent years, CDC has helped Uganda, an emerging disease "hot spot" for some of the world's most dangerous pathogens, build capacity in all parts of its public health system to recognize and control outbreaks of infectious disease. Of particular note was a recently implemented viral hemorrhagic fever surveillance program. And the system, in this particular case, worked well— the local laboratory quickly identified the infection, the hospital used proper infection control measures to prevent spread of the virus, and the mortuary followed guidelines in handling the body. Local customs of preparing a body for burial can dangerously expose the handlers to infectious body fluids.

Clusters of outbreaks in 2012 in Uganda and the Democratic Republic of the Congo (DRC) are sobering reminders, however, that Ebola has not been extinguished. Comparing current outbreaks with earlier outbreaks does offer some room for hope. Instead of the more than 400 deaths reported in 1976, there were fewer than 40 deaths reported in the 2012 outbreaks in Uganda and DRC. So although Ebola has not been eliminated, putting infection control measures in place once it has been detected seems to be effective in reducing its spread.

[1,2] *Steenhuysen, J. US disease agency reaches abroad to stem outbreaks. New York: Reuters, July 1, 2011.*

Supporting CDC's infectious disease mission by…

Securing state, local, and tribal capacity

CDC invests in a flexible and adaptable public health system at national, state, local, territorial and tribal levels. This includes building a sufficient and competent public health workforce; supporting surveillance systems; supporting modern and efficient laboratory facilities with well-trained laboratory staff; and improving information systems to support rapid exchange of health information for surveillance and outbreak investigation and response. This support, particularly for state, local, and territorial health departments, is extremely critical in combatting the ongoing and increasing threat posed by emerging (e.g., caused by antimicrobial-resistant bacteria) and re-emerging infectious disease (e.g., recent dengue fever outbreaks), in improving public health (e.g., food safety), and in responding to other public health emergencies.

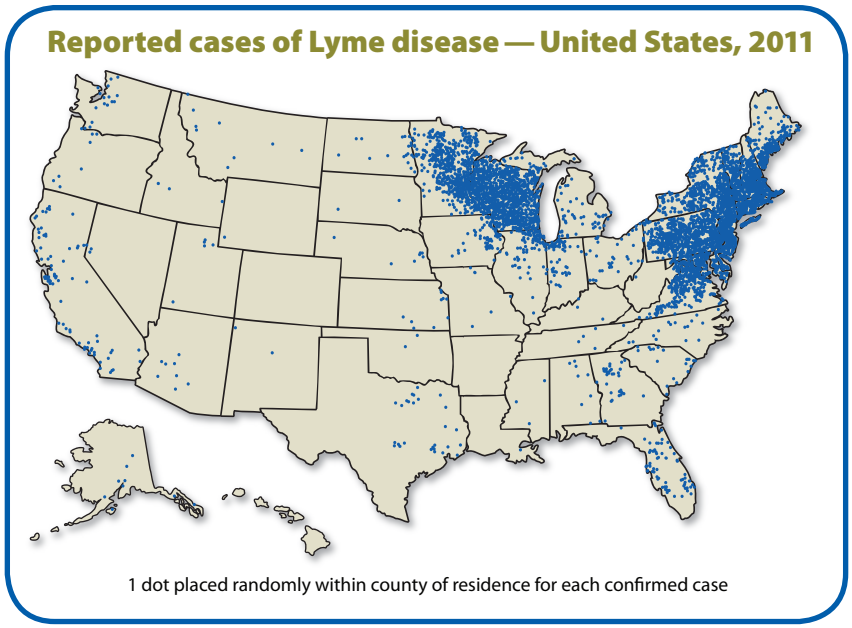
NCEZID supports state, local, and territorial health departments in these efforts to prevent and control a wide range of infectious diseases, including zoonotic and vector-borne diseases, high-consequence pathogens, drug-resistant pathogens, those associated with healthcare infections, and infections of refugees and immigrants through the Epidemiology and Laboratory Capacity for Infectious Diseases (ELC) and the Emerging Infections Program (EIP) cooperative agreements.

▲ Home treatment kits are ready for distribution as part of the "RMSF Rodeo," a pilot project targeted at reducing Rocky Mountain spotted fever in a large Indian reservation in eastern Arizona. *Courtesy Brooke DiPetrillo, CDC Foundation*

The ELC supports all 50 states, 6 local health departments (Los Angeles County, Philadelphia, New York City, Chicago, Houston, and Washington, DC), and the health departments in all 8 territories with sustaining core epidemiology and laboratory capacity to address public health concerns. EIP supports a network of 10 state health departments and their academic and other partners to conduct gold standard surveillance and state-of-the-art specialized applied epidemiologic research and to evaluate the impact of prevention programs and policies. In 2011, EIP data were used in more than 65 articles published in peer-reviewed journals. Together, ELC and EIP funding supports well over 900 full- and part-time positions in the state, territorial, local, and tribal health departments, including epidemiologists, laboratorians, and health information systems experts to ensure basic capacity at the local level where many infectious diseases are first identified. In addition, NCEZID staff work in close collaboration with state and local health departments, providing technical expertise, guidance, outbreak support, access to surveillance systems, and unique laboratory capacities.

Bull's eye— An EIP-funded study targets Lyme disease in three states

In July 2011, John took his son on a Boy Scout camping trip in the woods of Virginia. A few years earlier in Maryland, Linda played with her young daughter in their yard that bordered a park where deer are plentiful. John and Linda each got Lyme disease. They're not unique, as John's physician observed: "Every one of us seems to know somebody who has dealt with Lyme disease."



Lyme disease is caused by the bite of an infected blacklegged tick and is the Northeast's second most common reportable disease— a list that includes hepatitis, sexually transmitted diseases, and many foodborne diseases, to name just a few. In the mid-Atlantic and the upper Midwestern states, Lyme and other tick-borne diseases are also a serious public health problem. To understand which measures would be most effective in preventing Lyme and other tick-borne diseases, CDC's Emerging Infections Program is funding a 2-year prevention study through a collaborative group called TickNET in Connecticut, New York, and Maryland.

The TickNET partners found that more households wanted to participate than the study could accommodate, indicating an unmet need for tick-borne disease prevention. The study called for a one-time spraying of a widely available pesticide around the perimeters of yards (typically shrubby areas where most of the ticks live). Preliminary results from Year 1 showed that the pesticide reduced ticks by 76%. However, the number of ticks found on household members and the number of self-reported tick-borne disease cases were not significantly reduced.

Year 2 is currently underway, and scientists hope that results will help clarify and support public health recommendations for the use of pesticides to prevent disease. If the results from Year 1 and Year 2 are similar and tick-borne disease does not decrease, it may suggest that people are picking up ticks in places other than their yards. This finding would support recommending a reduction in residential pesticide use and would spur on additional prevention research for this serious public health problem.

And what happened to John and Linda? They each developed a bull's-eye rash (one of the common symptoms of Lyme disease), quickly got medical attention and started taking antibiotics, and fully recovered.

Not just chopped liver— New York City's "Team *Salmonella*" tracks down the source of an outbreak

Successful investigations often depend on asking the right question. Student interviewers, who were assisting the New York City Department of Health and Mental Hygiene in the investigation of an outbreak of *Salmonella* infections in the fall of 2011, did just that. They asked the question that led to identifying the source of the outbreak.

The students were part of the Foodborne Diseases Centers for Outbreak Response Enhancement (FoodCORE)-funded "Team *Salmonella*," trained interviewers who assist the public health staff in epidemiologic investigations of *Salmonella*-caused outbreaks in New York City. Six other FoodCORE centers, in addition to the one in New York City, work to improve state and local responses to foodborne disease outbreaks.

FoodCORE resources enable investigators to quickly conduct interviews with ill people while they still can remember what they ate, which is critical in stopping widespread outbreaks. FoodCORE support also helps laboratorians more swiftly conduct DNA fingerprinting of the bacteria and share information so public health officials can collaborate to determine sources of contaminated foods.

In this particular case, the breakthrough in the investigation came when two students on the team were discussing the results of their interviews. They theorized that chicken livers— a food not originally included on their questionnaires— might be the source of the *Salmonella*. The students, assisted by other FoodCORE and New York City public health staff, visited specialty stores where some of the people who became ill shopped to learn more about how the chicken livers were being prepared.

Suspect food items were collected for testing, and the outbreak strain was found in "kosher broiled chicken liver" products. As a result, the contaminated products were recalled from grocery stores on November 8, 2011, and additional illnesses were prevented.

These students were part of the Foodborne Diseases Centers for Outbreak Response Enhancement (FoodCORE)-funded "Team *Salmonella*," which assisted in epidemiologic investigations of *Salmonella*-caused outbreaks in New York City. ▼

Running on empty— The health impact of household running water on Alaska Natives

Which is the largest US state? Most people would quickly— and correctly— answer "Alaska." But if asked, "Which state ranks last for having running water in the home?" probably far fewer would know that the correct answer is also "Alaska." In fact, nearly one-quarter of rural Alaskan homes lack running water, also called in-home water service and defined as complete plumbing, with a working sink, toilet, and a shower or bathtub. Not surprisingly, there is increasing evidence that in-home water service is linked to better health.

Providing data to determine the effect of in-home water service on the health of Alaska Native people is one of many studies conducted by CDC's Arctic Investigations Program (AIP). Located in Anchorage, AIP is CDC's infectious disease field station in the Arctic whose mission is to prevent disease in people of the Arctic and sub-Arctic. AIP's focus on running water and infectious disease also aligns with one of NCEZID's fundamental commitments— to prevent and reduce infectious disease disparities among vulnerable populations, such as Alaska Natives.

The AIP team has conducted several studies that matched hospitalization rates to water service. They found higher rates of "water-washed disease," diseases caused by inadequate hand or body hygiene that tie directly to an inadequate supply of clean water. These diseases spread from person to person or can be prevented through hygienic habits that involve water. The studies found that the most common included pneumonia, influenza, a type of respiratory virus common among children, skin infections due to MRSA (methicillin-resistant *Staphylococcus aureus*), and dental caries (cavities) among children. A particularly disturbing finding was that the rate of pneumonia among Alaska Native infants is 11 times higher than the overall US rate. Interestingly, diarrhea-associated hospitalizations (which would suggest contaminated water that was ingested) did not differ according to the type of water service in the home. This is probably due to the availability of safe drinking water at a central watering point in all rural Alaska villages. However, hauling sufficient water quantities to the home for cooking, washing dishes, and hygienic habits is a barrier that likely explains the higher rates of water-washed diseases.

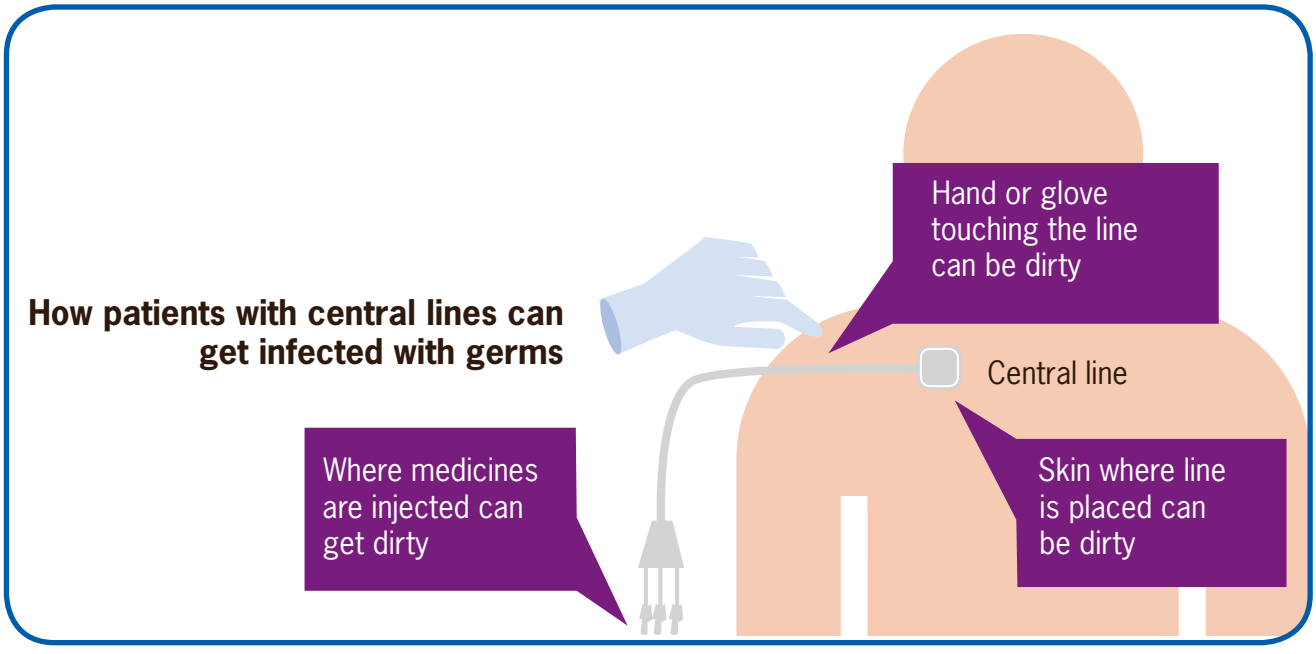
The AIP study recognizes that an inadequate supply of safe water was not the only infectious disease risk. Other social determinants, such as household crowding, indoor air quality, and nutrition also contributed to the problem. But the study brings researchers significantly closer to answering perhaps the most challenging question: "How much water is needed to maximize healthy behaviors?"

Getting the numbers right—Tennessee confirms success in infection reduction

Could the numbers be trusted? That is what Tennessee public health officials wanted to know when they saw a dramatic decrease throughout the state in one of the deadliest healthcare-associated infections (HAIs). Tennessee, compared with all states during 2009–2010, had the second-largest reported decrease in central line-associated bloodstream infections (CLABSIs). CLABSIs are caused by unclean or incorrectly inserted central lines, which are tubes placed in large veins to give patients important medical treatment. Up to 1 in 4 patients who get a CLABSI can die. But CLABSIs are largely preventable when healthcare providers use CDC-recommended infection control steps.

To validate this dramatic decrease, the Tennessee Department of Health charged its Healthcare-Associated Infections Team to reexamine the data. Since 2008, Tennessee has required hospitals to report CLABSIs and certain other HAIs to CDC's National Healthcare Safety Network (NHSN). CDC manages NHSN, the largest healthcare-associated infections reporting system in the United States, with more than 11,000 healthcare facilities participating. To ensure the CLABSI reductions reported to the NHSN were accurate, Tennessee's HAI Team undertook extensive validation efforts using resources provided by CDC.

The validation project targeted facilities with either very high or very low CLABSI rates during 2009 and 2010. They also included a random selection of facilities with average infection rates. The validation project gives the Tennessee Department of Health, its partners, and Tennessee hospitals confidence in the reported data. The dramatic reduction of CLABSIs reported in the state was verified to be accurate.



▲ Central line-associated bloodstream infections (called CLABSIs) are caused by unclean or incorrectly inserted central lines, which are tubes placed in large veins to give patients important medical treatment.

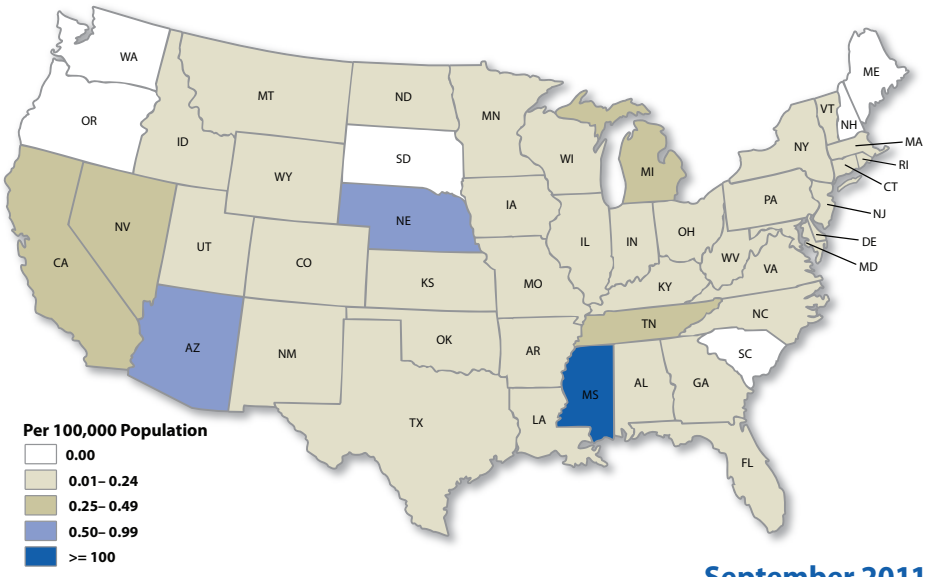
The summer of our discontent—ArboNET gives states vital information during outbreak of West Nile virus

In the United States, the summer of 2012 will be remembered for records that were set— the worst drought since the Dust Bowl and the most destructive wildfire season in history. Unfortunately, it also may be remembered for the second-largest outbreak of West Nile virus disease since it first appeared in the United States in 1999. By late November, more than 5,000 cases including 236 deaths had been reported to CDC. Of these cases, 51% were classified as "neuroinvasive," meaning that those people developed serious illnesses, such as encephalitis or meningitis. More than 80% of the cases were reported from 13 states; nearly one-third of the cases were from Texas.

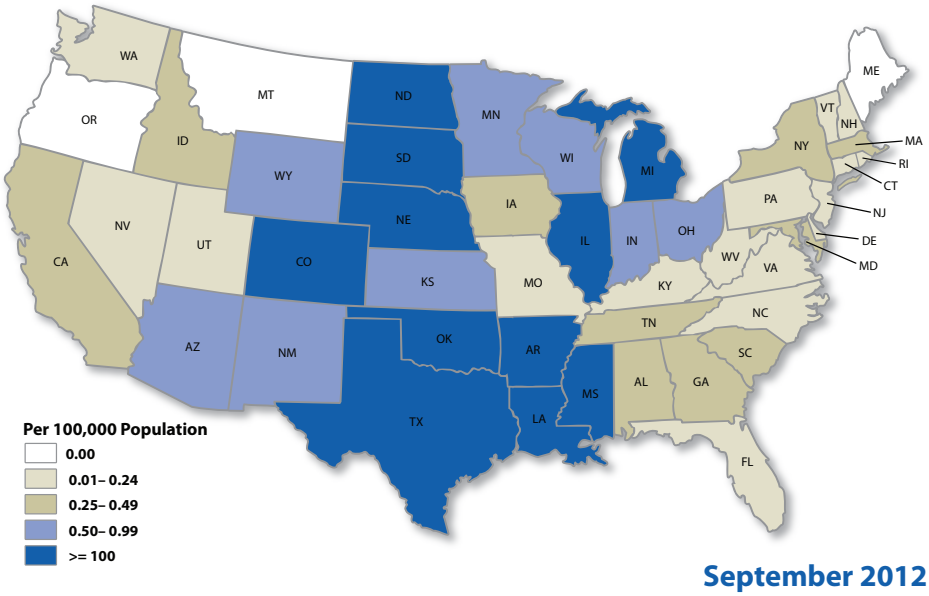
West Nile virus is a pathogen that is transmitted to people by infected mosquitoes that got the virus from diseased birds. Many people who are bitten by an infected mosquito won't get sick— but many others aren't as lucky. The virus generally peaks in late summer, which is why the 2012 outbreak's early start was cause for concern. "It is not clear why we are seeing more activity than in recent years," said Marc Fischer, medical epidemiologist with CDC. Although they haven't yet been able to answer "why" there is more activity, scientists are current on "how much" activity there is in the record-setting outbreak, thanks to a surveillance system that tracks West Nile virus in all 50 states.

The tracking system, called ArboNET (National Arboviral Surveillance System), collects and shares human, animal, and ecologic data with states— real-time information about West Nile activity to help local authorities make decisions about mosquito control or outbreak preparation and response. ArboNET (so named because it focuses on arbovirus diseases that are transmitted by an arthropod vector like a mosquito or tick) was developed in response to the introduction of West Nile virus into the United States in 1999. Strong collaboration between CDC, state and local health departments, blood services agencies, and the US Geological Survey enables ArboNET to provide a broad picture of virus transmission activity and migration. These data also provide the basis for developing predictive models to help identify risk factors and anticipate disease trends. In addition to West Nile virus, ArboNET reports on several other viruses including dengue, chikungunya, and eastern equine encephalitis.

West Nile virus activity by state, 2011 and 2012*



September 2011



September 2012

*Data for 2011 are final; data for 2012 are provisional.

