



INNOVATIONS TO STOP EMERGING and ZOOONOTIC INFECTIONS



**U.S. Department of
Health and Human Services**
Centers for Disease
Control and Prevention

Innovations to stop infections: Designing better mousetraps to catch infectious disease


Scientists across the US Centers for Disease Control and Prevention

innovate to stay one step ahead of infectious diseases. This report describes some recent ingenious solutions that scientists from CDC's National Center for Emerging and Zoonotic Infectious Diseases developed to reduce the threat of emerging and zoonotic infectious diseases.

Scientists at CDC's National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) are continually challenged to find better ways to prevent and protect us from a whole host of infectious diseases. Expert pathologists and laboratorians often are pulled into major outbreak responses, as they were when Zika exploded in the Western Hemisphere in 2015, to answer a myriad of questions about the little-known virus.

Other scientists are charged with thwarting the more commonly seen—but occasionally deadly—illnesses caused by contaminated food or unclean water. Still other disease experts keep their eyes poised on potential bioterror threats, like an intentional release of anthrax or smallpox.

Their new innovations take many shapes. Many are about making better, cheaper,



and faster tests. Some of the stand-out diagnostics include new ways to identify and stop deadly and drug-resistant bugs from spreading in healthcare settings. These cutting-edge scientists found a faster way to test dogs for rabies, for flushing out parasites in swimming pools, and even for identifying a virus in pet rats. They've applied whole genome sequencing to help stop foodborne outbreaks in their tracks. Laboratorians have honed new techniques like using lasers to more accurately diagnose Zika virus infection and a mobile app first responders can use in the field during an outbreak response.

Public health emergencies have spurred some of these seemingly overnight discoveries, but other innovations have been incubating for a while. The just-approved

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test to diagnose Rocky Mountain spotted fever was 10 years in the making. And our promising work—that has stretched over 2 decades—to develop nootkatone continues. Nootkatone is the active ingredient in next-generation pest control products that is plant-based and smells like citrus.

The same scientific rigor underpins all of these innovations, whether locally or globally focused, from the safer disposal of lab waste to headline-grabbing breakthroughs, like linking Zika to devastating birth defects. And the same sense of urgency fuels them all—to stay ahead of infectious germs that are infinitely varied, constantly changing, and more frequently crossing borders.



CATCHING THE SILENTLY SPREADING “NIGHTMARE BACTERIA”

PROBLEM

When patients are admitted to healthcare facilities, they do not expect to get a serious illness in the very place they go to get better. But that is sometimes the case for patients in healthcare facilities who have developed bloodstream infections from CRE (carbapenem-resistant Enterobacteriaceae). CRE is called the “nightmare bacteria” because it kills almost half of all people who get infected. CRE is a family of bacteria often found in people’s gastrointestinal tract that has become resistant to our strongest antibiotics. Patients

can be colonized with CRE, which means they carry CRE without getting an infection. These patients can still spread CRE to others as they move among hospitals, nursing homes, clinics, and other facilities. During an outbreak, CRE in colonized patients goes undetected and can silently spread throughout healthcare facilities. Currently, many hospital labs do not perform colonization testing for CRE. To stop the spread of CRE in their facilities, healthcare workers need innovative solutions to detect these hidden pockets of resistant bacteria.



CRE (carbapenem-resistant Enterobacteriaceae) is called the “nightmare bacteria” because it kills almost half of all people who get infected with it.

INNOVATION

All regional labs in CDC’s Antibiotic Resistance Laboratory Network (AR Lab Network) are **NOW PERFORMING CRE COLONIZATION TESTING FOR FACILITIES IN THEIR AREAS WHERE CRE OUTBREAKS HAVE BEEN DETECTED**. Rapid testing means healthcare workers know the extent of CRE colonization in their facilities and can take steps to prevent and stop infections. Additionally, the Association of Public Health Laboratories is developing software for the AR Lab Network to share the results in real-time with both the healthcare facility and the local health department.

A patient is lying in a hospital bed, covered with a patterned blanket. In the background, two nurses in blue scrubs are standing near a medical cart, one holding a clipboard. The scene is brightly lit, likely from large windows in a hospital room.

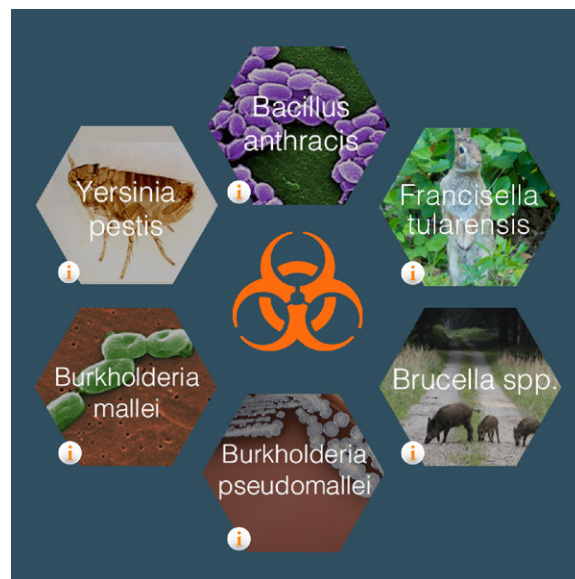
Bottom Line UP FRONT:

Patients carrying CRE can spread the bacteria without showing symptoms. Regional labs in CDC's AR Lab Network provide testing to let hospitals know the extent of the problem.

