ADVANCED MOLECULAR DETECTION

Portable, hand-held sequencers for field investigations, next-generation genomic sequencing technologies, and high-performance computing systems—these are some of the new technologies CDC is bringing to bear in the nation's public health system. All of these technologies help us identify and track pathogens faster, stop outbreaks sooner, and keep our nation safe from infectious disease threats. And the technologies that fuel AMD continue to advance at an exponential rate. CDC's AMD program is keeping pace with ever-advancing technologies so we can keep up with the pace of evolving and emerging pathogens and continue to protect the American people.

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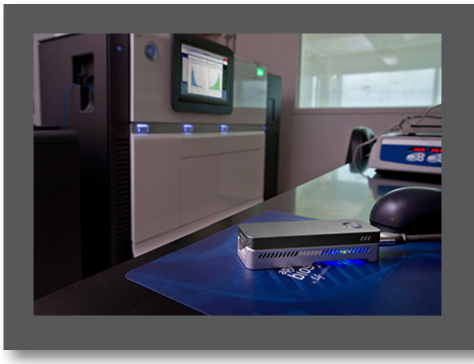
Exploring New Technologies



Due to its portability, nanopore sequencers have significant potential for use in remote and resource-limited areas.

KEEPING UP WITH CULTURE-INDEPENDENT DIAGNOSTIC TESTS

Culture-independent diagnostic tests (CIDTs) are the future of precision diagnostics in hospitals and doctors' offices. These tests rapidly identify pathogens without the need to culture (grow) them first, yielding a faster diagnosis. But CIDTs pose a problem for public health investigators. It is not enough to know which bacterium made someone sick. We also need to know the specific bacterial strain involved and whether it is resistant to antibiotics; detailed information not provided by CIDTs. For instance, the PulseNet foodborne disease surveillance system relies on isolates—bacterial strains isolated from clinical samples—to detect outbreaks. Public health laboratories need isolates to determine the bacterium's DNA fingerprint and share it with CDC and other disease investigators. And current CIDTs do not provide isolates. Fortunately, CDC is using AMD technologies to develop tools that can identify and extract disease-causing bacterial DNA from stool samples. When such tools are developed, it should be possible to identify specific features of a bacterium, link it to a source, and know which antibiotics are likely to work against it, without an isolate.

ADAPTING NANOPORE TECHNOLOGIES

Next generation sequencing (NGS) technologies are revolutionizing the diagnosis of human diseases and have become critical frontline tools in public health laboratories. NGS helps scientists rapidly analyze the DNA of known, unknown, and emerging pathogens. Yet, NGS systems are costly, complex, and confined to the laboratory where temperature and humidity are constant. However, new nanopore sequencing technologies provide portable, flexible, and inexpensive alternatives to NGS. These tiny sequencers weigh less than a deck of cards and remain stable even in harsher environmental conditions. Because they are small and can operate on available laptop computer or smartphone platforms, they are ideal for investigations at the site of infectious disease outbreaks, especially in remote areas with limited resources.

In addition, these sequencers have the potential to provide much faster results than current NGS technologies. CDC scientists are evaluating nanopore technologies for sequencing in field locations to address outbreaks of Ebola, MERS, rabies, influenza, and other viruses. By sequencing viruses at the site of an outbreak, we can more rapidly identify and track dangerous viruses at the source, before they have the chance to spread more widely.

SHARING DATA IN THE CLOUD

In the early days, CDC laboratories received clinical samples in the mail. Later, laboratory and epidemiologic data could be sent over computer networks with incredibly slow data speeds. But through the AMD program, CDC is modernizing its computing capacity to take advantage of secure cloud computing services. These efforts are making it faster and easier to collaborate with state and local health departments and partner organizations. As state public health laboratories develop sequencing capabilities, CDC's cloud computing capacity lets them share or compare genomic data from their laboratories with CDC labs

and databases in near real time. CDC has already developed this capacity with public health laboratories involved in influenza surveillance, speeding our ability to track circulating influenza virus strains. As CDC improves its computing capacity, the agency's laboratories will be able to provide similar services for other pathogens.