▲ The number of cases of West Nile virus in 2012 was the second-highest number of cases recorded since West Nile virus first appeared in the United States in 1999. The striking difference in incidence between 2011 and 2012 is due, in part, to the notably reduced (compared with prior years) number of West Nile virus cases reported in 2011.

▲ 2011 ELC funding helped strengthen public health capacity in several states including Montana, where it supported rural infection preventionists— part of an effort to reduce healthcare-associated infections.

Critical support directed at critical needs

In March 2011, test results of four patients with salmonellosis (illness caused by *Salmonella* infection) were reported by a hospital lab to a local health department in Maryland. Interviews were conducted, and it was quickly confirmed that all four had attended a drop-in charity fundraiser breakfast. Laboratories further identified the exact type of *Salmonella* infection, the food vehicle (sausage) was identified, and the product quickly recalled. The rapid and coordinated response from epidemiologists, information technology specialists, and laboratorians illustrates the Epidemiology and Laboratory Capacity for Infectious Diseases Cooperative Agreement (ELC) at work.

The ELC was formed in 1995 as a key component of CDC's national strategy to prevent, detect, and respond to new and emerging infectious diseases. The ELC serves as a platform to support all 50 state health departments, 6 local health departments (Los Angeles County, Philadelphia, New York City, Chicago, Houston, and Washington, D.C.), Puerto Rico, and the Republic of Palau in their infectious disease work in epidemiology and in the laboratory. In early fiscal year 2012, the ELC was expanded to include all of the other Pacific Island territories and the US Virgin Islands.

With ELC support, health departments build and strengthen their public health capacity by hiring and training staff, buying laboratory equipment and supplies for detecting emerging pathogens, and investing in information technology to improve disease reporting and monitoring. In fiscal year 2011, funding provided through the ELC cooperative agreement supported programs that focused on zoonotic, vector-borne, prion, and foodborne diseases; influenza; healthcare-associated infections and antimicrobial resistance; and public health informatics. A small sampling of recent work includes:

- **Colorado—** Early identification of outbreaks of a type of *E. coli* infection that was associated with ground bison and raw milk gouda cheese.
- **Montana—** Support for rural infection preventionists, part of an effort to prevent healthcare-associated infections.
- **Florida—** Laboratory testing that documented the emergence and disappearance of dengue in Key West, Florida.
- **Arkansas—** Epidemiology and lab staff working in concert to solve a waterborne infection associated with people swimming in a section of a river near agricultural operations.

Supporting CDC's infectious disease mission by…

Investigating how diseases from animals are spread to people

▲ *Courtesy Olaf Hajek*

Zoonotic diseases account for over 60% of all communicable diseases causing illness in humans and 75% of recently emerging infectious diseases. To reduce the public health impact of zoonotic and other emerging infectious diseases, NCEZID promotes a comprehensive, interdisciplinary One Health approach that engages the principles of human health, veterinary medicine, and ecosystem health.

NCEZID is actively working at the human-animal interface to increase understanding of the ecology and risk factors for transmission of disease between animals and humans and to advance evidence-based One Health strategies that will protect and improve human health. Rabies and brucellosis are examples of diseases where the best solution for preventing humans from getting a severe illness is not in treating the person, but by monitoring and treating the disease in animals. That way, humans are protected and the health of the animal is improved.

Unprecedented collaborations between NCEZID and animal health entities at the international, regional, and country level are being established to implement integrated and comprehensive response to zoonotic diseases that could pose public health threats. We are working collaboratively with human and animal health partners to improve global preparedness and response to pandemic threats of zoonotic origin through multidisciplinary and multi-sectoral collaborations.

NCEZID is also assuming a leadership role by building One Health partnerships and promoting trust-based relationships among multiple sectors and disciplines, internal and external to CDC. NCEZID facilitates the exchange of information and enhances communication across disciplines by sponsoring visiting scientists and fellows, lectures, and meetings. We also manage resources from across the agency and help allocate resources from outside of the agency to maximize impact.

A sample of zoonotic disease outbreaks caused by contact with animals

What caused the outbreak		Details about the outbreaks
	Frogs (amphibians)	A 2009–2011 outbreak resulted in >250 reported cases of infection with *Salmonella*, primarily involving young children.
	Turtles (reptiles)	Since 2006, 9 large multistate outbreaks have resulted in hundreds of reported illnesses. Young children are primarily affected. An estimated 6% of all *Salmonella* infections are associated with contact with reptiles; an estimated 11% of all *Salmonella* Infections in persons under age 21 are associated with contact with reptiles. Reptile-associated human *Salmonella* illnesses have been reported since 1963. In 1975, the US Food and Drug Administration established a ban prohibiting the sale or distribution of small turtles in the United States, except for bona fide scientific, exhibition, or educational purposes.
	Live poultry	Live poultry-associated *Salmonella* illnesses have been reported since 1955. Since the 1990s, more than 35 outbreaks have been reported to CDC, primarily involving young children. Outbreaks occur year-round. Most live poultry come from mail-order hatcheries or agricultural feed stores.
	Frozen feeder rodents	A 2010 outbreak led to at least 34 cases of *Salmonella* infection, primarily among children; a similar outbreak was also reported from the United Kingdom. In 2011–2012, 26 cases of *Salmonella* infection were linked to feeder rodents. Previous outbreaks of human *Salmonella* infections have been linked to frozen rodents used as reptile feed.
	Pet food products: Dry dog and cat food and pet treats	Since 2006, two outbreaks of *Salmonella* infection linked to dry pet food have been reported in the US: 79 *Salmonella* Schwarzengrund infections were reported in 2006–2008, primarily in children under the age of 2. 22 *Salmonella* Infantis infections were reported from the US and Canada in 2012 (as of June 14, 2012). In both outbreaks, Illnesses were linked to contact with multiple brands of contaminated dry dog and cat food from single pet food production facilities. Pet treats such as pig ear chews have also been associated with human *Salmonella* infections.
	Animal exhibits in public settings, such as petting zoos, fairs, schools, etc.	Since 1996, more than 150 infectious disease outbreaks of *Salmonella*, *E. coli*, and other zoonotic pathogens associated with contact with animals in public settings have been reported to CDC.

Animals can make people sick, but many people are not aware of the risks. CDC uses the Web, social media, and educational flyers to alert consumers and the pet industry about infections, like *Salmonella* and *E. coli* (two enteric, or intestinal, zoonoses), that people can get from direct contact with high-risk animals— including birds, amphibians, and reptiles.

Less is more—
New hope for a neglected disease

Although rare in the United States, each year rabies causes more than 55,000 deaths worldwide. CDC has developed a less costly, less complicated test that offers the prospect that this age-old scourge could be significantly reduced, or even possibly eliminated.

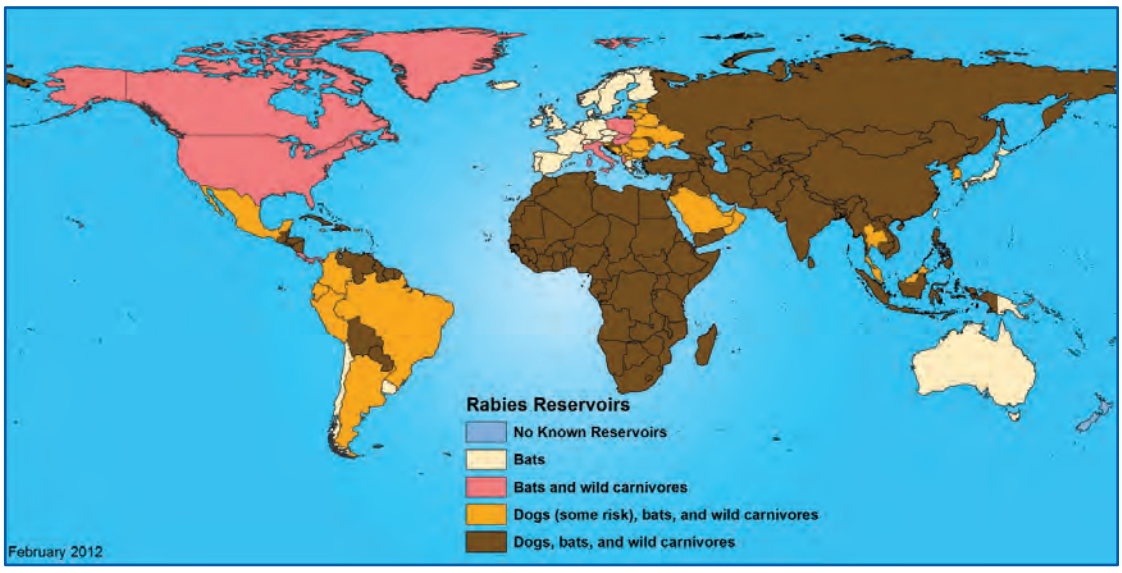
The rabies test is the only routine diagnostic test applied to an animal that directly determines the need for life-saving medical intervention in humans. For example, if a person is bitten by a suspect animal, and the test is negative, no vaccination is needed for that individual. However, if the animal tests positive, the bitten person can undergo a series of shots to prevent this fatal disease.

Today, in much of the developing world, rabies surveillance and diagnosis in domestic animals and wildlife face many challenges. High temperatures make it difficult to collect and preserve fresh specimens. The gold standard test currently used to diagnose rabies is limited by the high cost of acquiring and maintaining a fluorescent microscope. Difficulties in obtaining diagnostic results from the field have led to widespread underreporting of disease. Consequently, the true public health impact of rabies has been greatly underestimated.

A new test developed by CDC's Rabies Lab requires no specialized equipment or refrigeration, making it ideal for use in developing countries. The laboratory developed a highly concentrated cocktail of rabies antibodies that allows a diagnosis to be made in less than 1 hour.

This new test has been found to be as reliable a diagnostic method as the current and more expensive gold standard test. It has the advantage of requiring only a light microscope, which is widely available and 10 times less expensive than a fluorescent microscope. Reduced cost suggests high potential for making rabies diagnosis available in other cities and even rural areas of Africa, which could improve the ability to manage rabies, better respond to outbreaks, and support the need for critical vaccination for disease prevention after exposure to rabid animals, or reduce unnecessary use of post-exposure rabies shots.

Rabies: Global distribution of reservoirs



◀ Although rare in the United States, each year rabies causes more than 55,000 deaths worldwide. A new rabies diagnostic test developed by CDC's Rabies Lab requires no specialized equipment or refrigeration, making it ideal for use in developing countries. *Courtesy Kevin Liske*

Hungry, hungry hippos

But in this case it was hungry *people* who were eating hippos. A chain of events was started in late summer 2011 during the dry season in Zambia. Hippos, hunting for food by rooting in the soil, became infected with anthrax. People living near the sites of hippo deaths started to see the carcasses as a convenient and free source of food. The resulting outbreak of anthrax among people who had either eaten the meat of— or butchered— infected hippopotamuses became a serious and deadly twist on the title of a popular children's game.

When the Zambia Ministry of Health contacted CDC in mid-September, the anthrax outbreak had already sickened 500 people and caused 5 deaths. Mark Lehman, an Epidemic Intelligence Service officer, was sent to Chama in eastern Zambia to investigate the problem and make recommendations. Dr. Lehman first needed to determine how people were contracting the anthrax, most of which was the less lethal cutaneous (skin) form of the infection. Dr. Lehman and the team trained local community health workers to conduct surveys, which showed that the primary way people were getting infected was by carrying the hippo meat home from the butcher site. The survey also confirmed the reason they were eating hippo meat— food insecurity, or in other words, having nothing else to eat.

Armed with survey results, Dr. Lehman next assisted in resolving the outbreak, touring areas that had been affected as well as those still believed to be unaffected. He scoured game parks and lagoons in 100-plus degree temperatures and was gratified to discover many untouched hippo carcasses— an indication that people were probably understanding the risks of handling or eating the infected meat.

Mark Lehman's recommendations to the Ministry of Health included an offer of laboratory support and outbreak management strategies. He also encouraged Zambian officials to address the connection between the outbreak and environmental and food insecurity issues. Above all else, Dr. Lehman encouraged health officials to follow the World Health Organization (WHO) guidelines about anthrax outbreaks. Although they had copies of the WHO guidelines, they still looked to Mark Lehman for advice; as he later reflected, "I really just continued to tell them to follow WHO guidelines, but sometimes just being there in person makes a difference."

◀ Epidemic Intelligence Service Officer Dr. Mark Lehman with children in eastern Zambia.

Bigger than a breadbox— A win-win solution for curbing plague in Uganda

In the past 30 years, human plague outbreaks have become common in the previously plague-free West Nile region of Uganda. A new food storage device that CDC has developed and tested might not only reduce plague, but may also address the problem of food insecurity (not having enough food to eat) in this poverty-stricken area. And there's an added bonus— they are built from native materials and could be locally produced to provide a source of employment.

The recent increase in plague is associated with many factors— native forests and savannas being converted to fields used for subsistence farming, rapid increases in human population, and an invasion of black rats into new habitats created by vegetation clearing and village construction. This highly prolific black rat is the preferred host for fleas that spread plague to people.

▲ Food items stored in open baskets and on the floor makes them easily accessible to rodents in search of food. In addition to bringing plague-infested fleas into the huts, the rats also eat a significant amount of the villagers' food.

A key to reducing plague is cutting off rats' access to food supplies. After collecting information about local food storage practices and types of crops raised, rats were radio-collared, which resulted in cooking huts— rather than sleeping huts— being targeted for rat reduction measures. The roughly 100 food storage cabinets that were designed specifically to limit rat access to food supplies had another advantage. Because they can be secured, the food boxes could help curb the widespread problem of stealing food that contributed to food insecurity in the region. The food storage boxes are currently being evaluated to determine whether a larger scale trial will follow to document if there has also been a reduction in human plague.

◀ Ugandan carpenters constructed lockable food storage pantries like this from locally available materials to protect stored foods from rodents and theft.

Approximately 75% of recently emerging infectious diseases affecting people are zoonotic— they originate in animals.

Cute but contaminated— A cautionary tale about small turtles

▲ Small turtles cause *Salmonella* infection, especially among young children. Of the 160 illnesses in a 2012 outbreak, 64% were in children aged 10 years or younger.

For many of us, infection with *Salmonella* is associated with eating— as in eating food contaminated with *Salmonella* such as undercooked eggs, ground turkey, or chicken. But *Salmonella* infection can also be caused by touching— as more than 160 people discovered after they had handled small turtles. As of early September 2012, 6 overlapping outbreaks reported in 30 states of *Salmonella*-caused illness were linked to small turtles, those with a shell length of less than 4 inches. Of the 160 illnesses, 64% were in children aged 10 years or younger; 56% of those who became ill were Hispanic.

Infections caused by small turtles are a recurrent problem, despite the fact that the US Food and Drug Administration (FDA) has banned the sale and distribution of small turtles since 1975. In the outbreaks in 2012, almost half of ill people reported purchasing turtles from street vendors, making it difficult to determine the original source of the turtles.

Salmonella are naturally occurring bacteria in turtles, and those with *Salmonella* still appear healthy and clean. Contact with other reptiles (such as snakes and lizards) and amphibians (such as frogs and toads) can also be a source of *Salmonella* infections. *Salmonella* germs are shed in their droppings and can easily contaminate their bodies and anything else in areas where these animals live.

Of particular concern is that small turtles cause infection especially among young children. *Salmonella* infection can be caused by actually handling the turtles or contact with their environment (like the water in the turtle habitat). Despite the health risk, turtles remain popular pets. CDC collaborated with public health officials in multiple states and the FDA to investigate the six overlapping, multistate outbreaks. CDC posts updates about the outbreaks on their website, in addition to providing educational information designed to alert consumers to the dangers of handling small turtles.

Group of vampire bats in Peru.
Courtesy D. Streicker

Taking action

Supporting the prevention of infectious disease by focusing on…

Healthcare-associated infections

Current challenges

Healthcare-associated infections (HAIs) are a leading cause of preventable illness and death in the United States and a critical public health problem that affects 1 in 20 hospitalized patients. HAIs are caused by a variety of bacteria, fungi, and viruses, yet are preventable with proper adherence to evidence-based infection control practices. HAIs occur in all settings where patients receive medical care, including hospital and non-hospital settings (e.g., ambulatory surgical centers, long-term care and dialysis facilities), are associated with increased mortality, and account for at least $28 billion in excess healthcare expenditures annually.

What is CDC's role in preventing healthcare-associated infections?

CDC's healthcare-associated infections (HAIs) program began over 4 decades ago and leads the nation towards the goal of eliminating HAIs. It has formed the basis for healthcare facility, local, state, and national prevention programs that include surveillance, prevention research, developing guidelines to promote US healthcare quality, outbreak response and control, and laboratory support. CDC's role in preventing HAIs involves the following activities:

- **Conducting surveillance** for HAIs through the National Healthcare Safety Network (NHSN) and the Emerging Infections Program (EIP). NHSN is the largest Web-based medical surveillance system in the US, used by more than 11,000 healthcare facilities in all 50 states. EIP, a population-based network of state and local health departments in 10 states, is a national resource for surveillance, prevention, and control of emerging infectious diseases. CDC's surveillance systems serve as the national standard for defining HAI problems, identifying and prioritizing populations at risk, and measuring the impact of prevention efforts. CDC data are used by healthcare facilities for HAI prevention and by state and federal agencies for public reporting and quality improvement programs. *(continued on the next page)*

Having cancer is bad enough—don't let an infection happen

▲ *Courtesy CDC Foundation*

One of the most dangerous side effects of chemotherapy cannot be seen. A low white blood cell count, or neutropenia, puts cancer patients at a higher risk for getting an infection. White blood cells are the body's main defense against infection. For patients with this condition, any infection can become serious quickly.

Cancer patients who are treated with chemotherapy are more likely to get infections through everyday activities with their family and friends or from healthcare settings. It has been estimated that each year, 60,000 cancer patients are hospitalized for chemotherapy-induced neutropenia, and every 2 hours a patient dies from this complication. Because of the nature of their illness, great attention to infection prevention is warranted in the care of cancer patients.

Preventing Infections in Cancer Patients is a comprehensive program, resulting from the collaboration of CDC through a partnership between the CDC Foundation and Amgen. The two main components include the *Basic Infection Control and Prevention Plan for Outpatient Oncology Settings* and a patient and caregiver website: www.preventcancerinfections.org. The program also produced a variety of additional materials for patients, caregivers, and healthcare providers that provide information, action steps, and tools to help reduce the risk of developing potentially life-threatening infections during chemotherapy treatment.

What is CDC's role in preventing healthcare-associated infections? *(continued from previous page)*

- **Developing evidence-based guidelines** that provide the scientific basis for HAI prevention tools and oversight requirements by working with the Healthcare Infection Control Practices Advisory Committee through a transparent, public process. These guidelines establish the standard of care and provide evidence for provider and surveyor checklists and federal prevention initiatives, such as the Agency for Healthcare Research and Quality's Comprehensive Unit-Based Safety Program and the Centers for Medicare & Medicaid Services' (CMS) healthcare facility Survey and Certification process.
- **Maximizing HAI prevention efforts** through working with healthcare facilities, health departments, federal agencies, and professional organizations to implement HAI prevention programs. CDC supports state health departments' efforts to expand HAI prevention beyond hospitals. For example, in June 2012, CDC released a report and updated recommendations that detail how states and healthcare facilities should deal with carbapenem-resistant Enterobacteriaceae, deadly germs that can cause healthcare-associated infections.
- **Investigating and controlling outbreaks** and maintaining critical core laboratory capacities, including the national reference laboratory for antimicrobial susceptibility testing, environmental microbiology, and diagnostic methods for emerging healthcare-associated pathogens.

Accomplishments

NHSN data show dramatic reductions in healthcare-associated infections. In 2011, the following reductions in infections occurred (compared with the baseline):

- **41% reduction** in central line-associated bloodstream infections (CLABSIs)
- **7% reduction** in catheter-associated urinary tract infections (CAUTIs)
- **17% reduction** in surgical site infections (SSIs)
- Additionally, a **25% reduction** in the number of people developing healthcare-associated invasive MRSA infections, as measured by the Emerging Infections Program
- **NCEZID will publish the *Standardized Infection Ratio (SIR) Report* using NHSN data**, providing a state-by-state breakdown of healthcare-associated infections and detailing reductions in infection rates across the country in early 2013. CDC's support to states has contributed to a national CLABSI SIR reduction from 0.68 in 2010 to 0.59 in 2011.
- **Projects in three states have documented approximately a 20% reduction in *Clostridium difficile* when clinicians followed CDC infection prevention recommendations.** *C. difficile* is a pathogen that causes serious diarrhea and has been linked to 14,000 U.S. deaths and an estimated $1 billion each year in excess costs to the healthcare system. Although many HAIs have declined, the incidence of *C. difficile* infections remains at historic highs. The recent CDC *Vital Signs* report indicates that about 75% of *C. difficile* infections begin in medical settings such as nursing homes and outpatient clinics. In March 2012, CDC issued a call to action to prevent *C. difficile* infections.