THERE'S AN APP FOR THAT: RESPONDING TO OUTBREAKS WITH THE TOUCH OF A FINGER

PROBLEM

During the past 3 years, public health workers who have served in the two largest emergency responses in CDC history have learned valuable lessons. Confronting epidemics of Ebola and Zika has shown public health experts what we're doing right and where we need to improve. One of the biggest take-aways from both responses is that information needs to be made available to responders as quickly as possible. During an outbreak, lives can depend on first responders, laboratories, and clinicians having access to accurate information about the disease and the risk to patients.



A screenshot of the LRN Rule-Out and Refer app that helps responders rule out pathogens not causing the outbreak.

INNOVATIONS

To make information more available during an outbreak, NCEZID experts developed mobile apps for first responders and laboratories. The apps are not merely informational but also useful as training tools.

Field Facts App

The Field Facts **APP GIVES RESPONDERS IN THE FIELD SPECIFIC INFORMATION ABOUT THE PATHOGEN** that is causing a disease outbreak. When opening the app, users will receive information on the ways people can be exposed to the pathogen, how the disease is spread, and disease symptoms. The app also gives users general information on biosafety, what kind of protective clothing to wear and emergency contact information.

LRN Rule-Out and Refer App

During an outbreak, laboratorians need to rapidly eliminate pathogens that are not involved so they can zero in on the pathogens that are causing the outbreak. The **LRN Rule-Out and Refer app** (named for CDC's Laboratory Response Network) gives users a **STEP-BY-STEP GUIDE FOR RULING OUT BIOTHREATS** and biochemical test images and videos to help specifically identify pathogens. Easily accessible information helps laboratorians working in the field to complete these processes more quickly during an outbreak.



Bottom Line UP FRONT:

CDC experts have created mobile and tablet applications that offer, at the touch of a finger, information needed during a large disease outbreak.

A CDC emergency responder using a tablet during the 2014-2015 Ebola response in Sierra Leone.

A DANGEROUS FUNGUS AMONG US

PROBLEM

In June 2016, CDC alerted US healthcare providers and laboratories to be aware of a new, drug-resistant fungus called *Candida auris* that posed a serious threat. *C. auris*, as it's known, is a yeast that causes serious and often fatal infections and can strike people in the very places they seek care—hospitals, nursing homes, and other healthcare facilities. It's especially concerning because the fungus can last on skin and healthcare surfaces, like bedrails and chairs, for a long time.

Containing *C. auris* is complicated because it can be spread from person to person and can be difficult to identify. Standard laboratory tests in healthcare facilities can lead to misidentification, delaying infection control and treatment. Specialized laboratory methods are needed to accurately diagnose *C. auris* infection. This makes it difficult to control its spread in healthcare settings, where *C. auris* has caused outbreaks.



Candida auris

INNOVATIONS

Isolating *C. auris*

Less than 3 weeks after CDC alerted healthcare providers about *C. auris*, CDC took an important step toward helping public health workers accurately identify the threat. CDC's Antibiotic Resistance (AR) Isolate Bank collects samples (called isolates) of *C. auris* and *C. auris* "imposters"—look-alike yeasts commonly misidentified as *C. auris*. **CDC MAKES THESE UNIQUE SAMPLES AVAILABLE AT NO COST TO ENCOURAGE RESEARCH** and development. This will help diagnostic companies to develop tests that could quickly differentiate *C. auris* from other yeasts.

Devising a new test

Patients who are colonized with *C. auris* may not show symptoms but still spread it across healthcare facilities. NCEZID's mycotic diseases lab developed **A VERY SENSITIVE AND ACCURATE TEST TO DETECT *C. auris***, allowing facilities and health departments to identify hidden pockets of disease and take steps to prevent its spread and stop transmission. The result? Diagnosis and detection of *C. auris* can be faster and more accurate, preventing more illnesses and deaths.



Bottom Line UP FRONT:

A fungus called *C. auris* can be spread in healthcare facilities. NCEZID is helping develop new tests to better detect *C. auris*.

A NEW TEST FOR A RARE VIRUS IN PET RATS

PROBLEM

When a couple of pet rat breeders got sick in late 2016 and early 2017, NCEZID determined that they were infected with Seoul virus, a type of hantavirus found in Norway rats. Seoul virus can sicken people who have contact with infected rats, their urine and droppings, or contaminated surfaces. Over 5 months, 17 people in 7 states were infected with Seoul virus and 3 were hospitalized. Seoul virus had previously been found in pockets of wild rats in the United States, but this was the first outbreak in pet rats in this country.



Complicating the problem: rats infected with Seoul virus show no symptoms, so it was hard for breeders and owners to know if their rats were infected with the virus—and whether people or other rats in the household might be at risk for infection. Existing testing was cumbersome and couldn't quickly tell if the sick rat had Seoul virus or another hantavirus.

Seoul virus is carried by Norway rats (above). In 2017, the first US outbreak of Seoul virus linked to pet rats (opposite page) occurred.

INNOVATION

NCEZID experts developed a new test for rats that enabled CDC laboratories to test for the outbreak strain of Seoul virus more quickly, in fewer steps than older tests. The test also differentiates between Seoul virus and other types of hantavirus that can infect people. Since January 2017, NCEZID laboratorians have used the test on more than 2,000 blood and tissue specimens from domesticated rats in more than 100 rat-breeding facilities in 16 states.

NCEZID also wanted to **MAKE TESTING EASIER AND CHEAPER FOR RAT BREEDERS AND OWNERS**. We validated two commercially available tests for Seoul virus, and hope that better access to testing will encourage rat breeders and owners to test their rats. This testing will be key in preventing the spread of Seoul virus among pet rats—and in decreasing the risk of infection in people.



