ADVANCED MOLECULAR DETECTION

Accomplishments: 2018

Since the **Advanced Molecular Detection (AMD) Program** began in 2014, CDC has become a leader in applying next-generation sequencing (NGS) to public health challenges. In just five years, CDC built a workforce capable of applying NGS and related technologies to over 50 infectious diseases. To make use of this enormous flow of genomic data, the agency has increased its high-performance computing capacity and is increasingly making use of cloud services. CDC's infectious disease laboratories now lead the way in using NGS to improve health.

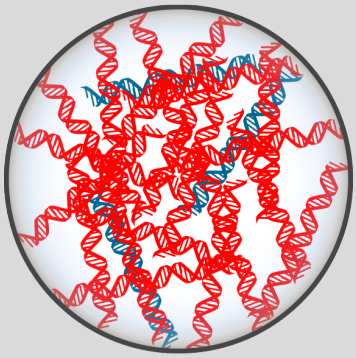
Moreover, state and local public health laboratories across the United States now have NGS capacity and the systems needed to support it. These advancements are helping public health agencies discover new trends in drug resistance, detect emerging infectious diseases faster, and stop outbreaks more effectively.

CDC Scientists Use AMD to Develop Groundbreaking Method for Parasite Diagnostics

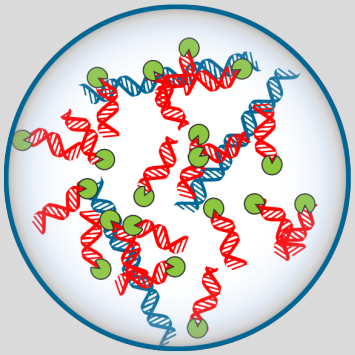
Diseases caused by parasites can be difficult to diagnose, but scientists with CDC's Division of Parasitic Diseases and Malaria have developed a new laboratory method with the potential to shift that paradigm. The method, called Universal Parasite Diagnostic assay, or UPDx, selectively detects parasite DNA in a clinical blood sample without interference from human DNA. CDC scientists believe UPDx may be applied in the future to other pathogens and disease processes. Because of this potential, CDC has applied for a patent on this method in order to ensure it remains available to researchers and diagnostics developers.

Supported by the AMD Program, scientists developed UPDx using next-generation genomic sequencing and bioinformatics to create a faster, more accurate and more sensitive test. UPDx will make it easier to identify the parasite that is making someone sick and provide important genetic information needed to treat or control these infections, all in one test.

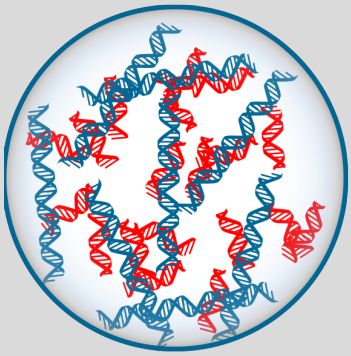
Better Parasite Diagnostics



Conventional methods produce a sample with high amounts of **human DNA** (**red**) and a small amount of **parasite DNA** (**blue**).

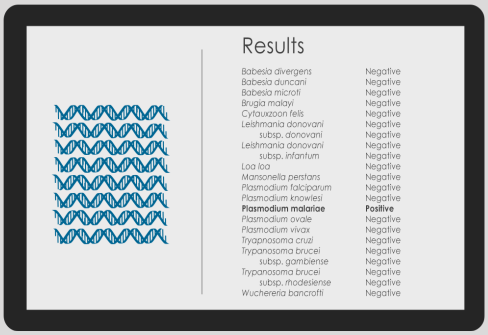


UPDx cuts human DNA by using **enzymes** (**green**) to shorten the length of the human sequences.



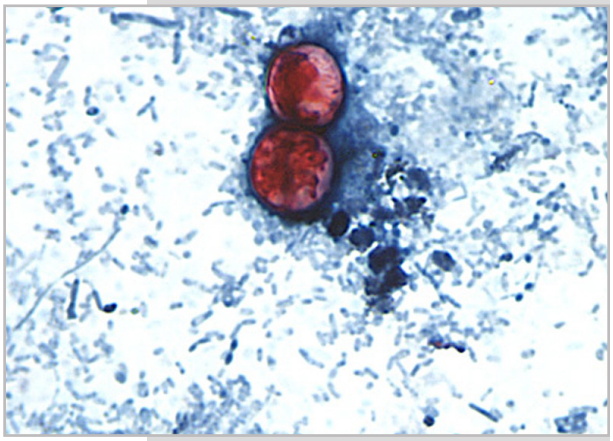
UPDx amplifies parasite DNA allowing scientists to more easily detect and **identify all parasites** in a sample.

Developed with AMD technology, UPDx can replace multiple single-pathogen tests by moving to a sequencing first testing method.



AMD leads to better analysis and tracking of *Cyclospora*

In the summer of 2018, state and local public health agencies registered an unusually large number of domestically acquired *Cyclospora* illnesses. *Cyclospora cayetanensis* is a one-celled parasite that causes intestinal infections. Two multi-state outbreaks of *Cyclospora* were linked to prepackaged vegetable trays and fast food salads that sickened more than 700 people. CDC researchers had expected to receive, at most, 200 samples of *Cyclospora* for the entire May-August season, the typical season for cyclosporiasis in the United States. At the peak of the 2018 outbreaks, they were receiving around 120 samples each week.