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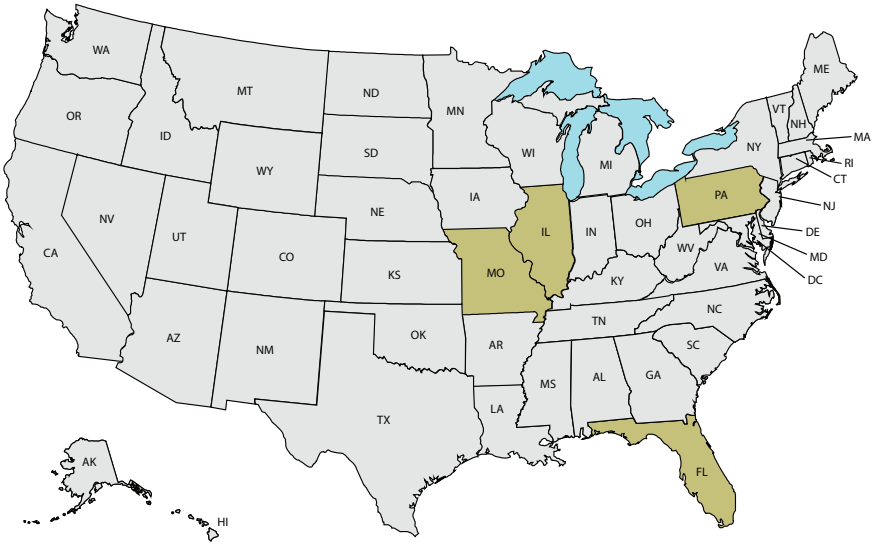
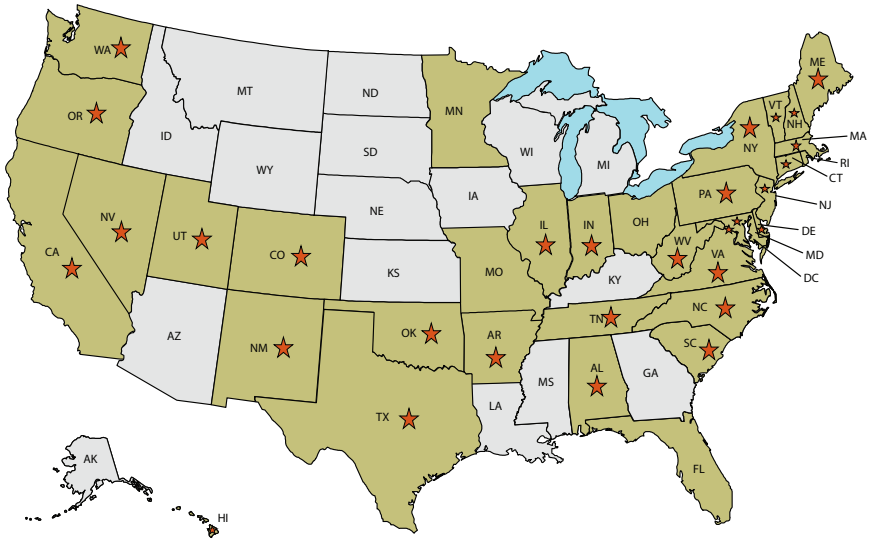
State-level public reporting HAI policy, 2004

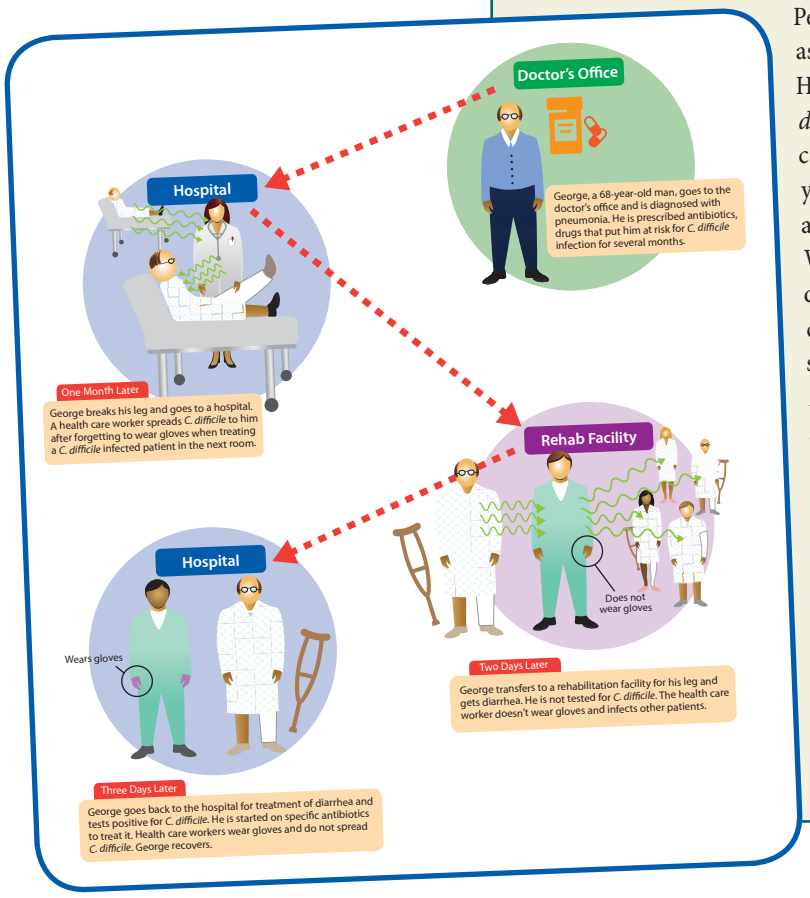


State-level public reporting HAI policy, 2012



▲ In 2012, more states are requiring public reporting of healthcare-associated infections (HAIs). More than 11,000 hospitals in all 50 states use CDC's National Healthcare Safety Network (NHSN) to track HAIs. To date, 29 states and the District of Columbia require reporting of HAIs using CDC's NHSN.

Stopping the spread of a difficult infection



People getting medical care can have serious healthcare-associated infections (HAIs). Although most types of HAIs are declining, one— caused by the germ *Clostridium difficile** — remains at historically high levels. *C. difficile* causes diarrhea and is linked to 14,000 US deaths each year. Those most at risk are people— especially older adults— who take antibiotics and also get medical care. When a person takes antibiotics, good bacteria are destroyed for several months. During this time, patients can get sick from *C. difficile* picked up from contaminated surfaces or spread from a healthcare provider's hands. About 25% of *C. difficile* infections first produce symptoms in hospital patients, but 75% start in nursing home patients or in people recently cared for in doctors' offices and clinics. *C. difficile* infections cost at least $1 billion in extra healthcare costs annually. A March 2012 CDC *Vital Signs* reports that *C. difficile* infections can be prevented by following CDC recommendations. Hospitals that have implemented these recommendations saw *C. difficile* infection rates decline by 20%. The US Department of Health and Human Services has targeted a 30% reduction in *C. difficile* infections by 2015.

**Clostridium difficile (klah-STRID-ee-um DIFF-i-seel)*

Accomplishments *(continued from previous page)*

- **NCEZID has expanded prevention of HAIs across all healthcare settings by increasing the types of HAIs reported** to NHSN. As of December 2012, more than 11,000 facilities, including approximately 5,000 hospitals, are using NHSN to track HAIs and target prevention. In October 2012, approximately 5,000 dialysis facilities, 430 long-term acute care facilities, and 1,200 inpatient rehabilitation centers began reporting HAIs through NHSN.
- **NCEZID developed and published evidence-based guidelines including the *Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care (2011)***, the 2011 *Guidelines for the Prevention of Intravascular Catheter-Related Infections*, and the *Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings* (2011). CDC continues to work with professional and federal partners to ensure that CDC guidelines become the standard of care. For example, CMS has incorporated CDC HAI prevention recommendations into surveyor tools used by CMS for facility survey and certification.

Controlling deadly infections in dialysis treatment

Hemodialysis (often called "dialysis") is a life-saving treatment for people with advanced kidney disease. About 350,000 people receive hemodialysis treatment at any given time, and roughly 8 in 10 of these patients start treatment through a central line. A central line is a tube that a doctor places in a large vein of a patient's neck or chest to give important medical treatment. When not put in correctly and kept clean, central lines can become a freeway for germs to enter the body and cause serious bloodstream infections (called BSIs). Of patients who get a bloodstream infection from having a central line, up to 1 in 4 die.

About 37,000 bloodstream infections occurred in 2008 in hemodialysis patients with central lines. The CDC Dialysis BSI Prevention Collaborative is a partnership aimed at preventing bloodstream infections in hemodialysis patients. Open to free-standing and hospital-based outpatient dialysis facilities across the country, the collaborative measures how many bloodstream infections are occurring and offers evidence-based practices to prevent these devastating infections.

It's working! After a New Jersey outpatient hemodialysis center began using the CDC Dialysis BSI Prevention Collaborative's infection-control practices, along with a program that enlisted staff member support in using safer procedures, they had only one vascular access-related BSI in 12 months.

What's next?

CDC's goal is to eliminate HAIs across all healthcare settings and support state public health activities related to HAI monitoring, response, and prevention. In the coming years we will focus on

- **Extending prevention activities to non-hospital settings** (e.g., long-term care facilities, ambulatory surgical centers) where increasingly, more complex medical care is being provided and rates of HAIs have not decreased.
- **Providing NHSN data** to measure the impact of state and national HAI prevention initiatives including state HAI prevention collaboratives, the *HHS Action Plan to Prevent HAIs: Roadmap to Elimination*, the CMS Value-Based Purchasing program, and other HHS HAI prevention initiatives.
- **Developing and disseminating evidence-based guidelines** and prevention tools to ensure that the safest care is delivered in all healthcare settings.
- **Guiding prevention strategies and best practices** to target HAIs whose rates have not decreased to address important scientific gaps in HAI prevention.
- **Supporting state-based efforts to prevent HAIs,** including providing technical expertise and training, outbreak response, support for HAI prevention programs, policy evaluation, and laboratory support.

Supporting the prevention of infectious disease by focusing on…

Antimicrobial resistance

Current challenges

Antimicrobial resistance (AR) is one of the world's most pressing public health threats. A wide range of pathogens— including the bacteria that cause tuberculosis and healthcare-associated infections, the viruses that cause influenza, the parasites that cause malaria, and the fungi that cause yeast infections— are becoming resistant to the antimicrobial agents used for treatment. Antibiotics have been used so widely and for so long that the infectious organisms the antibiotics are designed to kill have adapted and continue to adapt to them, making the drugs less effective. Patients infected with drug-resistant microbes are more likely to require hospitalization, remain in the hospital longer, and have a poor prognosis. Effectively combating antimicrobial resistance requires developing new drugs, appropriately using existing drugs, and vigilantly tracking and stopping the spread of resistance.

What is CDC's role in preventing antimicrobial resistance?

NCEZID plays a critical and unique role in combating AR and uses a multifaceted approach to prevent and control antimicrobial resistance through surveillance, laboratory work, outbreak response, educational campaigns, and partnerships with state agencies and national organizations. We work closely with federal partners, the Interagency Task Force on Antimicrobial Resistance, and international organizations.

Our role includes the following:

- **Monitoring disease, deaths, antibiotic use, and resistance trends** caused by microbial infections of public health importance. We also monitor antibiotic use and resistance rates, inform and guide prevention efforts, and evaluate the effectiveness of prevention programs.
- **Providing technical assistance and laboratory support** for outbreak investigations of AR organisms. We use molecular fingerprinting (DNA analysis) to understand the epidemiology of multidrug-resistant organisms, compare strain types, and identify emerging mechanisms of resistance for healthcare-associated pathogens.

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What is CDC's role in preventing antimicrobial resistance?

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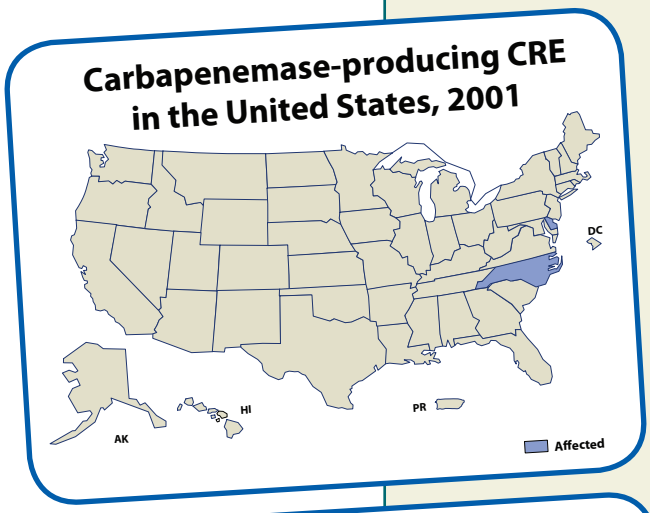
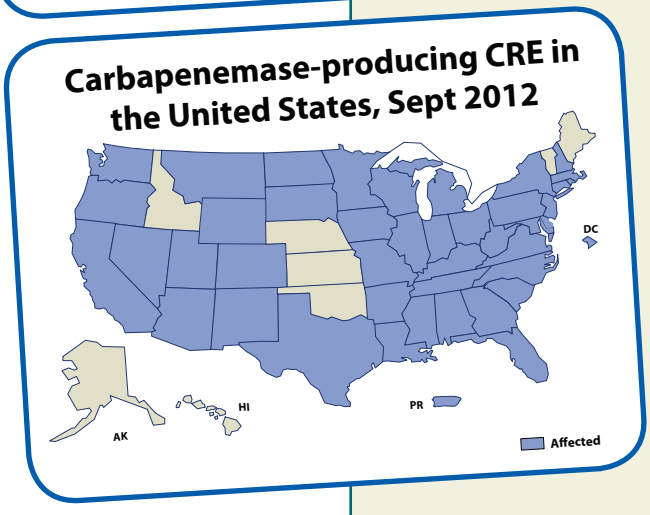
- **Developing and refining methods** to detect new resistant pathogens and susceptibility to antimicrobials. NCEZID reference laboratories provide gold-standard laboratory testing services for state health departments, clinical diagnostic laboratories, academic researchers, and hospital laboratories.
- **Developing evidence-based infection control and antimicrobial stewardship guidelines** to prevent transmission of infections and promote appropriate use of antimicrobials. CDC also has education campaigns that promote appropriate use of antibiotics in physicians' offices (called *Get Smart: Know When Antibiotics Work*) and in inpatient, outpatient, and long-term care settings (called *Get Smart for Healthcare*).

A dangerous— and spreading— infection





In August 2000, an infectious disease expert in a New York City hospital received a disturbing call from the microbiology laboratory about a patient in the intensive care unit from whom they had isolated a bacterium called *Klebsiella* pneumoniae*. This bacterium, as the doctor recalled in a 2008 *New Yorker* article titled "Superbugs," was "literally resistant to every meaningful antibiotic that we had." By 2012, *Klebsiella pneumoniae* carbapenemase (KPC)-producing *Klebsiella* infections, which in 2001 had been seen in only 2 states, had spread to more than 40 states and Puerto Rico. KPC and other carbapenemases are enzymes produced by certain bacteria, making them resistant to last-resort antibiotics. The group of highly resistant bacteria together are carbapenem-resistant Enterobacteriaceae (CRE).

In healthcare settings, CRE infections commonly occur among sick patients who are receiving treatment for other conditions. Patients whose care requires devices like ventilators (breathing machines) or intravenous (vein) catheters, and patients who are taking certain antibiotics are most at risk for CRE infections. Healthy people usually do not get CRE infections.

Some CRE bacteria have become resistant to most if not all available antibiotics and can be deadly— one report cites they can cause death in 40% of patients who become infected. Antibiotic stewardship programs and interventions, like CDC's *Get Smart for Healthcare*, work to combat unnecessary and inappropriate use of antibiotics that has contributed to the rise of antibiotic-resistant infections. The program aims is to ensure that patients get the right antibiotics at the right time for the right duration.

**Klebsiella (kleb-see-ell-uh)*

Accomplishments

NCEZID continued efforts to assess and combat increasing antimicrobial resistance in fiscal years 2011 and 2012. Significant accomplishments include the following:

- **Identifying and characterizing 3 new strains** of carbapenemase-resistant Enterobacteriaceae (CRE) bacteria that are resistant to nearly all antimicrobial agents. NCEZID assisted states with 12 CRE outbreak investigations over the past 2 years and is expanding programs to eradicate newly emerging AR pathogens in specific localities or regions, using surveillance and aggressive infection control measures in all healthcare facilities that share patients within those geographical areas.
- **Launching CDC's National Healthcare Safety Network's** new Antimicrobial Use module in March 2011 to allow facilities to electronically report inpatient antimicrobial usage data and compare facility-specific usage rates to a national risk-adjusted benchmark. Information from this national surveillance program will help facilities detect whether antimicrobial agents are being used excessively or inappropriately and, if so, target education and prevention. *(continued on the next page)*

Tainted turkey— Tracking antimicrobial resistance in food

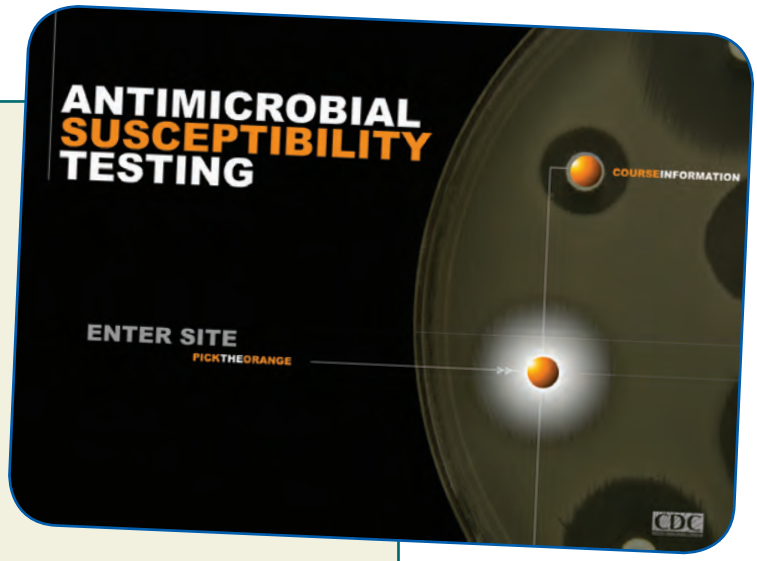
Antimicrobial use in food-producing animals may result in antimicrobial resistance that can be transmitted to people through the food supply. In summer 2011, scientists at CDC collaborated with public health officials in many states and the US Department of Agriculture's (USDA) Food Safety and Inspection Service to investigate a multistate outbreak of *Salmonella* infections. Ultimately, more than 36 million pounds of ground turkey that may have been contaminated with a multidrug-resistant strain of *Salmonella* Heidelberg were recalled, making it the largest USDA recall to date— of any food— in history.

The National Antimicrobial Resistance Monitoring System (NARMS) played a pivotal role in helping identify ground turkey as a likely source of infection. NARMS is a collaboration of CDC, the US Food and Drug Administration Center for Veterinary Medicine (FDA-CVM), and the US Department of Agriculture (Agricultural Research Service) that monitors trends in antimicrobial resistance among foodborne bacteria from humans, retail meats, and animals. In this case, a strain of *Salmonella* Heidelberg, highly similar to the outbreak strain, was detected by NARMS in ground turkey from two states. This information led NCEZID and its partners to emphasize ground turkey as a possible source in their investigation, ultimately leading to the factory where the meat was processed.

A total of 136 people in 34 states were infected. The outbreak strain of *Salmonella* Heidelberg was resistant to several antibiotics. There are still questions about whether the severity of this outbreak was due to pathogen dose (a high degree of contamination in the turkey that was consumed), the multidrug resistance of this particular strain of *Salmonella,* or treatment failure (medical management or procedures were unsuccessful).

Accomplishments *(continued from previous page)*

- **Conducting a randomized trial,** REDUCE-MRSA, in partnership with the Agency for Healthcare Research and Quality, in 45 hospital intensive care units to assess the comparative effectiveness of 3 strategies for preventing MRSA, a type of staph bacteria that is resistant to certain antibiotics.
- **Testing bacteria** isolated from people involved in foodborne disease outbreaks to help determine what foods or other exposures might be causing those outbreaks and testing over 5,000 samples of microbes including *Salmonella*, *Shigella*, *Campylobacter*, *E. coli*, and *Vibrio* to document the emerging resistance to antimicrobial drugs using the National Antimicrobial Resistance Monitoring System.