Bottom Line UP FRONT:

NCEZID created a test for a virus found in pet rats that sickened 17 people in the United States.

WASTE MANAGEMENT: SAFELY DISPOSING OF BIOHAZARDOUS WASTE

PROBLEM

Leaky bags is never a problem you want when handling biohazardous waste. Disposing of waste that contains infectious materials must be done with utmost caution. Biohazardous waste disposal is a far-reaching issue, affecting laboratories and hospitals that regularly decontaminate biohazardous waste. Autoclaving, the method most commonly used to inactivate infectious substances

before the waste is sent to a landfill, uses heat, steam, and pressure to kill organisms that can cause diseases. The effectiveness, however, varies depending on the type of autoclave, the material involved, the containers used, and other factors. Closing autoclave bags too tightly, for example, can cause pressure to build up and bags may explode. Preparing waste properly is vital to effective decontamination.



The autoclave process is used to inactivate laboratory waste before it's sent to the landfill.

INNOVATION

In 2017, a team of NCEZID experts researched ways to improve laboratory waste management practices. They spent countless hours investigating **HOW TO IMPROVE THE AUTOCLAVE PROCESS**. For example, they found that it is not necessary to add water to autoclave pans or bags for decontamination, and now insert a plastic pipe as the bag is closed, to leave a standardized opening for steam to pass through. These and other improvements reduce the chance of waste exposure. Experts used results of this research to inform autoclave safety training for laboratorians and to update procedures for disposing of soft waste versus hard waste, labeling waste, and more. There are plans for this research to be published to help laboratories reduce the risk of exposure to infectious waste for their employees and the greater community.

Bottom Line UP FRONT:

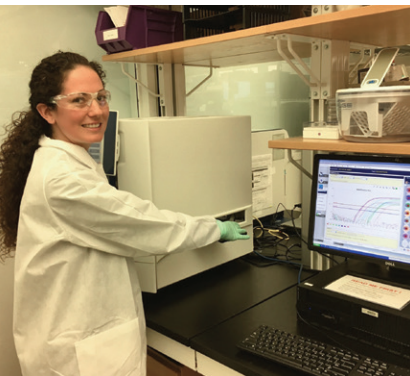
CDC experts found ways to decrease the risk of exposing lab workers and the community to biohazardous waste.

SAVING LIVES: NEW TEST QUICKLY DIAGNOSES DEADLY DISEASE

PROBLEM

Rabies is completely preventable, but it still kills about 60,000 people worldwide a year—mostly those who don't know they were exposed or don't have access to the series of shots that prevent rabies from developing (post-exposure prophylaxis or PEP). Once symptoms begin, the disease is nearly always

fatal. In the United States, an estimated 40,000 people per year receive PEP after contact with a possibly rabid animal. Doctors need to know whether a biting animal has rabies, so they can determine whether their patients need rabies vaccinations. This can help save lives and target the shots to those who need them.



NCEZID scientist uses a new test to quickly and accurately diagnose rabies in animals (above). People line up to get their [dogs vaccinated in Haiti](#) (opposite page).

INNOVATION

NCEZID experts have developed a new rabies test to quickly and accurately diagnose rabies in animals. The test is based on the popular PCR testing platform, meaning it can more easily be run and analyzed by lab staff without specialized training. As a result, it **PRODUCES MORE ACCURATE RESULTS AND FEWER FALSE-POSITIVES THAN THE CURRENT TEST.**

The new test is being validated across the United States and around the world. NCEZID hopes to soon make the test more broadly available to labs. The new test offers several advantages. It can be used in countries with limited resources, where staff already have been trained to use PCR tests for other viruses and bacteria. It can also test samples in a way that avoids the need for refrigeration in the field.



Bottom Line UP FRONT:

CDC experts have developed a new test to more quickly and accurately diagnose rabies virus in animals.

SOLIDIFYING THE FIRST LINE OF DEFENSE: NEW TESTS RAPIDLY DETECT SMALLPOX AND SIMILAR VIRUSES

PROBLEM

The eradication of smallpox from the world in 1977 was one of public health's greatest achievements. Smallpox remains the only human disease that has been defeated. This important achievement would not have been possible without the availability of a safe and effective vaccine. However, recent scientific advances have made it theoretically possible that the virus that causes smallpox could be recreated in a lab and used for a bioterror



Symptoms of smallpox include a rash and skin sores.

