DOD Employs Machine Learning to Fight the Next Pandemic

By: Kevin McCaney

News

Emerging Tech

Artificial Intelligence

Dec 4, 2017 | 11:58 am



In December 2013, a two-year-old boy named Emile in the West African country of Guinea contracted the deadly Ebola virus from a bat, a case that was not officially confirmed and reported until March 2014, by which time it had started to spread. An international response followed and by January 2016, the World Health Organization (WHO) declared the last of the affected countries to be Ebola-free. But by that time it had spread to six countries, mostly concentrated in Liberia, Sierra Leone, and Guinea, and resulted in more than 11,300 deaths–the deadliest outbreak of Ebola since its discovery in 1976. An independent panel of health experts subsequently deemed the response too slow and too often ineffective, resulting in "needless suffering and death."

Part of the problem with the response is that it was, unavoidably, reactive. The disease struck in a remote area of a poor country rife with animal species capable of carrying a zoonotic (transmitted between animals and humans) disease, and had spread quickly before aid organizations could get a handle on it. One recommendation from the independent health panel was that WHO create a plan for quicker response, but health researchers also are looking to become more proactive, by using machine learning to identify potential hot spots and even predict future outbreaks.

The Department of Defense is among the organizations leading the research. Pandemic threats such as Ebola, Zika, and avian flu are not only a danger to public health, but are also viewed as potential national security threats, as the National Intelligence Council, an arm of the Director of National Intelligence, points out in its 2017 report, Global Trends: Paradox of Progress.

The Defense Threat Reduction Agency (DTRA), along with the Department of Homeland Security, has developed a cloud-based Biosurveillance Ecosystem (BSVE) that uses machine learning and natural-language processing to scour a wide range of sources to identify signs of spreading disease, DTRA's Dr. Christopher M. Kiley said in a release.

The system, built with commercial and government technologies, "ingests and uses large data streams such as open-source social media feeds, RSS feeds from news organizations and blogs, disease ontologies, de-identified diagnostic results, historic outbreak data, zoonotic data, and non-health data," Kiley said. DTRA, which awarded Digital Infuzion a $12.8 million contract in 2015 for work on BSVE, earlier this year issued a request for information on ways to enhance the program.

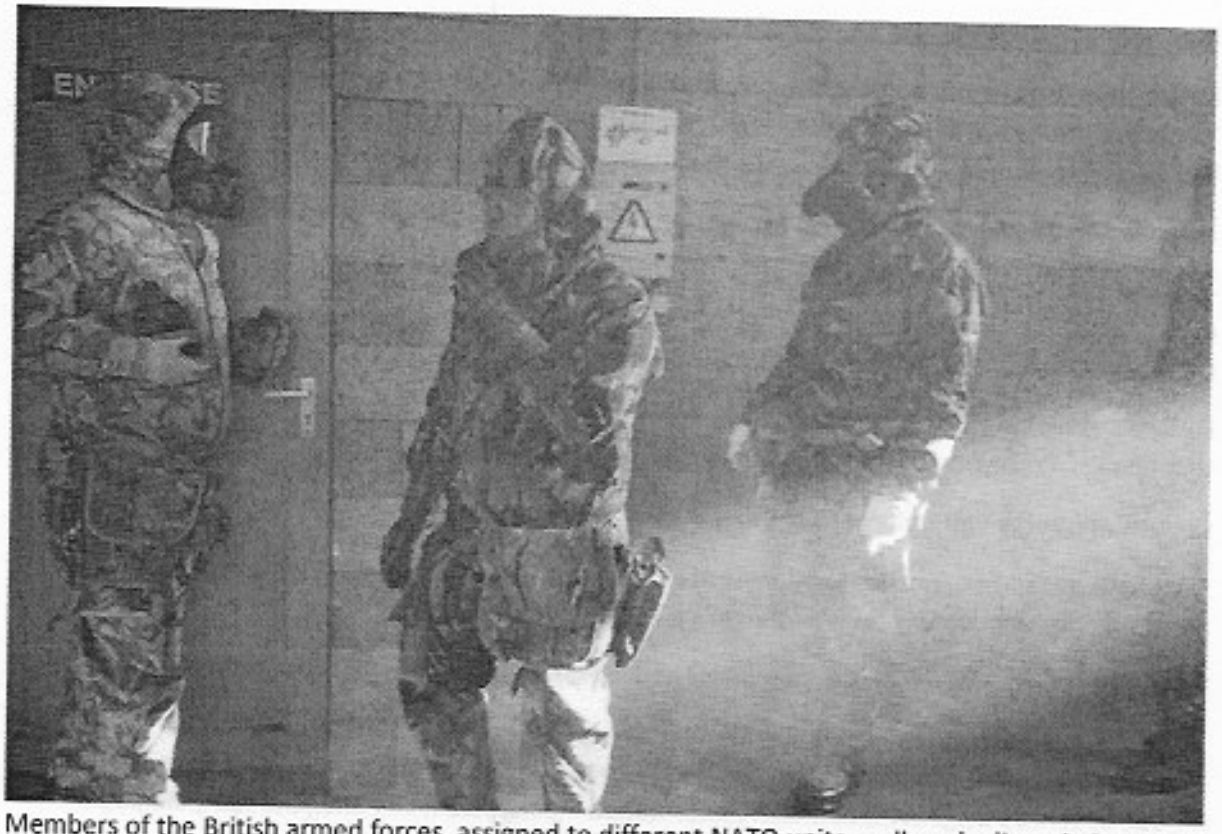
DTRA also is funding an international effort to use machine learning to parse social media for early signs of an outbreak. On another front, a National Institutes of Health program is working on prevention, employing machine learning to identify compounds that could prevent the growth of the Ebola virus.