It takes a task force…

The problem is severe, growing, and unfortunately, here to stay. The extensive use of antimicrobial drugs has resulted in drug resistance that threatens to reverse the medical advances of the last half century. The world may soon be faced with previously treatable diseases that have again become untreatable.

The challenge is to transform an increasingly urgent threat of antimicrobial resistance into a manageable problem. Enter the Interagency Task Force on Antimicrobial Resistance (ITFAR), multiple federal agencies working together to address the complex issue of antimicrobial drug resistance. In 2011, the task force released an updated revision of *A Public Health Action Plan to Combat Antimicrobial Resistance*. The revised plan focuses on federal activities in four topic areas dealing with antimicrobial resistance: surveillance, prevention and control, research, and product development. The original *Action Plan* (2001) focused primarily on domestic issues; the revised *Action Plan* also includes global issues, since resistance is a problem worldwide. The past decade has seen extraordinary change in the microbiology and epidemiology of antimicrobial resistant microbes and subsequent changes in treatment and patient outcomes.

Although development of new antimicrobial agents and effective stewardship of existing agents are key in protecting health in the face of ever-expanding antimicrobial resistance, success in preventing or eliminating resistance occurs with successful prevention or elimination of resistant microbes.

The Task Force and all participating federal agencies are continuing to stress the importance of good communication with the many stakeholders who share the goals of preventing and controlling antimicrobial-resistant infections. The Task Force remains committed to continuing communication with the public and health professionals, since antimicrobial resistance so profoundly affects public health and clinical medicine. Given the public health consequences of antimicrobial resistance and its ever-changing nature, the Task Force will continue to address the issue of antimicrobial resistance in this and future versions of the *Action Plan*.

"Approximately 50% of antibiotic use in hospitals is unnecessary or inappropriate."

What's next?

NCEZID will continue to support state and local health departments to enhance AR surveillance, prevention, and control interventions and applied research for AR by

- **Enhancing national, regional, and local surveillance capacity** through electronic reporting to detect and track emerging AR organisms, and identifying "hotspots" where multidrug-resistant organisms and other healthcare-associated pathogens are being amplified. We are also piloting regional prevention collaborative projects to use early detection systems for new AR threats. The aim is to trigger aggressive infection control measures in communities and states to prevent these emerging threats from spreading.
- **Strengthening capacity in both clinical and public health laboratories** to accurately detect priority, high-consequence antimicrobial-resistant pathogens, such as carbapenem-resistant Enterobacteriaceae (CRE), in collaboration with state public health departments.
- **Updating the *A Public Health Action Plan to Combat Antimicrobial Resistance*** published by the Interagency Task Force on Antimicrobial Resistance. This plan is the federal blueprint for combating AR.
- **Working with FDA to implement provisions of the GAIN** (Generating Antibiotic Incentives Now) Act, including developing, implementing, and measuring antimicrobial stewardship programs, and identifying a list of serious antimicrobial-resistant pathogens of public health significance. In 2013, CDC and FDA will finalize the GAIN list of AR pathogens of public health importance and share this with the members of the Interagency Task Force on Antimicrobial Resistance.

CDC's Emerging Infections Program tracks infections caused by gram-positive *Clostridium difficile* (pictured) that patients can get in a hospital or other healthcare facility. ▼

"There are certain things only a government can do. And one of those things is ensuring that the foods we eat are safe and do not cause us harm."

President Barack Obama

Supporting the prevention of infectious disease by focusing on…

Foodborne disease and food safety

▲ From late September through late November 2012, a total of 42 persons in 20 states were infected with *Salmonella* bacteria after eating contaminated peanut butter. A collaborative investigation among federal, state, and local public health authorities resulted in a voluntary recall of the contaminated peanut butter and other products containing nuts and seeds.

Current challenges

CDC estimates that roughly 1 in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases each year. The 1,000 or more outbreaks that are reported annually reveal familiar culprits, like *Salmonella*. Approximately 6.5 million illnesses are caused by food contaminated with norovirus and *Salmonella* each year. Infections caused by *Listeria* outbreaks led to 33 deaths in the United States in 2011 alone.

Foodborne illness also results in billions of dollars in healthcare-related and industry costs annually. Reducing foodborne illness by just 10% would keep 5 million Americans from getting sick each year.

In recent years, large multistate foodborne outbreaks have become more common, in part because an extensive network of foodborne illness surveillance systems identifies outbreaks and tracks trends that previously would have been missed. Also, an increasingly centralized food supply means that foods contaminated in production can be rapidly shipped to many states, causing widespread outbreaks.

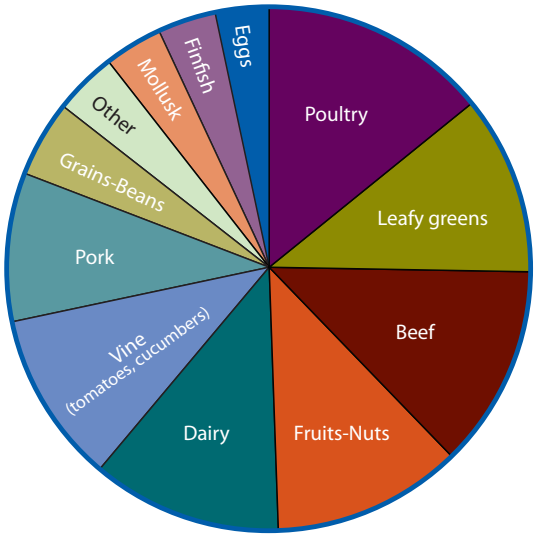
What is CDC's role in preventing foodborne illness?

Foodborne illness is a preventable and largely underreported public health problem. CDC has strong partnerships with state and local health departments and federal regulatory agencies, such as the US Food and Drug Administration (FDA) and US Department of Agriculture (USDA), to ensure a robust national food safety system. Our overarching goal in food safety is to gather information from ill persons about the germs that made them sick and use that knowledge to prevent further illness and death. We gather high-quality scientific data on food-related human illness that regulators, industry, and consumers can use to develop food safety priorities and improve food safety policies and practices in the United States. With additional effort and support for evidence-based, cost-effective strategies that we can put in place now, we can have a significant effect on our nation's health.

We provide the vital link between foodborne illness in people and the food safety systems of government regulatory agencies and food producers by

- **Monitoring human illnesses** through a network of complementary surveillance systems needed to detect and investigate outbreaks from tainted food in near real-time.
- **Estimating how many people get sick** from contaminated food and attributing those illnesses to specific foods and settings.
- **Conducting state-of-the-art laboratory testing** to detect emerging food-related diseases and track antimicrobial resistance trends.
- **Providing expert epidemiological and reference laboratory consultation** to local and state partners on outbreaks that they are investigating. *(continued on the next page)*

Foods that caused 1,000 foodborne disease outbreaks, 2006–2011*



**There were 1,011 outbreaks and 25,200 illnesses reported.*

Foodborne Disease Outbreak Surveillance System, 2012

Using data to reduce *E. coli* contamination

What do ground beef, leafy greens, unpasteurized apple juice, and raw cookie dough have in common? They all have been associated with one of the most lethal, and now one of the best known, foodborne pathogens— E. coli. Shiga toxin-producing *Escherichia coli* (often shortened to STEC O157 or *E. coli* O157) captured media attention in the United States in the 1990s after outbreaks of infections caused widespread sickness and even death.

After CDC and its partners launched the Foodborne Diseases Active Surveillance Network (FoodNet) in 1996, studies began linking sporadic cases of foodborne illness caused by *E. coli* to ground beef. When regulators and industry leaders started using CDC data to improve food handling and production standards, the incidence of *E. coli*-associated illness in foods such as ground beef, raw juice, and leafy greens rapidly declined. In fact, during the past 15 years, a dangerous type of *E. coli* infection, responsible for the recall of millions of pounds of ground beef, has been cut almost in half.

The cantaloupe crisis

In 2011, CDC confronted one of the deadliest foodborne outbreaks in the United States in nearly a century. The outbreak killed 33 people and caused one miscarriage. However, a coordinated public health response— built on rapid detection and investigation— likely prevented many more illnesses and deaths from the bacteria *Listeria*, found in cantaloupes from Colorado.

The outbreak was detected, its source was identified, and a national warning was issued, all in just 10 days, as compared with weeks that it took to respond to previous *Listeria* outbreaks. The rapid response was due to the work of many government agencies and healthcare professionals, in addition to PulseNet laboratories that identified the illnesses through DNA "fingerprints." PulseNet labs identified outbreak strains in Colorado patients, then connected them with illnesses in 27 other states. A nationwide network of 87 labs, PulseNet is designed to connect cases of illness across the country to quickly spot outbreaks, including many that otherwise would go undetected.

What is CDC's role in preventing foodborne illness?

(continued from previous page)

- **Extending detection and response globally** through several programs, including the Global Foodborne Infections Network. In 2000–2011, over 2,600 professionals have been trained in more than 25 countries.
- **Supporting implementation of the Food Safety Modernization Act** by prioritizing prevention, strengthening surveillance, and improving outbreak response and recovery.

Accomplishments

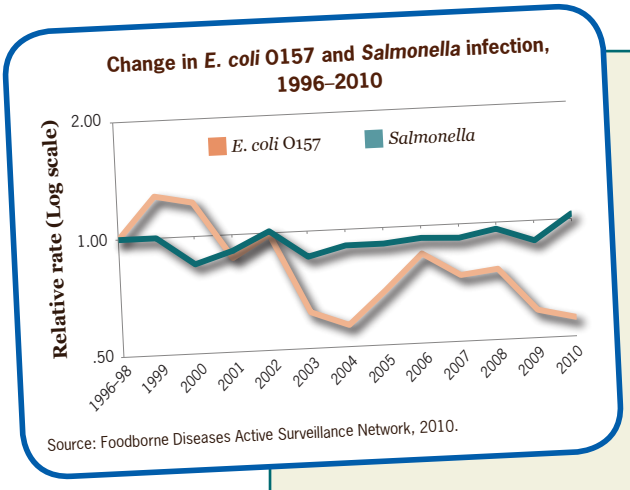
NCEZID's food safety program accomplished a number of important steps towards improving the safety of our food supply during 2011 and 2012. For example, we

- **Published the first** estimates of foodborne illness in more than a decade, and found that 48 million Americans, or 1 in 6, become sick each year from contaminated food. Some 3,000 die every year because of a food-related illness.
- **Rapidly detected and investigated more than 20 multistate outbreaks** and tracked some 150 clusters of suspected food-related illness— resulting in fewer illnesses and deaths. For example, we led early, rapid detection and investigation of the deadliest US outbreak in nearly a century. As tragic as this outbreak of *Listeria* was, swift and coordinated public health actions, starting in Colorado, saved lives. A new source of *Listeria* infection— cantaloupe— was identified, and the outbreak was stopped quickly. Although serious, listeriosis can be prevented. However, it takes teamwork. Everyone has a role— from farmers to families.
- **Developed new and better methods to detect, investigate, respond to, and control multistate outbreaks** of foodborne diseases. As a result, one state reported an 86% drop in the time it took to first interview patients after they reported an illness that seemed to be food-related— falling from 21 days down to just 3 days. This quicker communication opens the door to faster action that can save lives.
- **Used scientific evidence** to guide development and implementation of important prevention policies like FDA's Egg Safety Rule and the Food Safety Modernization Act. These new policies, along with related regulations and industry guidance, will help prevent people from becoming sick and dying from food gone bad.
- **Estimated the** attribution of illness to specific foods and communicated the dangers of raw milk and raw milk products. These efforts will help food safety partners figure out how to prevent foodborne illnesses and deaths.

What's next?

NCEZID's food safety program will continue to strengthen surveillance systems and laboratories needed to track foodborne illnesses; detect, investigate, and stop outbreaks when they occur; and provide information to prevent disease. In the coming years, we will focus on

- **Building state and local capacity** to detect outbreaks through strong laboratories to identify pathogens and detect outbreaks early and training partners in outbreak detection, investigation, and response.
- **Developing and assessing next-generation laboratory tests** to improve surveillance, outbreak detection, and response capacity nationally.
- **Adapting our surveillance systems** to respond to and integrate with technology changes like culture-independent laboratory tests.
- **Improving investigation and control** of foodborne health threats through the development of new tools, methods, and analytics to allow faster and more complete identification of foodborne outbreaks and their causes.
- **More accurately attributing illness to specific foods,** which will allow for the identification of prevention policies targeted to the highest risk foods.
- **Tracking trends and sharing data widely** and rapidly with public health partners, regulatory agencies, industry, and the public to guide safety and prevention policies to address food safety problems.



Targeting *Salmonella*— A stubborn foodborne infection

The 1,000 or more reported outbreaks of foodborne disease that happen each year reveal a familiar culprit— *Salmonella*. But the good news is that we know that reducing contamination works. During the past 15 years, a dangerous type of *E. coli* infection, responsible for the recall of millions of pounds of ground beef, has been cut almost in half. Yet during that same time, *Salmonella* infection, which causes more hospitalizations and deaths than any other type of germ found in food and $365 million in direct medical costs annually, has not declined.

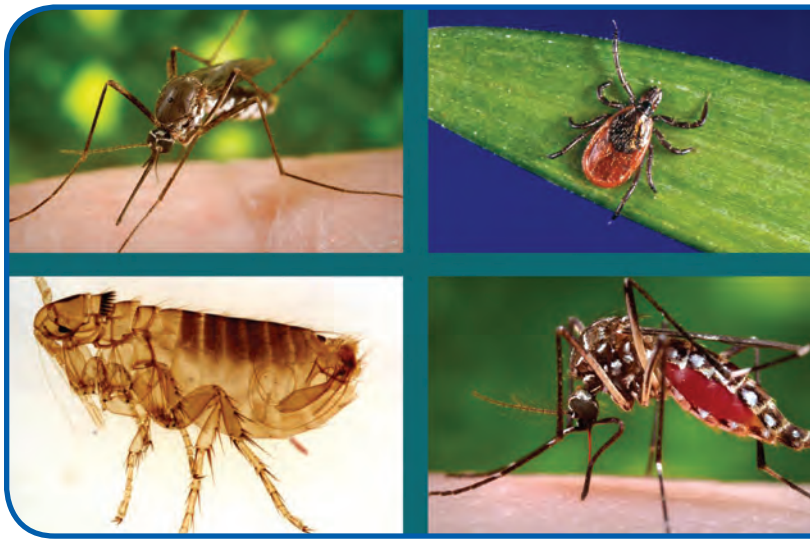
In 2011, a new CDC *Vital Signs* report focused on *Salmonella* contamination, which sickens 1 million people each year. Strong and specific action to identify and prevent contamination from the farm to the table, and other lessons learned from reducing *E. coli* 0157 infections could help reduce illness caused by *Salmonella*.

Supporting the prevention of infectious disease by focusing on…

Vector-borne diseases

Current challenges

Americans and millions of others are at risk for severe and fatal illness from vector-borne diseases. Vector-borne diseases include bacterial and viral diseases transmitted by mosquitoes, ticks, and fleas. Some of these diseases have long been present in the United States while others have recently emerged. These include some of the world's most destructive diseases, many of which are increasing due, in part, to globalization of trade and travel and global climate change. Of diagnosed diseases that must be reported to US federal, state, or local health officials, Lyme disease is the sixth most commonly reported, with 30,000 cases reported annually. Since 1999, more than 3 million people in the country have been infected with West Nile virus, including more than 12,700 people whose infections have been severe. Dengue infects as many as 100 million people worldwide. Many other vector-borne pathogens are also found in the United States.



What is CDC's role in preventing vector-borne diseases?

NCEZID is the acknowledged national and international leader in the prevention and control of infection with vector-borne viruses and bacteria. We have a unique capability, expertise, and mandate to fill this role at a time when vector-borne diseases are emerging and spreading at an alarming rate. Our core vector-borne disease activities include:

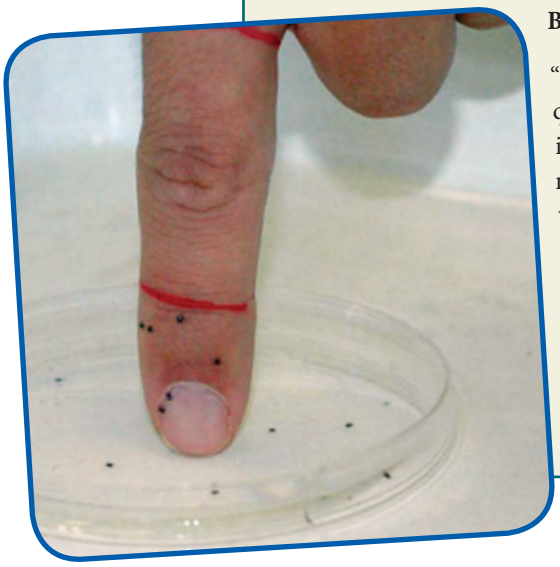
- **Developing and sharing cutting-edge laboratory technology** for the rapid identification of pathogens and diagnosis of emerging diseases.
- **Developing innovative vaccines** and vaccine implementation strategies.
- **Training and assisting front-line disease surveillance** and response staff. *(continued on the next page)*

Fighting ticks and mosquitoes, naturally

Virtually all prevention campaigns against tick- and mosquito-borne diseases recommend repellent use. Unfortunately, much of the public opts to take their chances with West Nile virus or Lyme disease rather than use repellent. In a recent national study, only 26% of people in the Lyme disease endemic northeastern states regularly applied repellent during warm months.

Is it possible to make a repellent that is both effective and marketable?

"Yes," says Marc Dolan, CDC entomologist. Nootkatone, a compound found in both Alaska yellow cedar trees and citrus fruits, has a unique action against insects and ticks. Dolan explains that it is "non-greasy, dries very quickly, and it has a very pleasant, citrus-y grapefruit odor to it."



But does it work?

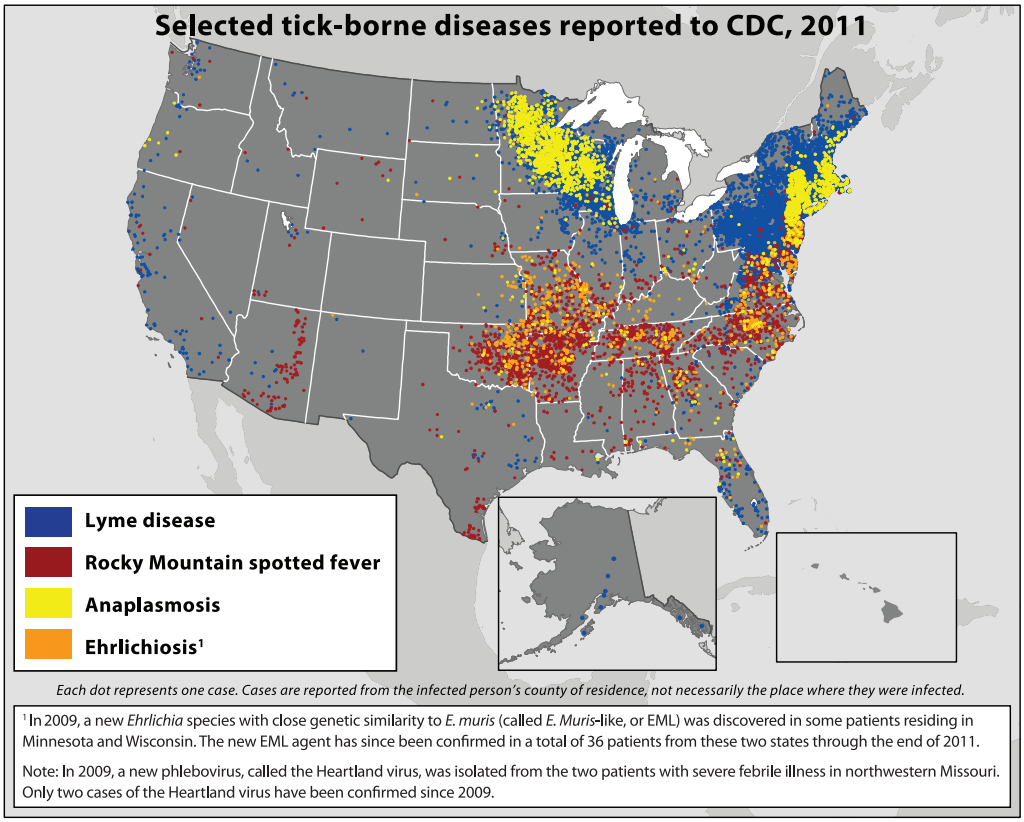
"This stuff has incredible knock-down," said Dolan. "It kills ticks very, very quickly, usually within about 15 seconds." In recent trials, nootkatone sprayed in a Lyme disease endemic area suppressed more than 90% of ticks. "Since nootkatone is a natural compound, we believe it may have a broad appeal and will ultimately increase the number of people using repellent and insecticide to protect themselves from ticks and mosquitoes," said Dolan.