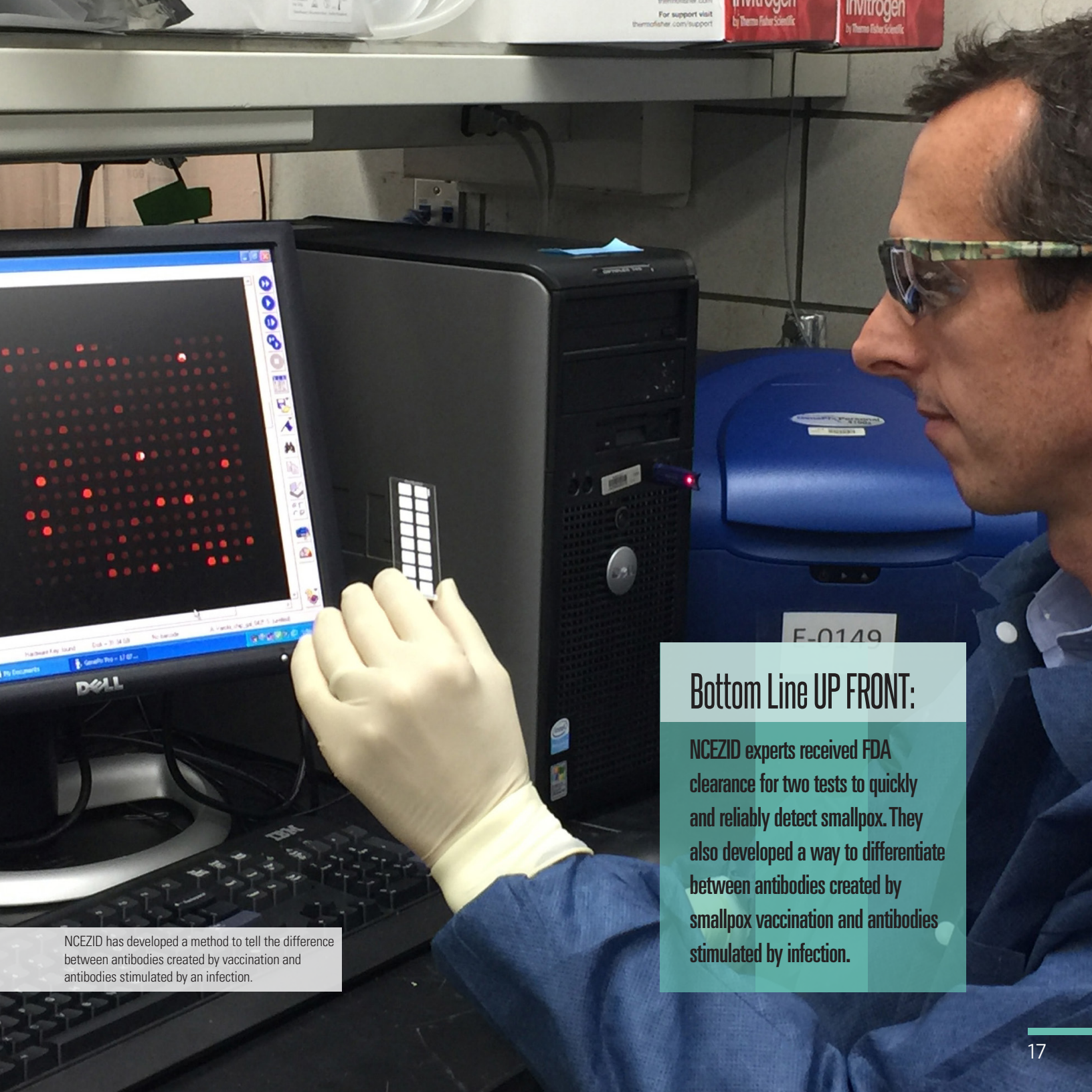
attack. It's important that we have tools ready, including tests to rapidly identify cases of smallpox, effective treatments, and vaccines to protect people should the disease reemerge.

Meanwhile, a related virus—monkeypox—continues to cause outbreaks in Africa. In 2003, monkeypox was responsible for nearly 50 illnesses in the United States after imported African rodents spread the disease to pet prairie dogs.

NCEZID scientists developed two new tests for variola virus, the virus that causes smallpox, and in 2017 the tests were approved by the US Food and Drug Administration for use in the United States. The tests **PROVIDE MORE RELIABLE RESULTS IN AS LITTLE AS 5 HOURS**. The tests have now been sent to labs in CDC's Laboratory Response Network—the labs that would be the first to receive samples if an outbreak were to begin. Although the risk of a bioterror event involving smallpox is believed to be low, the improved test could sound an early alarm in the event of a biological attack.

INNOVATIONS

NCEZID scientists also developed a test that **HELPS TELL THE DIFFERENCE BETWEEN ANTIBODIES CREATED BY A SMALLPOX VACCINATION AND ANTIBODIES THAT ARE THE RESULT OF A NEW INFECTION** with smallpox or a related virus, such as monkeypox. The microarray test includes specific proteins for variola virus and monkeypox virus. In 2017, NCEZID laboratorians used the microarray to confirm monkeypox cases in Africa. In the future, we hope to refine the test so it could be used in rural or resource-limited settings, including some areas of Africa where monkeypox outbreaks are common.



NCEZID has developed a method to tell the difference between antibodies created by vaccination and antibodies stimulated by an infection.

Bottom Line UP FRONT:

NCEZID experts received FDA clearance for two tests to quickly and reliably detect smallpox. They also developed a way to differentiate between antibodies created by smallpox vaccination and antibodies stimulated by infection.

FINDING AN UNLIKELY INGREDIENT TO PREVENT INSECT AND TICK BITES

PROBLEM

Virtually everyone is vulnerable to vector-borne diseases, spread by infected insects and ticks. These vector-borne diseases can be difficult to prevent and control, particularly since vaccines are available for only a few.

West Nile virus, Lyme disease, Rocky Mountain spotted fever—and now, Zika—are some of the more well-known diseases spread by infected insects or ticks in the United States.

Dengue virus, a major health problem in Puerto Rico, infects as many as 400 million worldwide each year and can be deadly. Many regions are experiencing vector-borne outbreaks for the first time as global travel and urbanization increases. Preventing bites from insects and ticks is vital to stopping the spread of vector-borne diseases, and more prevention methods are needed.



NCEZID scientists have found a natural ingredient that repels and kills mosquitoes, ticks, and other pests. The ingredient is a chemical compound called nootkatone that, oddly enough, gives grapefruit its smell.