Oocysts of *C. cayetanensis*

CDC scientists in the Division of Parasitic Diseases and Malaria had been developing methods to genetically type *Cyclospora cayetanensis* since the AMD program began in 2014. This work led to a prototype—essentially, a "DNA fingerprinting" tool—to help detect clusters of *Cyclospora* illness and to help investigators determine how these parasites get into the food supply. The unusually large number of samples received in 2018 helped researchers evaluate and improve the tool. CDC scientists will be typing *Cyclospora* samples in real time during the 2019 *Cyclospora* season to evaluate the tool's utility for outbreak detection.

Investigating an outbreak of multidrug-resistant *Salmonella* infections

In response to an ongoing outbreak of a multidrug-resistant strain of *Salmonella*, public health and regulatory officials in Minnesota used AMD technologies, like whole genome sequencing, to identify the outbreak strain making people sick after exposure to raw turkey pet food. The discovery by Minnesota health officials in February 2018 helped uncover a widespread problem of *Salmonella* Reading contamination in the turkey industry. Several turkey products, including ground turkey and raw turkey pet food, have been recalled since February 2018. CDC and the U.S. Department of Agriculture Food Safety and Inspection Service shared this information with representatives from the turkey industry and requested that they take steps to reduce *Salmonella* contamination.

Raw turkey pet food

As this investigation is ongoing, CDC will provide updates on the website (www.cdc.gov/salmonella/reading-07-18) when more information is available.

AMD helped identify the source for a deadly Legionnaires' disease outbreak in NH

In late summer 2018, the New Hampshire Division of Public Health Services worked with experts at CDC to identify the likely source of a Legionnaires' disease outbreak that sickened 34 people, two of whom died. Legionnaires' disease is a serious type of bacterial pneumonia (lung infection). The number of cases reported to CDC has been on the rise since 2000. Before CDC began applying AMD methods to *Legionella*, it had a less powerful, lower resolution tool for investigating such outbreaks. Scientists used whole genome sequencing (WGS) to analyze *Legionella pneumophila* isolates from clinical specimens and environmental samples. The combination of epidemiologic, environmental, and laboratory investigations identified the most likely source to be a popular regional tourist resort. Closure of the hot tub at the resort and remediation of the hotel water system led to cessation of the outbreak.

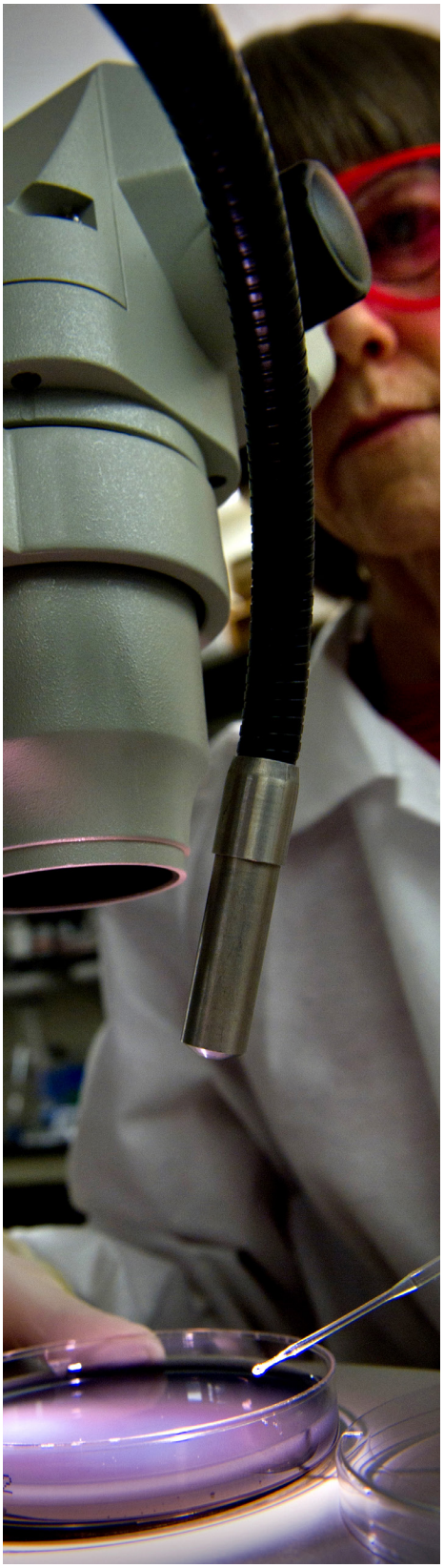
The Advanced Molecular Detection program prioritizes training for public health labs

As the role of pathogen genomics expands at the state and local level, public health labs have increasingly complex demands for training and other forms of workforce development. Providing effective options is a priority for the AMD program.

- In 2018, AMD expanded bioinformatics capacity in state public health laboratories by funding seven Bioinformatics Regional Resource (BRR) Leads to develop skills and provide training assistance. These BRR Leads provide customized AMD support to public health labs across the country.

- In response to an emerging demand, AMD partnered with the Association of Public Health Laboratories (APHL) to offer a 4-day course in intermediate bioinformatics for microbiologists. To provide additional support to epidemiologists, AMD partnered with the Council of State and Territorial Epidemiologists to offer a 2-day practical course in interpreting genomic data. These courses launched in early 2019.

- AMD and APHL continues to expand bioinfomatics capacity in the states and CDC through the APHL-CDC Bioinformatics Fellowships, a program to encourage bioinformaticians to apply their expertise in public health.



Ellen Brown, a microbiologist in CDC's Legionella Laboratory, identifying Legionella from environmental samples.

CDC's Advanced Molecular Detection (AMD) program integrates the latest next-generation genomic sequencing technologies with bioinformatics and epidemiology to help find, track, and stop disease-causing pathogens faster than ever before. The AMD program collaborates with other programs in the agency to build capacity at CDC and in state and local public health laboratories.

www.cdc.gov/amd

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