CDC and its academic partners are collaborating to develop nootkatone products. And the tests that CDC has run so far have gone very well. CDC has licensing agreements with commercial partners to develop nootkatone-containing products, including insecticides, repellents, soaps, and shampoos. These items could be available for purchase in the next few years.

◀ Ticks don't venture beyond the red line on the finger, indicating where nookatone was applied.

What is CDC's role in preventing vector-borne diseases? *(continued from previous page)*

- **Developing clinician education programs**, including a much-praised program for training clinicians how to manage severe dengue cases.
- **Detecting, preventing, and controlling mosquito-borne diseases** through the ArboNET surveillance system and tick-borne diseases through the TickNET system. Both systems further NCEZID's surveillance, research, and prevention efforts in collaboration with state and local health departments.
- **Closely collaborating with state, local, and tribal health departments**, industry, and international partners, such as the World Health Organization, to rapidly detect and implement timely, effective responses to known and newly identified pathogens.



Accomplishments

In fiscal years 2011 and 2012, NCEZID continued efforts to better understand and prevent vector-borne diseases around the world through surveillance, response to outbreaks, and scientific innovation. Examples of accomplishments include

Innovation: Innovative, applied research led to new methods for the diagnosis, prevention, and control of vector-borne diseases.

- Discoveries include the identification of two new tick-borne pathogens in the United States, found in partnership with state health departments— an *Ehrlichia muris*-like agent from Minnesota and Heartland virus from Missouri— and the identification of two new significant causes of human heart disease in Southeast Asia. Fieldwork and clinical epidemiology continue to identify the public health impact of these discoveries and ways to prevent infection.
- Vaccine efforts include clinical trials of a CDC-developed candidate dengue vaccine produced by commercial partners, which is effective against all four dengue serotypes. There has also been an assessment of a new vaccine against Japanese encephalitis virus in Cambodia. This is the first large-scale, prospective evaluation of this vaccine's effectiveness and is critical to future widespread adoption.
- Development of a clinician education program that has saved lives and reduced hospitalization costs by training more than 10,000 clinicians on optimal clinical management of severe dengue in Puerto Rico.

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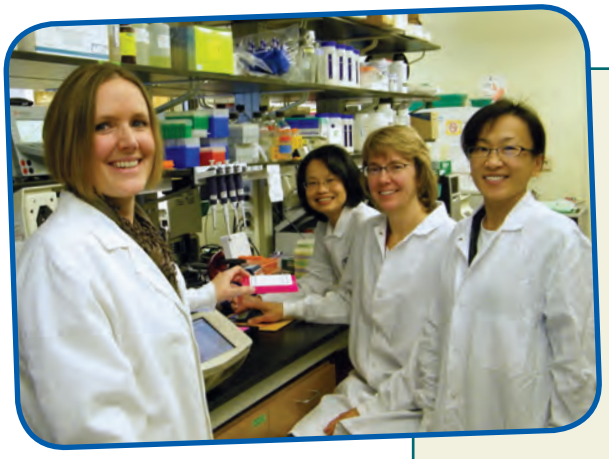


▲ Dr. Claire Huang (center) and her team (L–R), Janae Stovall, Karen Boroughs, and Betty Luy, developed a dengue vaccine candidate in their CDC laboratory in Fort Collins, Colorado. *Courtesy Judith Lavelle*

Developing a vaccine

Despite decades of effort by many scientists to develop a vaccine for dengue, no licensed vaccine is available (although several are currently in the later stages of development). Dengue is caused by infection with any of four closely related dengue viruses, and a successful dengue vaccine must offer immunity against all four.

CDC scientists in Fort Collins, Colorado, have developed a dengue vaccine candidate that is now being clinically evaluated in the United States and Colombia for safety and immunogenicity (ability to stimulate an adequate immune response). The first human Phase-I trial showed that the vaccine was safe, was well tolerated, and produced antibody levels that should protect against all four dengue viruses. Because of these encouraging results, a Phase-II clinical trial to assess immunogenicity began in late 2011. A successful Phase-II trial would be followed by Phase-IIb or Phase-III trials to determine the efficacy of the vaccine to prevent dengue. Clearly, development and testing of a human vaccine requires many steps.

This technology has been awarded multiple US and international patents. CDC's dengue vaccine team has partnered with Inviragen, Inc., a Colorado-based vaccine developer. Inviragen has produced the vaccine, named DENVax, and is conducting clinical development and testing of the vaccine for human use. The goal is to provide a safe, effective, and affordable dengue vaccine to protect people living in or traveling to dengue-endemic countries.

Accomplishments *(continued from previous page)*

Surveillance: Surveillance is critical to good public health decision making, allowing public health officials to make the best use of limited resources to prevent and respond to disease. NCEZID's TickNET works with state health departments to optimize surveillance and prevention activities for bacterial tick-borne diseases, such as Lyme disease and Rocky Mountain spotted fever. A study of the effectiveness of home pesticide use is under way through TickNET, addressing critical questions about the prevention of Lyme disease. ArboNET is a network for viral (largely mosquito-borne) disease detection, prevention, and control. ArboNET funding assists states, Puerto Rico, and six large municipalities to conduct case investigations, field collections, and analyses and submission of information to rapidly monitor and respond to potential epidemic conditions.

Outbreak response: NCEZID conducted outbreak investigations, helping state and foreign governments quickly respond to and contain vector-borne disease threats. Recent investigations include fatal cases of Rocky Mountain spotted fever on tribal lands in Arizona; the first yellow fever epidemic in Uganda in 40 years; human Q fever illness in western states; and dengue investigations among Ugandan peacekeeping troops in Somalia, dengue epidemics in the Western Pacific, the largest epidemic in Puerto Rico's history, and the first local transmission of dengue in Florida in 75 years.

What's next

Rapidly evolving trends such as urbanization and land use changes, migration, global climate change, invasive species, and globalization of trade all contribute to the dynamics of risk from emerging vector-borne pathogens. To move forward in the control and prevention of emerging vector-borne diseases, we must analyze and understand these trends and their impact on every aspect of the disease transmission cycle. By combining specialized epidemiology, ecology, laboratory, and prevention expertise, we will deliver

- **continued surveillance**, detection, prevention and control of vector-borne diseases;
- **new rapid, field-use diagnostic tests** for plague and yellow fever;
- **expansion of regional surveillance centers** and FDA-approved diagnostics/guidelines in preparation for dengue vaccine introduction; and
- **broadened capability to identify and characterize unknown pathogens** using next-generation genome sequencing.

A dangerous new virus knocking at our door

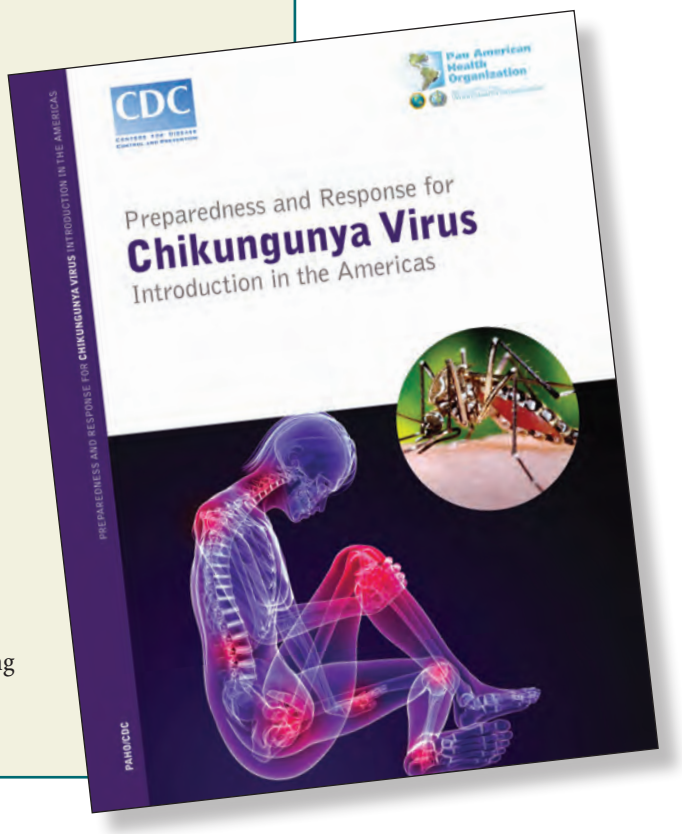
Hundreds of people who have traveled from the Americas to Asia and Africa in the past 5 years have become infected with chikungunya*, a virus transmitted by mosquitoes that causes fever and severe joint pain. To date, it has been introduced in the Western Hemisphere by returning travelers who have caught the virus abroad. Experts say, however, that outbreaks could easily occur if local mosquito populations become infected.

In early 2012, the Pan American Health Organization and World Health Organization, in collaboration with CDC, published new guidelines on chikungunya to help countries throughout the Americas improve their ability to detect the virus and to prepare to monitor, prevent, and control the disease, if— or more likely, when— it appears.

The name chikungunya means "that which bends up." The disease is rarely fatal, but the severe joint pain experienced with the disease can last for months. There is no specific treatment or commercially available vaccine for chikungunya virus infection. Chikungunya virus is spread through the bite of infected mosquitoes, particularly *Aedes aegypti* and *Aedes albopictus* (the "Asian Tiger" mosquito). *Aedes aegypti* is common in tropical and subtropical areas of the Americas, including the southern United States.

"Chikungunya-infected travelers continue to bring the virus to the Americas, including the United States," said Roger S. Nasci, a CDC scientist. "These guidelines provide the information needed to develop a comprehensive regional plan for rapidly detecting and, hopefully, reducing the potential impact of chikungunya virus in the Western Hemisphere."

**Chikungunya (chick-un-gun-ya)*



Supporting the prevention of infectious disease by focusing on…

CDC scientists in 2011 study bats in Uganda to learn more about their relationship to Marburg virus which, like Ebola, can cause a rare but deadly hemorrhagic fever in humans and other primates.▲

Highly pathogenic organisms

Current challenges

Select pathogens and diseases, such as rabies, anthrax, and viral hemorrhagic fevers, are of high consequence for those affected— often resulting in severe illness or death. Although rabies kills an estimated 55,000 people worldwide each year, many other high-consequence pathogens cause significantly less illness and death. Nonetheless, sporadic cases and small outbreaks do occur in the United States and all over the world and, importantly, these pathogens are potential bioterrorism agents. Our public health response efforts combine epidemiological, laboratory, ecological, and veterinary expertise to diagnose and stop the spread of these deadly diseases.

What is CDC's role in preventing illness and death caused by highly pathogenic organisms?

NCEZID maximizes public health and safety nationally and internationally through the detection, prevention, and control of disease, disability, and death caused by suspected and known highly pathogenic organisms. In many cases, we are the world experts and have the laboratory and epidemiologic capacity to respond to disease caused by these organisms. Our technical assistance is often sought by ministries of health and other international health organizations. Domestically, we investigate suspected cases of known highly pathogenic organisms and of infectious diseases of unknown causes reported by state and local health departments.

NCEZID's role is multifaceted but primarily focused on laboratory expertise and diagnostic development. We

- **Conduct research** to increase our understanding of pathogens, many of which must be handled in special biosafety level four (BSL-4) containment facilities, and apply that knowledge to achieve better disease outcomes.
- **Respond to outbreaks** all over the world to help control the spread of deadly diseases and prevent future outbreaks.
- **Provide knowledge, training, and the transfer** of technologies to partners and collaborators.
- **Lead surveillance and pathogen discovery** to increase our ability to rapidly identify newly emerging pathogens associated with high-fatality disease outbreaks.
- **Ensure the expertise, capacity, and preparedness** to safely handle, identify, and control known and previously unidentified highly pathogenic organisms.

Beware of disease— That can attack your dog!

In October 2011, the Michigan Department of Agriculture and Rural Development reported an outbreak of what was suspected to be a particularly virulent type of leptospirosis among dogs in the southeastern part of the state. Leptospirosis is among the most widespread of zoonotic diseases, which are infections transmitted naturally from domestic or wild animals to people. A team from CDC was called in to help define the size of the outbreak, to identify likely places where the dogs were getting infected, and to assess health risks among animal care workers, veterinarians, and owners of ill dogs.

Pet owners have probably seen brochures about leptospirosis in their veterinarian's office. It's a bacterial disease that can lead— without treatment with antibiotics— to potentially fatal infections of the kidney, liver, brain, lung, or heart. Leptospirosis used to be rare in household pets, but in the past few years it has been diagnosed more frequently. It's also found in farm animals and wildlife (rodents, raccoons, opossums). The bacteria that cause the disease can be spread through the urine of infected animals (especially rodents) and can get into water and soil and survive there for weeks. The two most common ways that people develop leptospirosis is drinking or swimming in contaminated water. Leptospirosis can also be caused by direct exposure to the urine or body fluids of infected animals.

CDC's team worked with local public health departments in Michigan to help control the outbreak and prevent its spread. They contacted veterinarians and pet owners and developed a plan to collect samples from rodents, which were identified as the likely primary source of the infection. The team also developed safety guidelines for those working with pets and pests, including demonstrating how protective equipment— such as respiratory masks, protective eyewear, and gloves— can help reduce the risk of infection.

Reducing that risk is also important for pet owners. CDC encouraged pet owners to talk with their veterinarian about yearly shots for their dogs, which can provide better protection for owners as well as dogs. CDC and local partners concluded that controlling populations of rats and stray dogs will reduce the threat of leptospirosis.

Accomplishments

NCEZID has successfully completed several high-impact public health research projects and response activities to further our prevention and control efforts. These include

- **Conducting animal trials** of a genetically engineered, live-attenuated Rift Valley fever vaccine for use in livestock. Rift Valley fever is an acute viral disease that affects domestic animals and humans. Vaccination of livestock will help eliminate one of the most significant sources of human infection in Africa and the Arabian Peninsula. *(continued on the next page)*

Zebras can have more than stripes

They sometimes have rabies, as several travelers from the United States discovered after returning from a safari adventure in Kenya in late summer 2011. Many people who travel to Kenya are looking for close encounters with exotic animals like lions, giraffes, and zebras. But for several US visitors and international travelers from 16 countries it may have been a lesson in "be careful what you wish for," because the lodge they chose also happened to be home to Zoe, an orphaned baby zebra that the lodge had adopted. Some guests visited Zoe in the stables where they could feed and pet her.

What the lodge and its guests did not know at the time was that Zoe had rabies. She was not showing signs of rabies yet but could have been "shedding" the rabies virus in her saliva for up to 2 weeks before she became ill. After she did show signs of illness, the staff thought she had a common gastrointestinal ailment. But once Zoe died, the results came back that she had died of rabies.

Because the rabies virus is transmitted through saliva, there was immediate concern. If the infected saliva entered an open wound or contaminated the eyes or mouth, a guest might have been exposed to rabies. CDC staff stationed in Kenya corroborated the rabies diagnosis. The Kenya Ministry of Health, CDC, and the World Health Organization worked quickly to track down the guests who might have been exposed to the deadly virus. CDC-Kenya worked with local officials and the lodge, and the team in Atlanta notified state health officials to contact travelers to assess for possible exposure and answer questions about the disease.

All US travelers were located for risk assessment, and 28 travelers received postexposure rabies shots. There have been no reports of rabies in travelers who had contact with Zoe, thanks to the quick response of the CDC and its public health partners.

Accomplishments *(continued from previous page)*

- **Enabling the rapid diagnosis of** Ebola hemorrhagic fever in Uganda by expanding surveillance in-country for viral hemorrhagic fever (VHF)— a group of diseases that include Ebola and Marburg hemorrhagic fevers. The expanded program included assigning a staff member to the Uganda Virus Research Institute (UVRI), providing training for case recognition and management for health professionals, providing reagents and training for diagnostic testing, and completing renovation of the VHF diagnostic laboratory at UVRI.
- **Providing training for enhanced laboratory-based surveillance** for monkeypox in the Democratic Republic of Congo (DRC). As a result, DRC has been sending monthly disease reports with laboratory samples for confirmation so that disease transmission dynamics can be better understood and to provide evidence for new disease control efforts.
- **Continuing to evaluate, update, and develop recommendations** for the use of medical countermeasures for anthrax and smallpox. For example, we completed a study to verify that alternative drugs for anthrax exposure can be of equal effectiveness as current first-line drugs.
- **Providing training to multiple international partners in diagnosing rabies infection** by a direct rapid immunohistochemistry test. This simple test, which requires only a standard light microscope, can provide local authorities with the information they need to make life-saving decisions about when to treat persons who have been bitten by dogs.

What's next?

NCEZID continues to seek better ways to ensure public health and safety nationally and internationally through the diagnosis, prevention, and control of disease, disability, and death caused by suspected and known viral, bacterial, prion, and related infections. NCEZID will not only conduct surveillance, investigations, and studies of these diseases, including bioterrorism agents and emerging infections, but also will expand its focus to include— but not be limited to— outcomes, such as:

- **Advancements in pathogen discovery** by testing for viruses in over 700 bat and rodent samples collected from multiple international study sites.
- **Better medical countermeasures** by advancing applied research on smallpox/orthopoxvirus medical countermeasures and safer vaccines.
- **Enhancements to efforts to control global canine rabies** through continued in-country consultations, diagnostic support, training, and health education to ministries of agriculture and health representatives.
- **Expansion of MicrobeNet**, a Web-based system that allows public health partners to rapidly identify unusual bacteria associated with individual cases or clusters of illness.

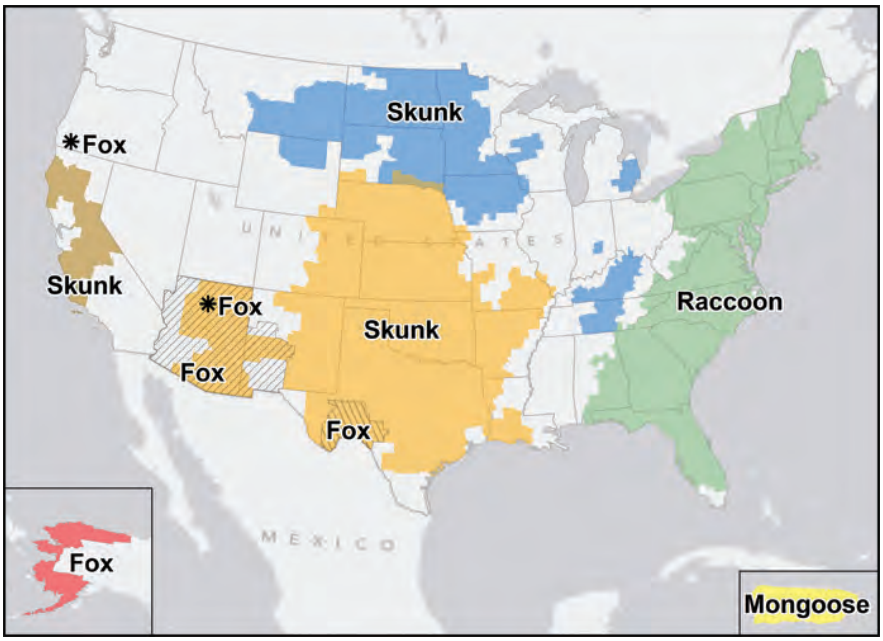
Bizarre bits

CDC received a rather unusual request from the Virginia Department of Health in March 2011. We were asked to come to a historical museum to help retrieve a letter from a display case in an exhibit called "Bizarre Bits." This letter, which had been sent through the mail, purportedly contained a highly lethal pathogen. Thinking the 2001 anthrax attacks? Different pathogen, different century.

▲ Depicts a number of what were "suspected" smallpox scab fragments from the archives of the Virginia Historical Society.

It was actually a 135-year-old smallpox vaccine scab enclosed in a letter, dated 1876, that a son had sent to his physician father who had requested it to make life-saving vaccine. The scab was not from the son but had been given to him from a Dr. Harris, "perfectly fresh…taken from an infant's arm yesterday." Because a smallpox scab even that old could potentially contain living virus, a team from CDC traveled to the museum to decontaminate the exhibit display case and safely transport the scab to CDC's laboratory for testing. After careful examination, they concluded that the scab posed no infectious threat, was not smallpox virus (variola virus), and likely represented material from the smallpox vaccine used in the late 1800s.