Nootkatone is found in Alaska yellow cedar trees, some herbs and citrus fruits, and has long been used in many products with a citrus smell. CDC scientists have found that **NOOTKATONE CAN BE USED TO KILL AND REPEL THE TYPE OF MOSQUITOES THAT CAN SPREAD ZIKA, YELLOW FEVER, DENGUE, AND CHIKUNGUNYA VIRUSES.**

INNOVATION

Developing insect repellents and insecticides that use nootkatone would be beneficial for a couple of reasons. It appears to work differently than available insecticides and could help fight mosquitoes that are resistant to existing insecticides. Furthermore, nootkatone could be used in soaps, sprays, and lotions, which would expand insect repellent options. **CDC IS PROVIDING FUNDING TO HELP ADVANCE THE DEVELOPMENT OF NOOTKATONE AS A NEW REPELLENT AND INSECTICIDE**, which is being developed by CDC collaborator, Evolva, Inc.



Bottom Line UP FRONT:

CDC has found an effective insect repellent for mosquitoes and ticks in an unlikely source.

TESTING FOR THE WORLD'S DEADLIEST TICKBORNE DISEASE

PROBLEM

Most people have heard of Lyme disease, but not as many are familiar with Rocky Mountain spotted fever (RMSF), the world's deadliest tickborne disease. Its name is a bit misleading since more than 60% of reported cases occur in five states (North Carolina, Tennessee, Oklahoma, Arkansas, and Missouri). Spread through the bite of an infected tick, RMSF can be deadly if not treated within days of infection.

Rocky Mountain spotted fever is spread by several species of ticks in the United States, including the American dog tick pictured below.



Current testing is tricky, so many treated cases are never confirmed and reported to CDC. RMSF is diagnosed and treated based on the suspicions of a patient's doctor and is confirmed using blood tests after treatment has already begun. The results of these tests can take weeks, so healthcare providers who suspect RMSF are advised to recommend antibiotic treatment before test results are available.

INNOVATION

After nearly 10 years and countless hours of work, NCEZID scientists have received US Food and Drug Administration (FDA) clearance for a real-time PCR test for a family of bacteria called *Rickettsia*, which causes RMSF and other diseases. This real-time PCR (or polymerase chain reaction) test can be used to **MORE QUICKLY IDENTIFY RICKETTSIAL DNA IN BLOOD SAMPLES**. Currently, the most common way to confirm a diagnosis of RMSF is to look for antibodies in two blood samples—one taken during the first week of illness, and the second 2 to 4 weeks

later. Most patients never return to give the second blood sample, so a vast majority of RMSF cases are never confirmed. An advantage of the PCR test is that it can detect rickettsial DNA in whole blood, without the need for multiple tests. By getting FDA clearance, CDC now can **MAKE THE TEST AVAILABLE TO A WIDE VARIETY OF LABORATORIES IN THE LABORATORY RESPONSE NETWORK**, increasing testing capacity and allowing for a more timely diagnosis of RMSF and other diseases.

Bottom Line UP FRONT:

NCEZID has received FDA clearance for a Rocky Mountain spotted fever diagnostic test.

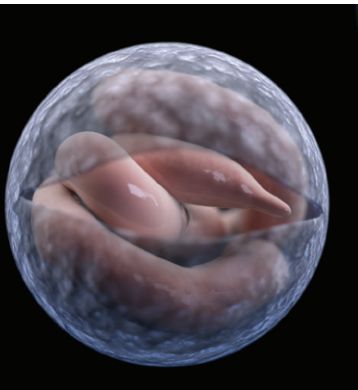


PARASITES IN THE WATER: NEW TRACKING SYSTEM HELPS CONTROL OUTBREAKS

PROBLEM

At swimming pools and water playgrounds across the country, *Cryptosporidium* (Crypto) can turn a day of fun into a nightmare for many people. This parasite is the leading cause of outbreaks of diarrheal illness (cryptosporidiosis) linked to recreational water spots, such as public pools. In fact, twice as many of these outbreaks were reported to CDC for 2016 compared with 2014.

Crypto is not easily killed by chlorine, and swallowing just a mouthful of contaminated water can make people sick for up to 3 weeks. As recently as the late 1990s, cryptosporidiosis incorrectly was thought to be caused by only one species of Crypto. Traditional tests cannot tell the difference among most Crypto species, making it difficult to track trends in illness, link cases, identify the source of outbreaks, and take appropriate steps to prevent further spread.



Infection with *Cryptosporidium* (above) is the leading cause of diarrheal illness linked to swimming pools and water playgrounds.

INNOVATION

Molecular detection work revealed that what we formerly thought was a single species of *Cryptosporidium* is really a collection of at least 30 species, many with multiple subtypes. NCEZID scientists have developed CryptoNet, the first US-based system that uses molecular detection methods to track a disease caused by parasites. Molecular detection methods **DISTINGUISH CRYPTO SPECIES AND THEIR SUBTYPES AND HELP EXPERTS UNDERSTAND HOW THE PARASITE IS SPREAD**. In 2016, CryptoNet was used to help investigate and solve outbreaks linked to swimming pools and water playgrounds in Alabama, Arizona, and Ohio. NCEZID scientists continue to develop advanced molecular detection methods to better distinguish Crypto subtypes and stop outbreaks.

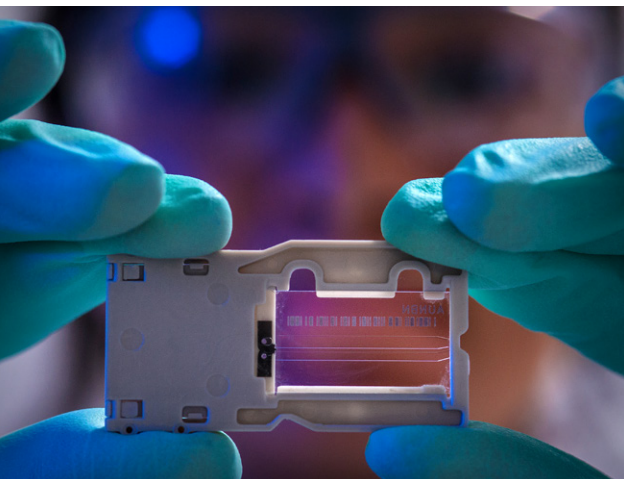
Bottom Line UP FRONT:

NCEZID has launched a new system to better track Crypto, the leading cause of diarrheal outbreaks linked to pools and water playgrounds.



FINDING THE FOOD CULPRIT: DNA TEST MAKES FOOD SAFER

NCEZID foodborne disease scientists are using a new method to more quickly and accurately detect outbreaks.



PROBLEM

How quickly would you like to learn about an outbreak associated with foods you typically eat? The sooner the better. Rapid and precise identification of the bacteria causing foodborne illness is critical for timely foodborne outbreak response. Existing laboratory methods, used for many years to identify and describe bacterial foodborne pathogens, are complex and typically take 1 to 3 weeks to complete.

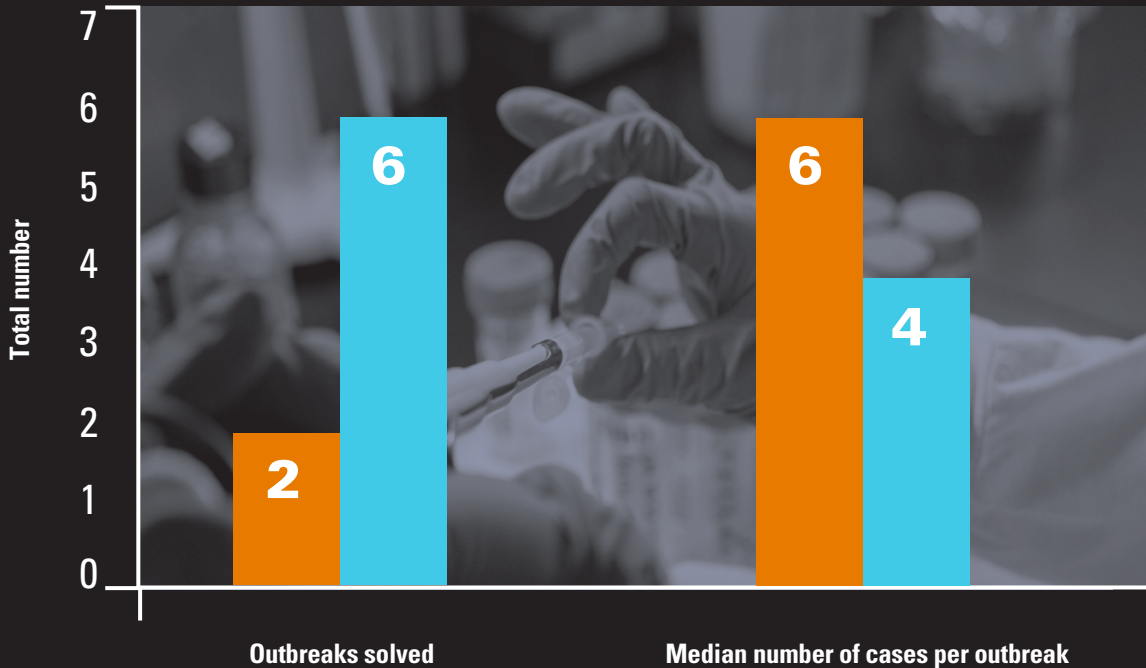
The good news is that a laboratory method called whole genome sequencing (WGS) is already transforming the way we identify and describe foodborne bacterial pathogens, and CDC is expanding its reach. **WGS GIVES AN EXACT DNA PROFILE OF BACTERIA** that disease detectives can use to detect outbreaks and help identify a possible food culprit. WGS is an advanced molecular detection technology that provides scientists with more data in less time. This makes it possible to detect and solve foodborne outbreaks faster, resulting in fewer people getting sick. CDC's PulseNet,

INNOVATION

a national laboratory network, is using WGS to improve its process for finding the most common foodborne pathogens, such as *Listeria* and *Salmonella*.

Now, **NCEZID IS MAKING WGS TESTING AVAILABLE TO ALL PUBLIC HEALTH LABORATORIES IN THE UNITED STATES**, providing a more complete national picture of foodborne illnesses than we have ever had. The goal is to convert PulseNet to a fully WGS-based network by the end of 2018. The lessons learned through WGS will help the industry to produce safer food and prevent future illnesses.

Detecting *Listeria*: Before and After WGS*



MORE
Outbreaks
Solved

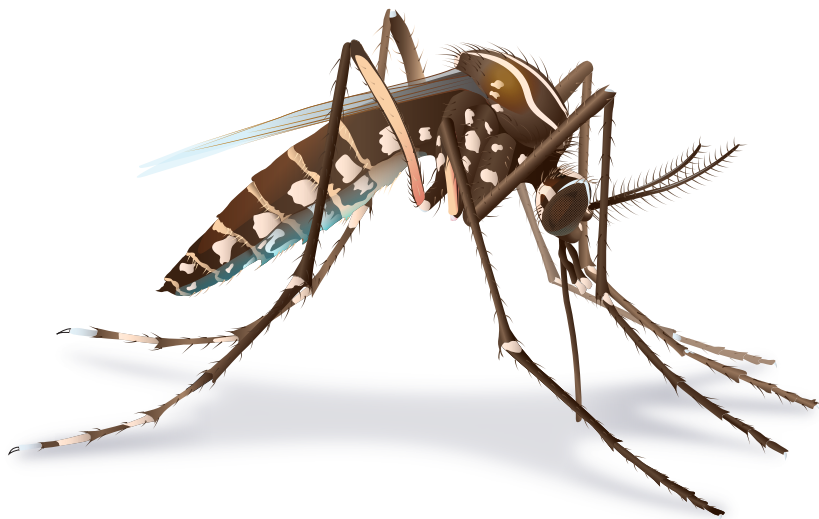
FEWER
Cases per
Outbreak

-  Before-WGS (Sept 2012 – Aug 2013)
-  Using WGS (Sept 2013 – Aug 2016)