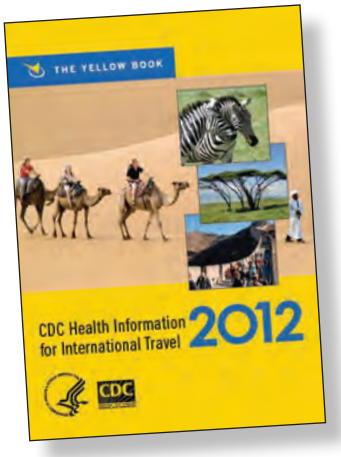
Terrestrial rabies reservoirs in the United States*, 2010



During the past century, rabies in the United States has changed dramatically. More than 90% of all animal cases reported annually to CDC now occur in wildlife; before 1960 the majority of cases were in domestic animals. The principal rabies hosts today are wild carnivores and bats. ►

Also includes Puerto Rico, where mongoose rabies are present

Supporting the prevention of infectious disease by focusing on…



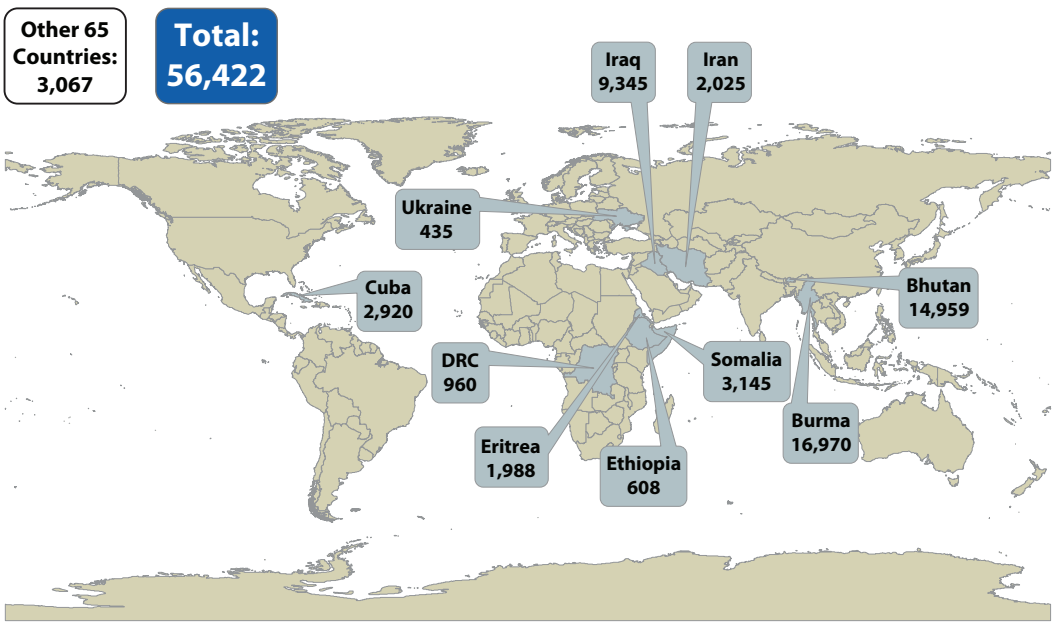
▲ The *Yellow Book* is a reference for doctors, nurses, and other healthcare professionals who advise international travelers about health risks.

Global migration and quarantine

Current challenges

In today's globalized world, more than 1 billion people annually cross international borders, with more than 2 million traveling to or through the United States each day. In addition, about 500,000 immigrants and on average, 50,000 refugees come to the United States each year. Globally mobile populations, such as immigrants, refugees, travelers, and expatriates, face increased risk of transmission of infectious diseases, such as tuberculosis, intestinal parasites, and other neglected tropical diseases.

US refugee arrivals, October 2010–September 2011



These countries were the top 10 countries for US refugee arrivals for October 2010–September 2011. CDC provides guidelines for disease screening and treatment for refugees coming to the United States.

What is CDC's role in global migration and quarantine?

NCEZID improves and protects the health of international populations, such as refugees, immigrants, tourists, and students. Our global migration health and quarantine activities reduce infectious diseases among immigrants, refugees, and international travelers and prevent disease importation and spread within the United States. We also have a unique regulatory function in preventing disease spread in mobile populations.

To address infectious disease health risks associated with international travel and migrating populations, NCEZID

- **Provides technical and regulatory oversight** of health screening and post-arrival health monitoring of immigrant and refugee populations undergoing US resettlement.
- **Modernizes regulations** to ensure swift and appropriate response to events of public health significance. Through delegated authority, CDC has statutory responsibility for preventing the introduction, transmission, and spread of communicable diseases into the United States.
- **Operates up to 20 quarantine stations** across the United States that serve to limit the introduction and spread of infectious diseases by working with federal, state, and local partners to respond to public health events and develop comprehensive operational plans to manage ill and/or exposed travelers.
- **Manages CDC's Travelers' Health website**, one of the CDC's most popular websites, with 20–30 million hits annually.

NCEZID has specialized knowledge of the complex issues surrounding border and migration health and strong relationships with international and domestic partners. NCEZID has a greater impact by training and leveraging these partnerships (e.g., with 50,000 US Customs and Border Protection agents, 600 physicians who conduct health assessments overseas, and 5,000 civil surgeons who assess vaccination status in the United States) to execute frontline public health activities.

CDC quarantine officers defend against arriving health threats

▲ Perry Camagong, Quarantine Public Health officer at the Los Angeles Quarantine Station, grabs supplies for a response. *Courtesy ©David Snyder/CDC Foundation*

In August 2011, the Los Angeles Quarantine Station was notified by California public health officials that during air travel, an unvaccinated adolescent refugee from Malaysia was diagnosed with measles and contagious. Thirty refugees who traveled from Malaysia on the same flight and 35 passengers who sat near the index case-patient (the adolescent refugee) were now scattered over 12 states. The Los Angeles station quickly coordinated with other partners to find other refugees and travelers who may have been exposed. Six additional measles case-patients were identified following the flight. The Los Angeles Quarantine Station's swift response in orchestrating the work with many partners helped contain what could have been a larger outbreak of measles.

As the story illustrates, CDC's quarantine staff play a critical role in safeguarding the nation's health. They work closely with first responders, public health departments, hospitals, airlines, and ships to take fast action when potential health threats are identified. CDC has 20 quarantine stations at entry points to the United States where most international travelers arrive.

CDC staff also train US Customs and Border Protection officers and others at airports, seaports, and land borders to recognize and report any symptoms in travelers that might represent a contagious communicable disease that could threaten the public's health— for instance, severe diarrhea, fever, cough, or jaundice. These important partners serve as eyes and ears for the quarantine staff.

Using new media to warn travelers about an old disease

In 2011, measles cases quadrupled in the United States, with 222 cases reported. Most of these people got infected with measles virus when they were traveling abroad; nearly one-half of those had traveled to Europe where there were more than 38,000 confirmed and suspect cases of measles. Most of the US travelers who got infected had not been vaccinated. Because travelers often do not consider infectious disease risks when traveling to Europe, CDC worked to develop communication messages on the need to be vaccinated before international travel.

Recognizing the need to reach travelers through social media and nontraditional communication channels, CDC posted a series of weekly messages on its Facebook page. Similar messages were sent out through Twitter and text messaging. CDC also developed an animated short of two characters discussing the need for measles vaccination, which was posted to its YouTube channel and promoted on Facebook. CDC used multiple nontraditional communication channels to creatively engage their audience and spread positive, science-based messages.

Accomplishments

In fiscal years 2011 and 2012, NCEZID took steps to mitigate health risks associated with globally mobile populations that resulted in measurable public health benefits. Examples of NCEZID's accomplishments during this time include

- **Implementing improved tuberculosis (TB) screening and treatment** of immigrants and refugees using Technical Instructions for Tuberculosis Screening and Treatment Using Cultures and Directly Observed Therapy. This has resulted in a 200% increase in TB case diagnosis and treatment at an annual cost savings to states of greater than $30 million. Individuals identified are referred to state and local health departments for follow-up after arrival into the United States to prevent new cases of TB infection.
- **Developing and releasing new tools** for addressing travelers' health needs: published print and electronic copies (including a mobile app) of *CDC Health Information for International Travel 2012*, also known as *The Yellow Book*, and posted a new online course, "*Yellow Fever: Information for Healthcare Professionals Advising Travelers*," at www.cdc.gov/travel. This updated guidance better educates the public on destination-specific travel risks and provides useful recommendations to prevent travel-related illness.
- **Assessing and revising procedures for contact tracing** of commercial aviation passengers with infectious TB during extended flights. The revised procedures are expected to cut the number of contact investigations by about 50% while still detecting infected passengers. These new procedures will reduce the burden on state and local public health departments and free up resources for other public health priorities.
- **Collaborating with other centers at CDC in investigating and responding to binational US-Mexico outbreaks** of Legionnaires' disease and Guillain-Barré syndrome and responding to and providing technical assistance for more than a dozen outbreaks of infectious diseases, including cholera, dengue fever, diphtheria, malaria, measles, meningitis, mumps, rubella, and varicella in refugee camps and migrant populations throughout Africa and Asia.

Protecting travelers during the Japanese nuclear disaster

On March 11, 2011, a 9.0 magnitude earthquake occurred off the east coast of Japan and triggered a tsunami. These events killed thousands of people and caused serious, widespread damage to buildings, roads, and power lines. Damage to the Fukushima Daiichi nuclear power plant after the earthquake and tsunami resulted in a leak of radioactive material from this facility.

As part of CDC's response to the Fukushima Daiichi nuclear disaster, NCEZID provided health information on the Travelers' Health website for travelers leaving for or returning from Japan, including humanitarian aid workers, as well as for US citizens living in the country. US Health and Human Services Secretary Kathleen Sebelius personally thanked CDC's communication team and other HHS staff who worked together to quickly deal with the significant health and communication challenges, commending them all for the "long hours and good work in a very difficult situation."

During the event, CDC collaborated with the US Customs and Border Protection and the Conference of Radiation Control Program Directors to rapidly develop and implement a protocol for airport and maritime radiation exposure entry screening in the United States. During March–April 2011, approximately 353,000 travelers arriving directly from Japan were screened at 25 US airports using this protocol. No travelers were detected with contamination sufficient to require a public health response. The successful response during the nuclear disaster will help preparedness measures and planning for future emergency responses.

What's next?

Over the next 5 years, we will to continue to safeguard the health of globally mobile populations by enhancing domestic and international detection and surveillance of infectious diseases using electronic information sharing. We will continue to strengthen partnerships and engage with partner agencies and organizations to develop, implement, and support measures that improve the health status of vulnerable populations, reduce health risks for frequent travelers and US citizens living abroad, prevent importation of communicable diseases to the United States, and ensure timely and effective response to public health emergencies. Primary areas of focus include

- **Strengthening the Refugee Resettlement Health Program** to improve efficiency and health outcomes in domestic and overseas refugee populations.
- **Improving surveillance and response to communicable diseases in travelers**, immigrants, and imported animals entering the United States.
- **Reducing the importation of infectious diseases across the US-Mexico border** by enhancing US-Mexico collaboration with comprehensive and systematic bi-national information sharing, coordinating to improve disease surveillance and control, and identifying appropriate interventions for mobile populations in the border region.
- **Maintaining, strengthening, and expanding** our international and domestic partnerships.

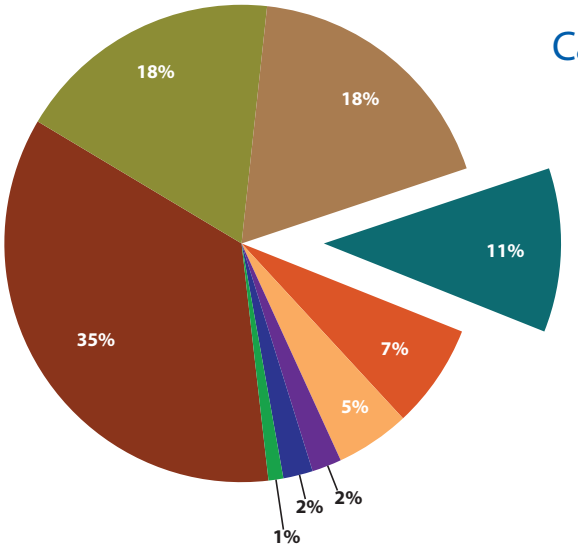
Supporting the prevention of infectious disease by focusing on…

Waterborne diseases and water safety

Current challenges

Worldwide, 780 million people do not have access to safe water, and an estimated 2.5 billion people— 50% of the developing world— lack access to adequate sanitation. Diarrheal diseases such as cholera kill more children than AIDS, malaria, and measles combined, making it the second leading cause of death among children under 5. Approximately 88% of deaths due to diarrheal illness are attributable to unsafe water, poor sanitation, and inadequate hygiene.

Despite drinking water treatment advances, an estimated 4–33 million annual diarrheal illness episodes still occur in the United States from exposure to contaminated municipal drinking water. At least 40,000 hospitalizations at a cost of $970 million per year result from just five waterborne diseases. In addition, we face emerging public health concerns such as chlorine-tolerant pathogens and the increasing complexity of waterborne diseases.



Causes of child deaths worldwide

- Neonatal causes
- Other
- Pneumonia*
- **Diarrhea***
- Malaria
- Injuries
- AIDS
- Meningitis
- Measles

*Includes neonatal deaths

Source: Liu et al. *Lancet* 2012

CDC scientist Amy Kahler works with a colleague, Bradd Haley from the University of Maryland, to sample water for *Vibrio cholerae* in a canal near Port-au-Prince, Haiti, that is used as a drinking water source by the local community. *Courtesy Bonnie Mull* ▶

CDC's "Water Lab" leads quest to find *V. cholerae* in Haiti

During the 2010 cholera outbreak in Haiti, CDC's Environmental Microbiology Laboratory (called the "Water Lab") led the effort to collect and analyze water and seafood samples for *Vibrio cholerae*. Since the initial outbreak investigation, the Water Lab has conducted an environmental surveillance project for *V. cholerae* and other enteric (intestinal) pathogens in Haiti. In conjunction with the environmental surveillance field investigations, CDC staff have trained several laboratorians in the Haiti National Public Health Laboratory (LNSP) and have plans to further assist LNSP in developing environmental microbiology laboratory testing capacity.

Even 1 year after the outbreak, the CDC environmental surveillance project continued to detect *V. cholerae* in freshwater in Haiti. They trained LNSP on new water sampling testing methods for cholera, including ultrafiltration (capable of concentrating pathogenic bacteria, viruses, and parasites all from a single water sample) and plankton net sampling. Using these new sampling methods will enable LNSP and CDC staff to evaluate whether *V. cholerae* is becoming established in the Haitian environment.

What is CDC's role in preventing waterborne diseases?

NCEZID's water program has a global and a domestic component. Our global program seeks to reduce the burden of disease in developing countries due to unsafe water, poor sanitation, and inadequate hygiene. Our domestic water program focuses on surveillance and prevention to ensure healthy drinking and recreational water in the United States.

Globally, NCEZID provides a vital resource for testing, evaluating, and monitoring interventions to improve water quality and hygiene by

- **Making water safe through CDC's** Safe Water System, a point-of-use/household water treatment, safe storage, and behavior change system being promoted in over 30 countries. Enough chlorine solution has been sold in 1998–2010 to treat 90 billion liters of water, which will help prevent the spread of waterborne diseases.
- **Improving hygiene by measuring the impact of hand washing** and improving the efficacy, sustainability, and integration of hygiene interventions into communities and institutions, such as schools and clinics.
- **Assisting foreign governments and the UN** during outbreaks of waterborne disease. In particular, CDC provides key surveillance, epidemiologic, laboratory, training, and WASH (water, sanitation, and hygiene) expertise to reduce illness and death from cholera in Haiti. *(continued on the next page)*

▲ *Courtesy CDC Foundation*

Packaging preventions pays off

An estimated 780 million people don't have access to an improved drinking water source, and 2.5 billion people— half of the developing world— lack access to adequate sanitation. That amounts to more than 35% of the world's population. In countries like Malawi, where there is limited access to safe water and inadequate sanitation, there are also other health issues not related to safe water, such as a high rate of HIV. A group of public health interventions were successfully packaged in Malawi for pregnant women getting services at antenatal clinics.

Guidance about proper hand washing, safe water treatment and storage practices, and HIV testing and counseling were integrated at the clinics into the services provided for their patients. An evaluation of this program revealed that, from their first visit to the follow-up visit after the birth of their baby, there was a significant increase in the percentage of women who had residual chlorine in water stored in their homes and who were able to demonstrate proper hand washing technique.

Success begets success: 56% of evaluation participants had four or more antenatal clinic visits, 90% delivered at a health facility, 99% of women and their partners were tested for HIV, and 98% had disclosed their status to their partner. In addition, there was an increase in the percentage of pregnant women receiving antiretroviral drugs (drugs that help people who are HIV-positive) and an increase in the use of antiretroviral medication for prevention in HIV-exposed infants.

What is CDC's role in preventing waterborne diseases?

(continued from previous page)

Domestically, NCEZID provides critical systems, programs, and data to better prevent waterborne disease in the United States by

- **Tracking waterborne disease and outbreaks** through the national Waterborne Disease and Outbreak Reporting System, which identifies causes, risk factors, and trends that can be used for establishing national public health prevention priorities.
- **Assisting state and local governments with investigations** of waterborne outbreaks.
- **Evaluating new methods** for removing or inactivating waterborne pathogens.
- **Developing and operating public health programs** like CDC's Healthy Swimming Program, the primary federal program to reduce the spread of infectious disease at swimming pools.
- **Developing, with partners, the national Model Aquatic Health Code (MAHC)**, an effort to create a national resource to help state and local health agencies develop pool regulations and codes.

Novel video contest helps swimmers stay healthy

▲ And the winner of the video contest is… *RWI Police* (which stands for recreational water illness).

In 2011, CDC's Healthy Swimming Program was looking to catch a wave, so to speak. They needed a novel way to alert the public to a problem that had substantially increased during the past 20 years— recreational water illness (RWI) associated with swimming. They especially needed to get the word out about crypto (short for *Cryptosporidium*)— a germ that had become the leading cause of swimming pool-related outbreaks of diarrheal illness. Cases of crypto had increased more than 200% from 2004 to 2008. Crypto can stay alive for days even in well-maintained pools, and, contrary to popular belief, chlorine does not kill all germs (like crypto) instantly.

The Healthy Swimming Program came up with an innovative solution— a video contest (CDC's first ever) which challenged the public to create 60-second videos that included four healthy swimming messages. A panel of CDC judges selected the top 5 out of 49 entries, and the public was asked to vote online for the winner.

During a 2-month period, the video contest generated a lot of interest— 56,110 website page views, more than 475,000 Facebook impressions, 2,000-plus individual votes for the finalists, and approximately 10,000 views of the top five videos. The winning video, titled "RWI Police" was selected in late July.

There were, in fact, many winners. The Healthy Swimming Program and its state and local partners got high-quality, humorous, evergreen videos (including the four runner-up videos) that could help them continue to spread the word about RWIs. The Healthy Swimming Program also won some important visibility at a substantially reduced rate. If the program had tried to produce similar videos, the production costs alone would have been more than $10,000. And, most importantly, swimmers received useful information to help them avoid getting sick.

Accomplishments

NCEZID has made substantial progress in demonstrating the importance of water, sanitation, and hygiene-related-disease and laying the groundwork for prevention activities. Examples from fiscal years 2011 and 2012 include

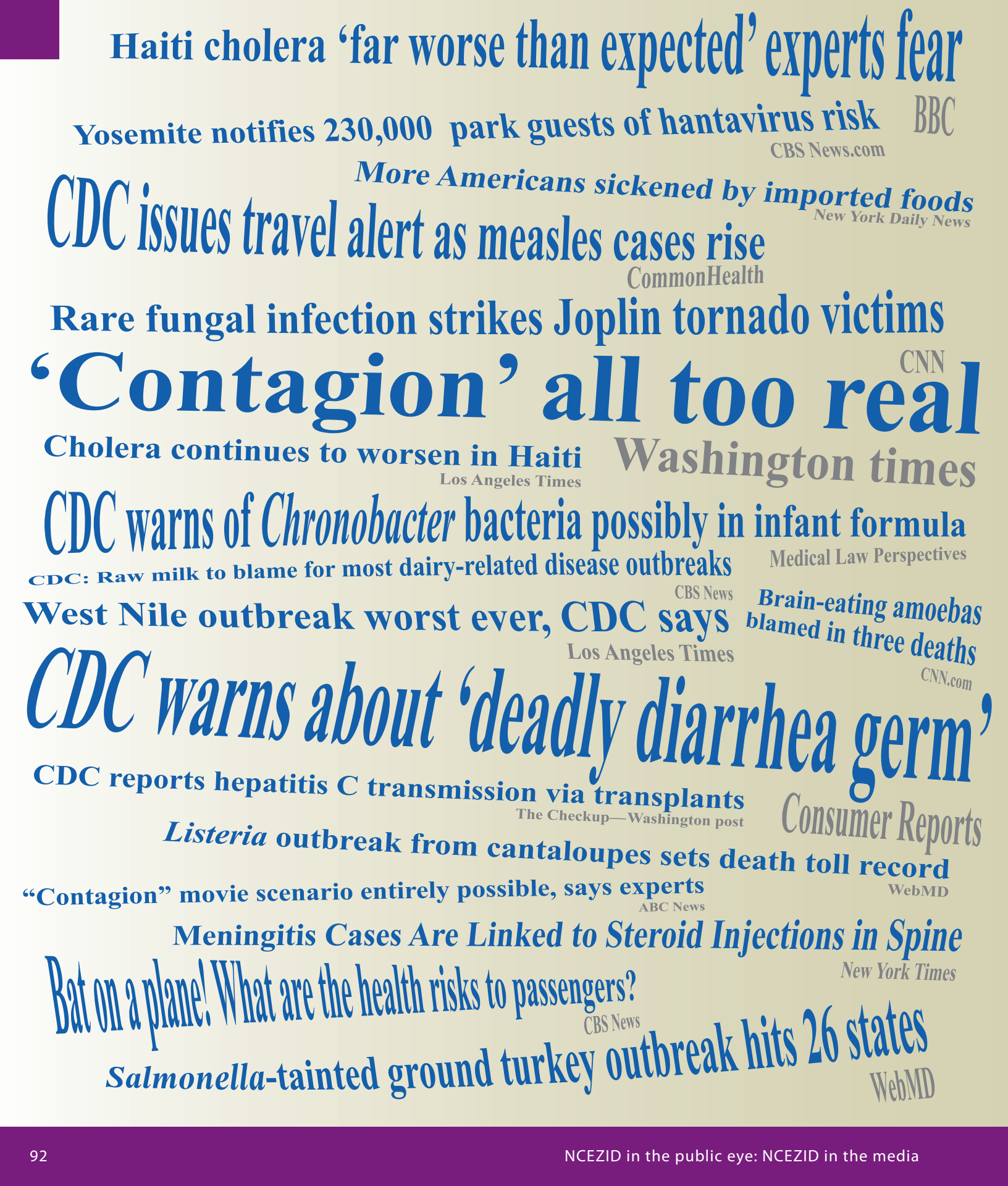
- **Response:** Helped investigate the cholera outbreak in Haiti and reduce the mortality rate below 1% by identifying the key risk factors, developing tracking systems, providing clinical and community health worker training, providing water treatment and sanitation guidance, and giving laboratory assistance. These efforts have continued to keep disease in check, track possible resurgence, and prevent future transmission. We also assisted other governments with international outbreaks of cholera and typhoid fever. In the United States, CDC investigated risk factors associated with elevated levels of *Acanthamoeba* keratitis, an eye infection that can result in permanent visual impairment or blindness, demonstrating that inadequate hygiene and contact lens use are associated with this eye infection.
- **Data for action:** Demonstrated the efficacy and benefits of integrating safe water and hygiene supplies into other public health initiatives, such as HIV care packages and programs targeted at pregnant women and school-aged children. We also published national tracking numbers for waterborne outbreaks reported for 2007–2008 and lessons learned from drinking water outbreaks over the past 36 years. This information can be used by policy makers, partners in industry and state and local health departments, and individuals to reduce potential risks from drinking and recreational water. NCEZID also documented that five waterborne diseases alone cause 40,000 annual hospitalizations that cost almost $1 billion a year. Understanding the costs of these diseases can help us and others focus on interventions to reduce their prevalence.
- **Guidelines and information:** Worked closely with partners to develop and post for public comment 14 Model Aquatic Health Code modules. The finalized first edition will be available by the end of 2013. These modules, developed with partners, provide an evidence-based set of model health codes to local and state regulating organizations. They can be adopted as needed to help keep the public safe— from injuries as well as from waterborne pathogens— when they're engaged in recreational water activities.
- **Developed new detection methods:** Developed a laboratory platform that uses one blood test to determine exposure to 17 pathogens. We also developed a new rapid sampling and concentration method for water that detects parasitic, viral, and bacterial contaminants.

What's next?

Our focus internationally will be on expanding programs that have been proven to work well, continuing to assisting other countries on outbreak investigations, and exploring new technologies and interventions to increase access to safe water and improved hygiene. In the United States, our programs will focus on increasing surveillance for new waterborne diseases and finalizing the Model Aquatic Health Code project to provide an evidence-based health code for states and localities to use as appropriate.

Specific activities we are focusing on include

- **Conducting a pilot intervention of ceramic filters** to reduce the burden of cryptosporidiosis in household drinking water in rural Kenya.
- **Testing the impact** of a targeted vaccine campaign on control of an outbreak of typhoid fever in Uganda.
- **Pilot testing** CryptoNet, the first state-based molecular tracking system for a parasitic infection, cryptosporidiosis. CryptoNet will help us better understand the spread of cryptosporidiosis in the United States.


Haiti cholera 'far worse than expected' experts fear
Yosemite notifies 230,000 park guests of hantavirus risk
BBC
CBS News.com
More Americans sickened by imported foods
New York Daily News
CDC issues travel alert as measles cases rise
CommonHealth
Rare fungal infection strikes Joplin tornado victims
'Contagion' all too real
CNN
Cholera continues to worsen in Haiti
Los Angeles Times
Washington times
CDC warns of Chronobacter bacteria possibly in infant formula
Medical Law Perspectives
CDC: Raw milk to blame for most dairy-related disease outbreaks
CBS News
West Nile outbreak worst ever, CDC says
Los Angeles Times
Brain-eating amoebas blamed in three deaths
CNN.com
CDC warns about 'deadly diarrhea germ'
CDC reports hepatitis C transmission via transplants
The Checkup—Washington post
Consumer Reports
Listeria outbreak from cantaloupes sets death toll record
"Contagion" movie scenario entirely possible, says experts
ABC News
WebMD
Meningitis Cases Are Linked to Steroid Injections in Spine
New York Times
Bat on a plane! What are the health risks to passengers?
CBS News
Salmonella-tainted ground turkey outbreak hits 26 states
WebMD

NCEZID in the public eye

NCEZID in the media

Pick up a newspaper, flip through the major news channels, or log onto news websites on any given day and you're likely to find a handful of stories about the work that CDC staff, and more specifically NCEZID scientists, do.

Foodborne disease outbreaks and healthcare-associated infections are perennial media favorites because they are universal and may affect millions of people each year. After all, everyone eats and everyone either needs healthcare or has a loved one who does. Media stories on our foodborne outbreak responses become THE story of the day for as long as the outbreaks continue. And reporters closely follow the twists and turns of our investigations into healthcare-associated outbreaks like the recent meningitis outbreak caused by fungus in steroid injections. Each year, they also cover our annual foodborne disease reports to not only provide the numbers but useful tips to help their audience protect themselves.

▲ Experts in NCEZID provided technical advice to the makers of the movie *Contagion*, which premiered in September 2011. Kate Winslet, who starred in the movie, is pictured here with technical advisor Ian Lipkin and Stuart Nichol (from the Division of High-Consequence Pathogens and Pathology) during a laboratory tour.

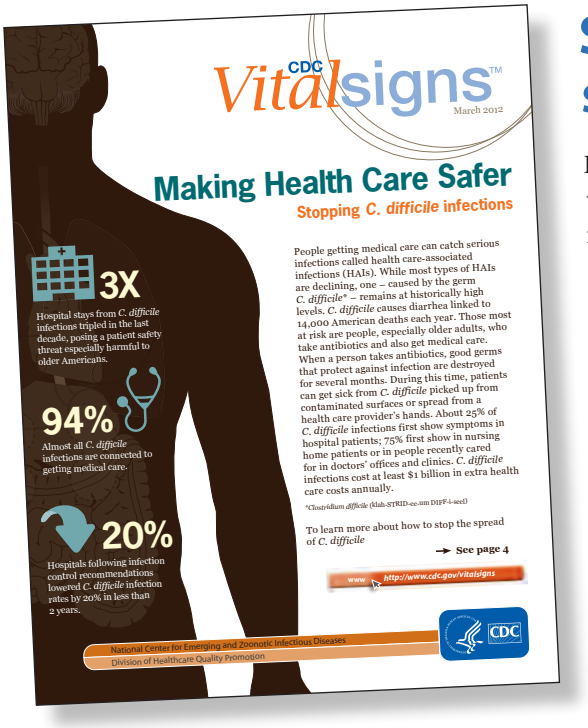
▲ In 2011, the TV network Animal Planet's series "Killer Outbreaks" featured potentially deadly viruses, bacteria, and infections (including anthrax, *E. coli*, hantavirus, rabies, West Nile virus, monkeypox, and *Salmonella*) and incorporated commentary from CDC experts and victims of outbreaks.

NCEZID also houses a wide variety of other topics that tickle the media's interest by being unique, unexpected, occasionally bizarre, and sometimes fatal.

During 2011– 2012, these have included cases of *Naegleria*, which the media dubbed "brain eating ameba," rare fungal infections in people injured during a tornado, a man who contracted anthrax while traveling in the upper Midwest, hepatitis outbreaks following unsafe surgery practices during transplants, evidence of people in Peru possibly surviving rabies exposure without treatment, discovery of a new phlebovirus, and the second-largest West Nile outbreak since the virus arrived in 1999.

And it's not just the bizarre that catches the media's attention. Each year, we provide useful information for thousands of media stories that help the public stay safe and healthy. The advice makes its way into stories on healthy swimming, avoiding mosquito and tick bites, safely cooking and storing food, and preparing for international travel.

The diversity and distinctiveness of the diseases NCEZID covers helps ensure that our work will never be out of the media for long. We are constantly watching for and ready to respond to the next infectious disease threat, and the media are watching us. We never know what the next outbreak or discovery will be, but we can bet the media will be there ready to write, talk, and blog about it. As they do, they will continue to keep NCEZID, our staff, and the tremendous work we do in the public eye.



Science is not just for scientists anymore

During the past 2 years, CDC has been using different forms of media to bring visibility to important public health issues. Recognizing that people are "hungry" for accurate guidance concerning their health, CDC launched *Vital Signs* in summer 2010 to shine a light on topics of special concern. Each month, *Vital Signs* takes the latest CDC science on topics, including NCEZID topics such as foodborne disease or healthcare-associated infections, and turns it into health information that is accessible, clear, and actionable for everyone. The scientific content from the *Morbidity and Mortality Weekly Report* is transformed into consumer-friendly fact sheets, web features, podcasts, and social media messages. In its first year, *Vital Signs* got off to a great start, with an estimated reach of approximately 4.4 billion potential viewings through a variety of different media, hugely exceeding their original expectations of reaching about 1 million.

NCEZID, along with the rest of CDC, is fully embracing social media to push public health messages out to the broadest audience possible. Each month, *Vital Signs* regularly updates its Facebook pages and Twitter feeds with messages such as, "*Salmonella* is a common culprit that can contaminate a variety of foods," that cautions about foodborne disease. The Center has also participated in recent Twitter chats about medication safety and travel health. One of the more novel attempts to engage the public on important issues in public health was NCEZID's Healthy Swimming Program contest. People were encouraged to submit creative videos to promote healthy swimming, and the top videos were posted on CDC's YouTube channel.

Each month, the webcast "Public Health Grand Rounds" fosters discussion on major public health issues. Each session focuses on key challenges related to a specific health topic, many with an infectious disease focus such as Lyme disease, rabies elimination, healthcare-acquired infections, and foodborne disease. Grand Rounds explores cutting-edge scientific evidence and the potential impact of different interventions. A new collaboration between CDC and Medscape is the CDC Expert Commentary, designed to deliver CDC's authoritative guidance directly to Medscape's physicians, nurses, pharmacists, and other healthcare professionals on current topics, such as the dangers of consuming raw milk and raw sprouts, *Salmonella* and *Listeria* contamination, Lyme disease, dangerous healthcare-acquired infections such as *C. difficile*, and the health risks in recreational water. The commentaries are also posted on CDC's website.

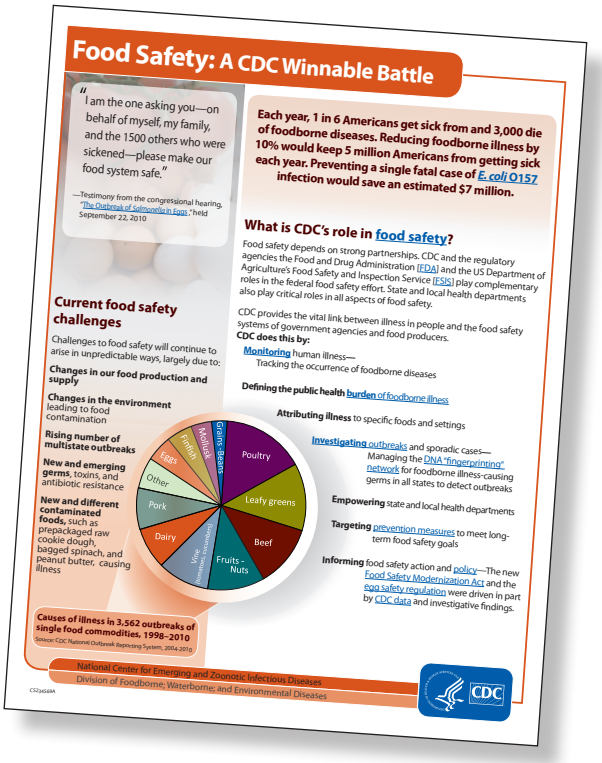
"The most important medical advance in the twentieth century may be that ordinary people were able to use science, even if they were not scientists themselves."

William Foege, MD, MPH, Senior Fellow, Global Health Program, Bill & Melinda Gates Foundation
and former Director of the Centers for Disease Control and Prevention

NCEZID also has a blog presence. The Safe Healthcare blog initiates conversations on a variety of topics— antibiotic use, injection and medication safety, and infections in dialysis clinics to name just a few. The Center's work also is highlighted in the Public Health Matters blog. First-hand accounts of fighting cholera in Haiti, responding to a dengue outbreak in the remote Marshall Islands, and experiencing the consequences of petting rabid zebras in Kenya are a few of the blog posts that have been published.

A winning strategy to make a measurable impact

To keep pace with emerging public health challenges and address the leading causes of death and disability, CDC began work on "Winnable Battles" in fall 2010. Winnable Battles are public health priorities, which have large-scale impact on health and known, effective strategies that can produce positive outcomes. The charge under Winnable Battles is to identify optimal strategies and rally resources and partnerships to achieve measurable impact quickly in a few targeted areas.



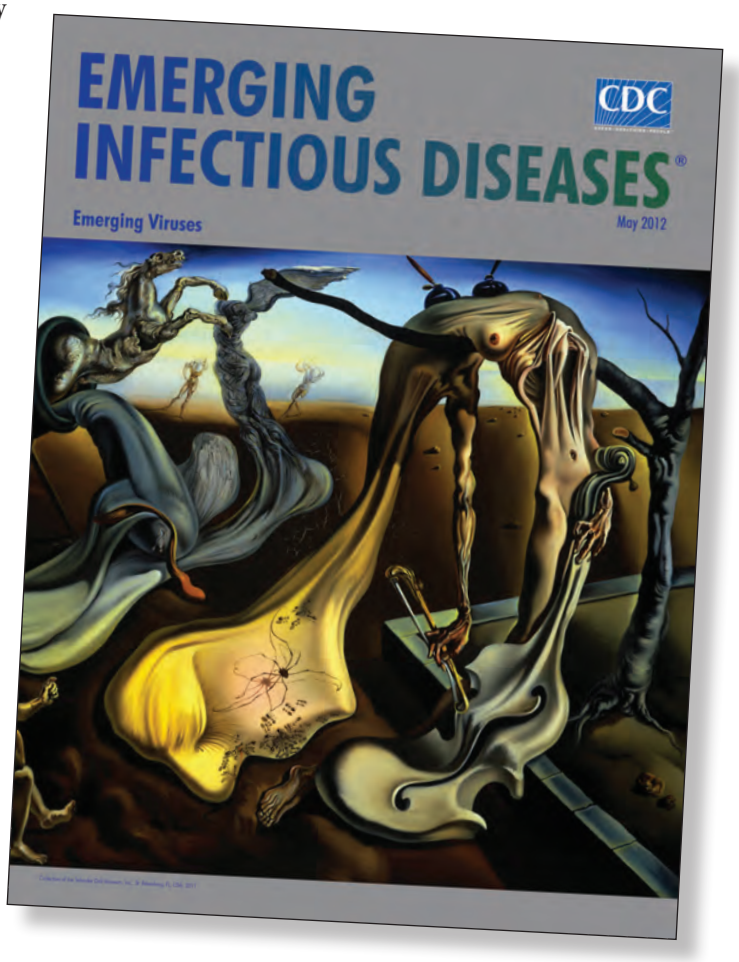
NCEZID is home to two Winnable Battles. With one in six Americans getting sick from contaminated food each year, reducing foodborne diseases is an important— and attainable— public health goal, or Winnable Battle. For example, during the past 15 years, a dangerous type of *E. coli* infection has been cut almost in half. But *Salmonella* infections, which account for $365 million in direct medical costs each year, have not declined. Applying lessons learned from reducing *E. coli* to reducing *Salmonella* could help reduce 1 million illnesses each year.

At any given time, about 1 in every 20 patients has an infection related to their hospital care. Healthcare-associated infections (HAIs) not only affect patient lives but also add to our growing healthcare costs. CDC has identified eliminating HAIs as another Winnable Battle. For example, if healthcare providers use CDC's infection control steps, bloodstream infections in patients with central lines— one of the most deadly but also most preventable HAIs— could be significantly reduced.

Emerging Infectious Diseases

Emerging Infectious Diseases® has consistently ranked as one of the nation's premier public health infectious disease journals since its founding in 1995. Widely read within the infectious disease community and expanding its reach to a broader audience, the journal explains factors that lead to emergence of new diseases; reports laboratory and epidemiologic findings; provides updates of trends and research; highlights developments in antimicrobial drugs and vaccines; and through insightful analysis and commentary, promotes disease prevention and elimination.

Always at the forefront, the journal tracks emergence and reemergence, from Schmallenberg virus and MRSA (methicillin-resistant *Staphylococcus aureus*) to prions and pandemic flu, and brings the latest information online to more than 60,000 subscribers. *Emerging Infectious Diseases*® reaches out to diverse audiences with continuing medical education, podcasts, and social media.



▲ Images for the cover of *Emerging Infectious Diseases* are selected for artistic quality and are drawn from many periods, ancient to contemporary. The covers are used to "humanize" and enhance the scientific content by illustrating ideas, raising consciousness, revealing truth, stimulating the intellect, and firing the emotions.

Key publications

NCEZID nominated the following articles for CDC's 2012 Shepard Awards, which recognize the best manuscripts reporting original research published by a CDC or ATSDR scientist in a reputable, peer-reviewed journal. Established in 1986, the Charles C. Shepard Award was named in honor of Charles C. Shepard, MD, the internationally recognized microbiologist who was chief of the Leprosy and Rickettsia Branch at CDC for more than 30 years, until his death in 1985.

Winner of the 2012 Shepard Award in the Laboratory Science category:

Bird BH, Maartens LH, Campbell S, Erasmus BJ, Erickson BR, Dodd KA, Spiropoulou CF, Cannon D, Drew CP, Knust B, McElroy AK, Khristova ML, Albariño CG, Nichol ST. Rift Valley fever virus vaccine lacking the NSs and NSm genes is safe, nonteratogenic, and confers protection from viremia, pyrexia, and abortion following challenge in adult and pregnant sheep. J Virol 2011;85:12901-9.

▲ Barbara Knust (one of the winners of the 2012 Shepard Award in the Laboratory Science category) checks the temperature of a sheep during a Rift Valley fever vaccine trial in South Africa.

Other nominees:

Abrams JY, Schonberger LB, Belay ED, Maddox RA, Leschek EW, Mills JL, Wysowski DK, Fradkin JE. Lower risk of Creutzfeldt-Jakob disease in pituitary growth hormone recipients initiating treatment after 1977. J Clin Endocrinol Metab 2011;96:E1666–9.

Budnitz DS, Lovegrove MC, Shehab N, Richards CL. Emergency hospitalizations for adverse drug events in older Americans. N Engl J Med 2001 Nov 24;365(21):2002–12.