* Whole genome sequencing



MAPPING ZIKA: TOOLS TO HELP TRAVELERS AND OTHERS UNDERSTAND THEIR RISK OF INFECTION



PROBLEM

Zika virus infection can have heartbreaking consequences for pregnant women and their fetuses. Zika is primarily spread through the bite of an infected mosquito, and it can be passed through sex from a person who has Zika to his or her partners. Where you and your partner live and travel can affect your chances of getting Zika. It's crucial to know where Zika is being spread by mosquitoes, especially for those who are pregnant or trying to become pregnant, and their partners. The search was on for effective ways of alerting people to areas with risk of Zika, so they could understand the risk.

NCEZID experts created interactive online tools to give people Zika information that is specific to their travel destination and circumstances. CDC's **WORLD MAP OF AREAS WITH RISK OF ZIKA ALLOWS USERS TO SEARCH FOR LOCATION-SPECIFIC ZIKA INFORMATION** and travel recommendations.

The map is regularly updated and is color-coded to show areas that have a risk of Zika, a low likelihood of Zika, and no known risk of Zika. You can simply search for your location, and the map will give you Zika information for that specific destination.

INNOVATIONS

Another tool, the "Know Your Zika Risk" widget, offers tailored risk and prevention messages based on information provided by users. Users can indicate where they live, where they or their partners have traveled or plan to travel, and whether they or their partner is pregnant or trying to become pregnant. **THE TOOL THEN TELLS USERS WHETHER ZIKA IS BEING SPREAD IN THEIR AREAS**, what their specific risk is, and how they can protect themselves, their partners, and their communities. Both tools give people quick and easy ways to get precise information, so they can make informed decisions and prevent Zika virus infection.

4:33 PM

wwwnc.cdc.gov

57%

Verizon

Click on your destination for Zika information

Search for a place by name or zoom and click on the map to see CDC's travel recommendations for Zika. Follow the links in the pop-up message to learn more.



There is risk of Zika in Mexico

- Women who are pregnant should not travel to Mexico.
- Partners of pregnant women and couples considering pregnancy should know [the risks to pregnancy](#) and [take prevention steps](#).
- All travelers should [prevent mosquito bites](#) and [sexual exposure](#) to Zika virus.

Learn more to protect against Zika in Mexico.

Bottom Line UP FRONT:

NCEZID experts developed interactive tools to give people fast, individualized information about their risk of Zika and how they can protect themselves and others.



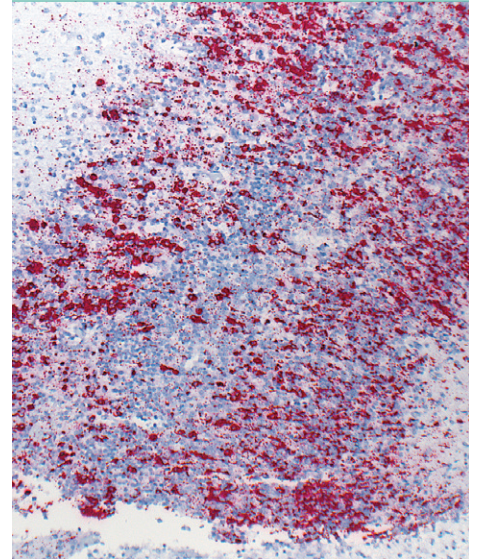
DRILLING DOWN ON ZIKA: NEW WAYS TO LOOK INSIDE THE VIRUS



PROBLEM

As Zika virus rapidly spread throughout South and Central America in 2015, scientists noticed an increase in cases of microcephaly, the devastating birth defect where a baby's head is much smaller than expected. They wondered if Zika infection during pregnancy might cause birth defects. Deciphering the relationship between the two wasn't easy. Zika virus had just emerged for the first time in the Western Hemisphere, and many people infected with Zika virus don't have symptoms or will only have mild symptoms.

NCEZID scientists developed tests and techniques to show Zika virus causes birth defects and pregnancy losses when a woman is infected during pregnancy.



NCEZID test showing Zika virus RNA highlighted in red.