Cavallaro E, Date K, Medus C, Meyer S, Miller B, Kim C, Nowicki S, Cosgrove S, Sweat D, Phan Q, Flint J, Daly ER, Adams J, Hyytia-Trees E, Gerner-Smidt P, Hoekstra RM, Schwensohn C, Langer A, Sodha SV, Rogers MC, Angulo FJ, Tauxe RV, Williams IT, Behravesh CB; *Salmonella* Typhimurium Outbreak Investigation Team. *Salmonella* Typhimurium infections associated with peanut products. N Engl J Med 2011 Aug 18;365(7):601–10.

Dolan MC, Schulze TL, Jordan RA, Dietrich G, Schulze CJ, Hojgaard A, Ullmann AJ, Sackal C, Zeidner NS, Piesman J. Elimination of *Borrelia burgdorferi* and *Anaplasma phagocytophilum* in rodent reservoirs and *Ixodes scapularis* ticks using a doxycycline hyclate-laden bait. Am J Trop Med Hyg 2011 Dec;85(6):1114–20.

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Gibney KB, Fischer M, Prince HE, Kramer LD, St George K, Kosoy OL, Laven JJ, Staples JE. Chikungunya fever in the United States: a fifteen year review of cases. Clin Infect Dis 2011 Mar 1;52(5):e121–6.

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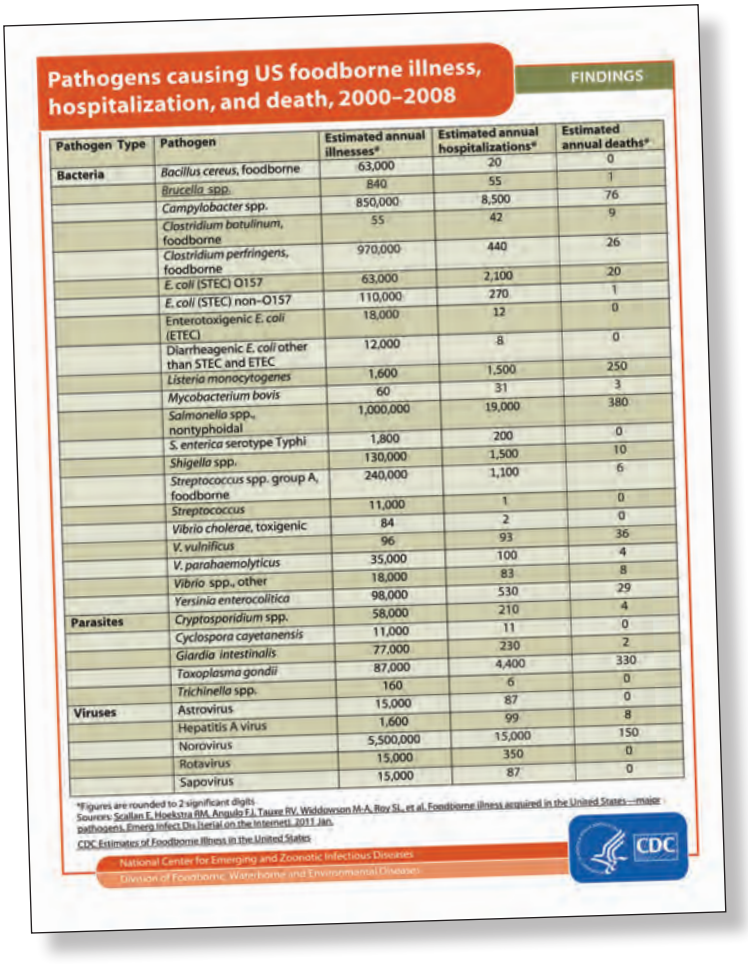

Pathogens causing US foodborne illness, hospitalization, and death, 2000–2008

FINDINGS

Pathogen Type	Pathogen	Estimated annual illnesses*	Estimated annual hospitalizations*	Estimated annual deaths*
Bacteria	*Bacillus cereus*, foodborne	63,000	20	0
	Brucella spp.	840	55	1
	Campylobacter spp.	850,000	8,500	76
	Clostridium botulinum, foodborne	55	42	9
	Clostridium perfringens, foodborne	970,000	440	26
	E. coli (STEC) O157	63,000	2,100	20
	E. coli (STEC) non-O157	110,000	270	1
	Enterotoxigenic *E. coli* (ETEC)	18,000	12	0
	Diarrheagenic *E. coli* other than STEC and ETEC	12,000	8	0
	Listeria monocytogenes	1,600	1,500	250
	Mycobacterium bovis	60	31	3
	Salmonella spp., nontyphoidal	1,000,000	19,000	380
	S. enterica serotype Typhi	1,800	200	0
	Shigella spp.	130,000	1,500	10
	Streptococcus spp. group A, foodborne	240,000	1,100	6
	Streptococcus	11,000	1	0
	Vibrio cholerae, toxigenic	84	2	0
	V. vulnificus	96	93	36
	V. parahaemolyticus	35,000	100	4
	Vibrio spp., other	18,000	83	8
	Yersinia enterocolitica	98,000	530	29
Parasites	*Cryptosporidium* spp.	58,000	210	4
	Cyclospora cayetanensis	11,000	11	0
	Giardia intestinalis	77,000	230	2
	Taxoplasma gondii	87,000	4,400	330
	Trichinella spp.	160	6	0
Viruses	Astrovirus	15,000	87	0
	Hepatitis A virus	1,600	99	8
	Norovirus	5,500,000	15,000	150
	Rotavirus	15,000	350	0
	Sapovirus	15,000	87	0

*Figures are rounded to 2 significant digits.

Sources: Scallan E, Hoekstra RM, Angulo FJ, Tauxe RV, Widdowson M-A, Roy SL, et al. Foodborne illness acquired in the United States—major pathogens. Emerg Infect Dis [serial on the Internet]. 2011 Jan.

CDC Estimates of Foodborne Illness in the United States

National Center for Emerging and Zoonotic Infectious Diseases

Division of Foodborne, Waterborne and Environmental Diseases

CDC

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Smith SK, Self J, Weiss S, Carroll D, Braden Z, Regnery RL, Davidson W, Jordan R, Hruby DE, Damon IK. Effective antiviral treatment of systemic orthopoxvirus disease: ST-246 treatment of prairie dogs infected with monkeypox virus. J Virol 2011;85:9176–87.

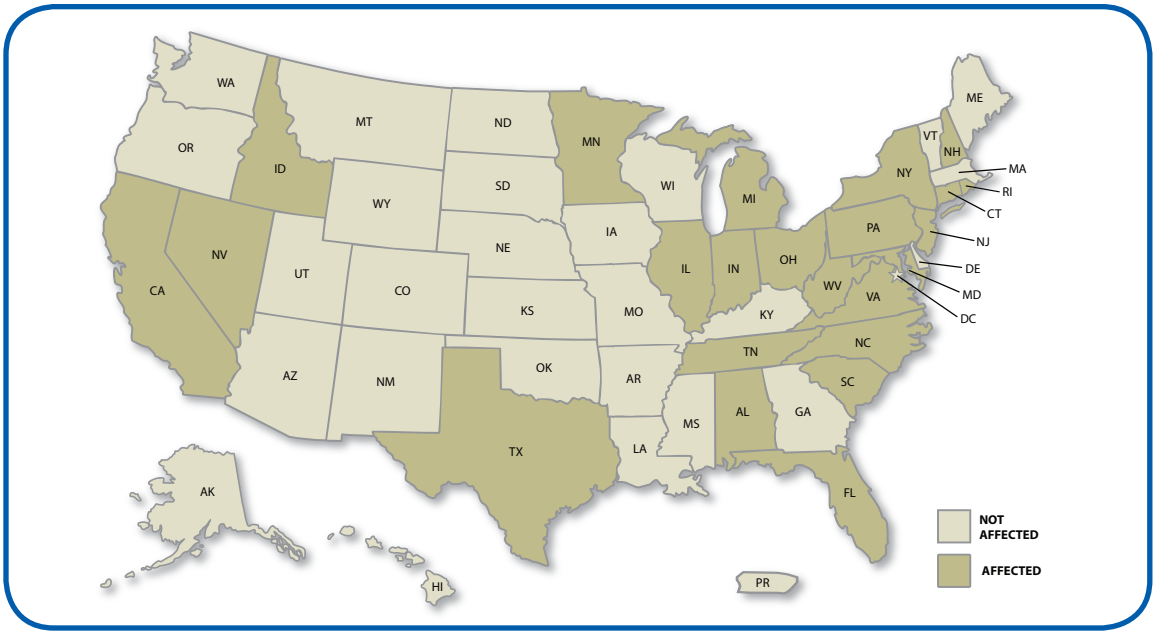
Late-breaking news...

▲ Drs. Ben Park (left) and Tom Chiller helped lead CDC's investigation into the outbreak of fungal meningitis.

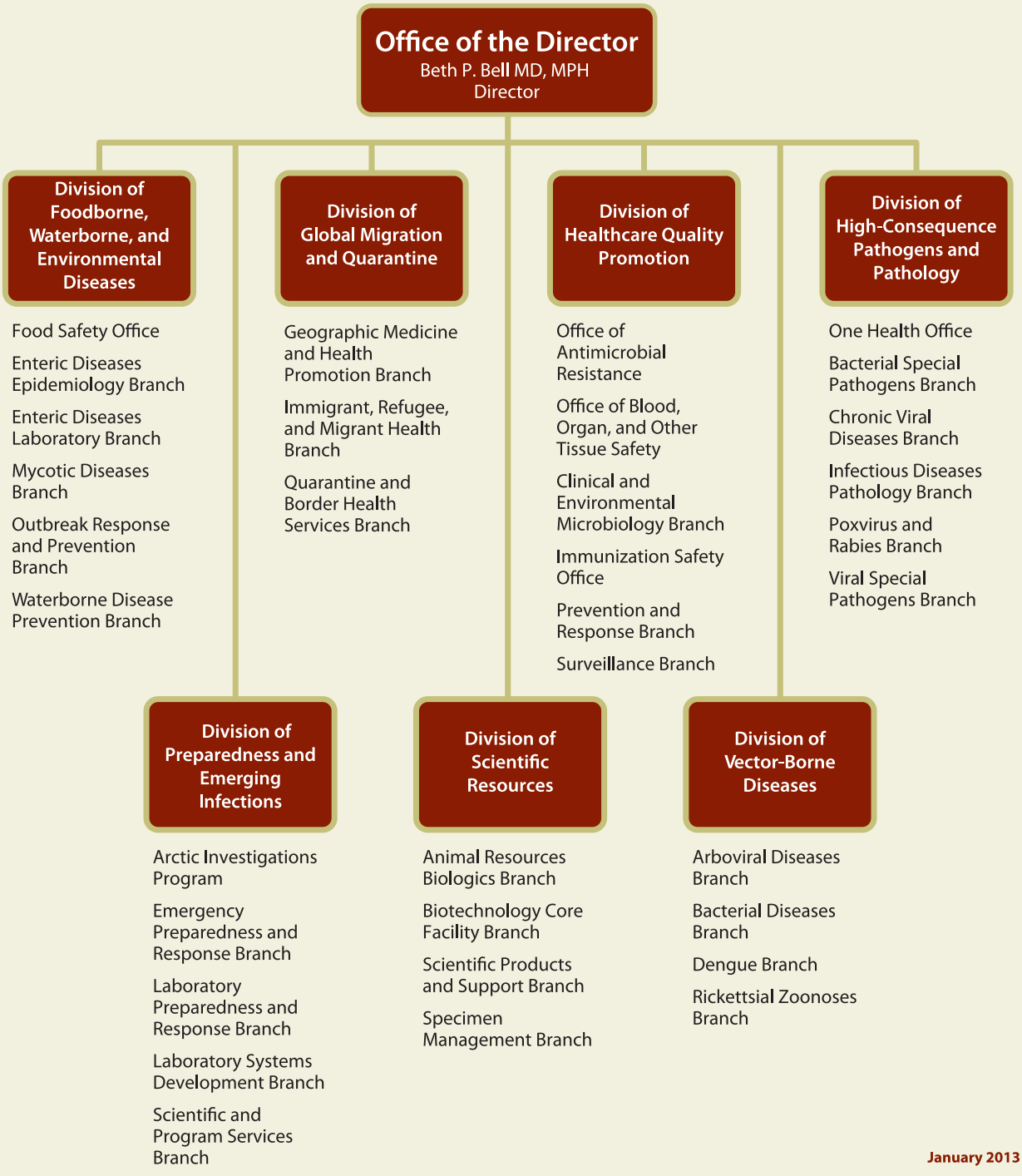
CDC responds to multistate outbreak of fungal meningitis and other infections

In fall 2012, just as *NCEZID: Our Work, Our Stories 2011–2012* was in the final stage of production, NCEZID was called on to assist state and local health departments and the US Food and Drug Administration in the investigation of a large, multistate outbreak of fungal meningitis and other infections. The infections were first reported in September 2012 among patients who received contaminated steroid injections from the New England Compounding Center. Several patients suffered strokes that were believed to have resulted from their infections. The investigation also included infections from injections in a peripheral joint, such as a knee, shoulder, or ankle. Patients who received injections in peripheral joints only were not believed to be at risk for meningitis, but they could be at risk for other fungal infections. As of early December 2012, more than 500 cases of fungal infections and 36 deaths had been linked to the contaminated steroid injections.

Healthcare facilities that received three recalled lots of methylprednisolone acetate from New England Compounding Center on September 26, 2012



National Center for Emerging and Zoonotic Infectious Diseases



Our organization

Fact check

Name: National Center for Emerging and Zoonotic Infectious Diseases (NCEZID)

Mission: To reduce illness and death associated with emerging and zoonotic infectious diseases and to protect against the unintentional and intentional spread of infectious diseases

Established: 2010, as part of the Organizational Improvement initiative of 2009–2010. Two centers, the National Center for Preparedness, Detection, and Control of Infectious Diseases and the National Center for Zoonotic, Vector-borne, and Enteric Diseases, were combined to form NCEZID.

Organization: NCEZID is made up of seven divisions:

- Division of Foodborne, Waterborne, and Environmental Diseases (DFWED)
- Division of Global Migration and Quarantine (DGMQ)
- Division of High-Consequence Pathogens and Pathology (DHCPP)
- Division of Healthcare Quality Promotion (DHQP)
- Division of Preparedness and Emerging Infections (DPEI)
- Division of Scientific Resources (DSR)
- Division of Vector-Borne Diseases (DVBD)

Leadership: Beth P. Bell, MD, MPH, Director

Staff: 1100 (approximate) full-time equivalents (FTEs)

900 (approximate) FTE staff in Atlanta

200 (approximate) FTE staff outside Atlanta (Ft. Collins, CO; Anchorage, AK; San Juan, Puerto Rico; quarantine stations; international)

+ 900 (approximate) contract employees, students, fellows, etc.

2000 (approximate) **total NCEZID FTE and non-FTE staff**

Click here for Budget Update

NCEZID budget

CDC's National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) was appropriated $304.2 million in fiscal year (FY) 2012. In both FY 2012 and FY 2011*, $51.7 million of NCEZID's total funding was directed from the Prevention and Public Health Fund. NCEZID's FY 2012 appropriation is approximately level with its FY 2011 appropriation; however, the FY 2013 President's Budget proposes increases of $16.7 million for Food Safety and $12.6 million for the National Healthcare Safety Network (NHSN) activities. In addition, the FY13 President's Budget outlined a decrease of $2.4 million for Core Infectious Diseases.

The FY13 President's Budget consolidated several of NCEZID's FY 2012 appropriated budget lines into one line entitled Core Infectious Diseases. This line reflects approximately 60% of NCEZID's FY12 appropriation ($184 million), and includes the following FY 2012 appropriated budget lines:

- Vector-borne diseases
- Lyme disease
- Chronic Fatigue Syndrome
- Prion
- Hanta/Special pathogens (renamed high-consequence pathogens)
- Emerging Infections

In addition, the Core Infectious Disease line supports a variety of critical NCEZID activities such as:

- Healthcare-associated infections
- Antimicrobial resistance
- Scientific resources and laboratory support
- Preparedness and emerging infections

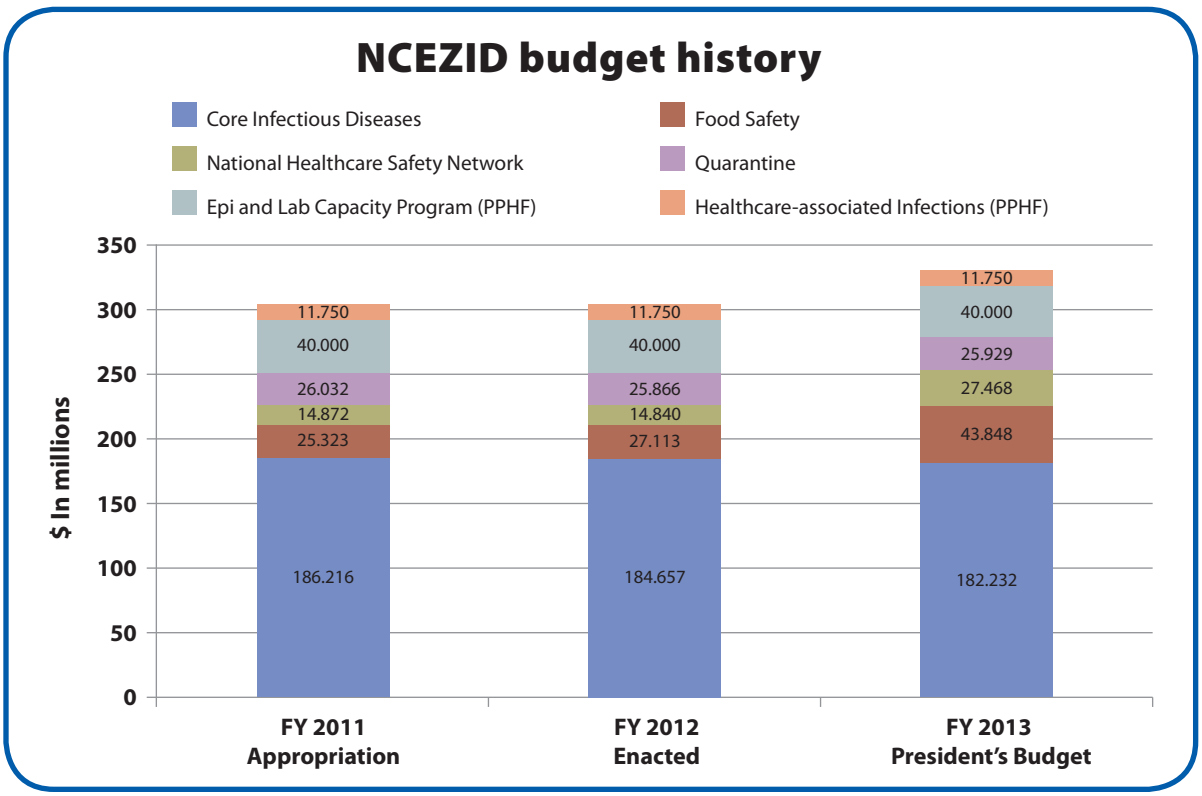
Fiscal year 2011 (FY 2011) began October1, 2010, and ended September 30, 2011. Fiscal year 2012 (FY 2012) began October1, 2011, and ended September 30, 2012.

NCEZID budget history

Revised budget activity/description	FY 2011 Appropriation	FY 2012 Enacted	FY 2013 President's Budget (PB)	FY 2013 PB +/- FY 2012
Emerging and Zoonotic Infectious Diseases	$304.193	$304.226	$331.227	$27.001
Core Infectious Diseases	$186.216	$184.657	$182.232	$(2.425)
Food Safety	$25.323	$27.113	$43.848	$16.735
National Healthcare Safety Network	$14.872	$14.840	$27.468	$12.628
Quarantine	$26.032	$25.866	$25.929	$0.063
Epi and Lab Capacity Program (PPHF)*	$40.000	$40.000	$40.000	$0
Healthcare-associated Infections (PPHF)*	$11.750	$11.750	$11.750	$0

*Affordable Care Act Appropriation; not part of Budget Authority.
PPHF is the abbreviation for Prevention and Public Health Fund

(in millions)



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For more information please contact

National Center for Emerging and Zoonotic Infectious Diseases
1600 Clifton Road NE, Atlanta, GA 30333

Telephone: 1-800-CDC-INFO (232-4636) or visit www.cdc.gov and click on "Contact CDC-INFO."

Web: http://www.cdc.gov/ncezid/

www.cdc.gov/ncezid

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