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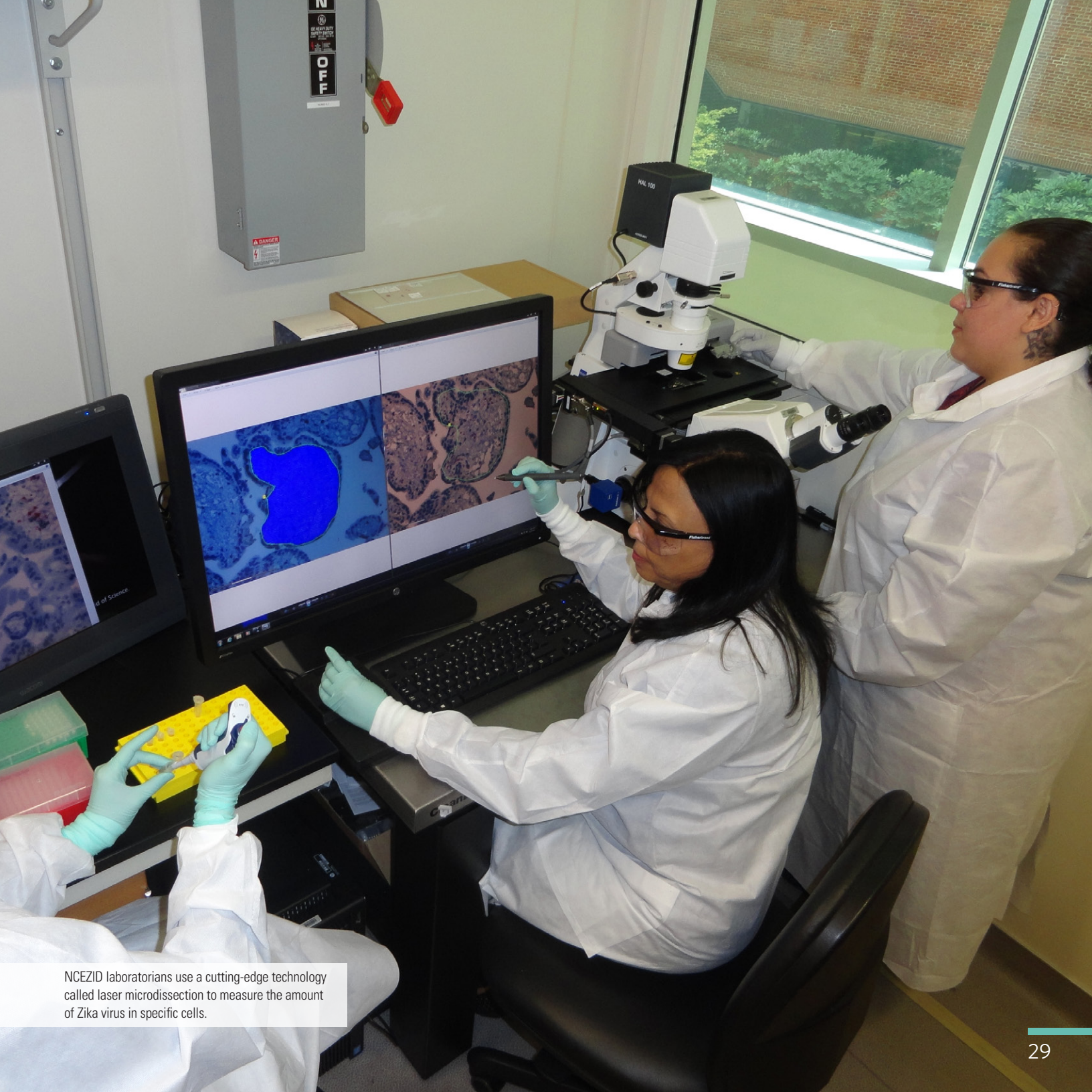
Testing tissues

During the first months of the outbreak, NCEZID scientists developed special tests that **IDENTIFIED THE VIRUS IN BRAIN TISSUES FROM INFANTS WHO DIED FROM MICROCEPHALY AND IN PLACENTAS** from women who had miscarriages.

This discovery cemented the connection between birth defects and Zika virus infection during pregnancy. They also found that the virus could make copies of itself in the fetuses' brains and in women's placentas and persist in these tissues for months. This may help explain how the virus can cause so much damage.

Laser Microdissection

NCEZID scientists used a technique known as laser microdissection to **PINPOINT THE SPECIFIC CELLS WHERE ZIKA VIRUS MIGHT BE PERSISTING AND REPLICATING**. This involves looking under the microscope and guiding a laser to cut away specific cells from areas of the brain and placental tissues, so scientists could measure the amount of Zika virus genetic materials (RNA) in specific cells. This testing method sheds light on where the virus may replicate and how it moves across the placenta from the mother to the fetus and infects the fetuses' brains.



NCEZID laboratorians use a cutting-edge technology called laser microdissection to measure the amount of Zika virus in specific cells.

Innovating to stop infections: What's on the horizon?



Scientists can use hand-held DNA sequencers during outbreak investigations in remote locations.

CDC scientists are on the verge of unveiling promising new ways to combat infectious disease. A few examples that NCEZID scientists are working on include:

SEQUENCING DNA IN THE PALM OF YOUR HAND

Using tiny sequencers that outbreak investigators can take into the field.

LASERS IN THE LAB

Expand use of the laser microdissection technique to look for causes of death and undiscovered pathogens.

MOBILE APPS THAT TRACK DOG VACCINATIONS

Making sure more dogs get the vaccination they need to prevent rabies.

PROTECTING OUR MICROBIOMES

Find out how a disrupted microbiome (beneficial microorganisms that live naturally in and on our bodies) puts people at risk.

A MORE ROBUST PATHOGEN LIBRARY

Expand MicrobeNet to include information about which microbes are resistant.

IMPROVING EARLY DETECTION OF LYME DISEASE

A novel approach to diagnose Lyme disease.

DETECTING HPV

New sequencing tool to make a test for human papillomavirus infection that is faster and cheaper.

NOVEL VACCINE PLATFORMS

Exploring new ways to prevent and treat infection with hemorrhagic fevers like Ebola and Marburg.

PRINTER THAT "PRINTS" DRUGS

Enables labs to test new antibiotics for patients with infections that cannot be treated with current drugs.

NEW DENGUE VACCINE CANDIDATE

Testing to see how well it protects against dengue and to understand its side effects.



National Center for Emerging and Zoonotic Infectious Diseases

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