Defense efforts are working in parallel with other research, such as that being done by the non-profit Cary Institute of Ecosystem Studies, which has focused on the recent Ebola outbreak and is using machine learning to predict which species–in this case, bats–are most likely to carry the disease. The research team's machine learning model created profiles of bat species, analyzed 57 different variables in behavior and predicted which bats were potential carriers with 87 percent accuracy.

"Using machine learning methods developed for artificial intelligence, we were able to bring together data from ecology, biogeography, and public health to identify bat species with a high probability of harboring Ebola and other filoviruses," said Barbara Han, a disease ecologist at Cary and the lead author of a paper on the team's research.

DoD Chemical-Biological Program has a Global Mission

By Cheryl Pellerin DoD News, Defense Media Activity



Members of the British armed forces, assigned to different NATO units, walk and adjust their general service respirators inside the U.S. Army Training Support Center Benelux chemical, biological, radiological and nuclear chamber on Chievres Air Base, Belgium, Jan. 19, 2016. British forces assigned to NATO trained under supervision of the British Joint European Training Team. U.S. Army photo by Pierre-Etienne Courtejoie

WASHINGTON, Feb. 3, 2016 — Keeping warfighters safe from infectious diseases and chemical agents is a Defense Department effort that requires a range of capabilities, from global biosurveillance and quick response to medical countermeasures and interagency and international collaboration.

At the Pentagon, the Chemical and Biological Defense Program, or CBDP, is an early and critical part of the effort. Dr. D. Christian Hassell, deputy assistant secretary of defense for chemical and biological defense, leads the program.

Hassell, an analytic chemist and former director of the FBI Laboratory, oversees the department's chem-bio program.

Chem-Bio Threats

One of his jobs is to coordinate the development of tools and capabilities that help warfighters prevent, protect against, respond to and recover from chem-bio threats and effects.

To do that, Hassell works with CBDP components such as the Joint Science and Technology Office for Chemical and Biological Defense at the Defense Threat Reduction Agency, or DTRA, and the Joint Program Executive Office for Chemical and Biological Defense.

Hassell also works closely with the interagency and international partners to coordinate a range of efforts that involve protecting service members and DoD civilians wherever they are in the world.

Monitoring the World

Rather than dividing the program into chem and bio, Hassell told DoD News in a recent interview, "my office is organized [as] ... a physical team and a medical team, [depending on] whether we're looking at the external protection versus the internal protection."

He added, "The external or physical team does things like [personal protection] suits, protective shelter and detectors, and there they look both at chem and bio."

On the medical or internal team, Hassell explained, "they're looking at diagnostics, vaccines and therapeutic drugs," also for chem and bio applications.

Hassell and his team don't monitor the world for chem-bio threats, he said. "We develop the tools that enable" those who do, he added.

Countermeasures and Defenses

Such tools include diagnostics and chemical and biological detectors that nearly anyone could use in an emergency to quickly identify pathogens and disease.

The CBDP oversees development of medical countermeasures to protect warfighters against disease and chemical threats.

Another tool in development is global biosurveillance using a technical architecture of tools that include advanced diagnostic, detection, information management and analytics technologies.

Early Warning

In the chem-bio world, early warning is the best protection for warfighters, Hassell said, and global biosurveillance is the best way to see a problem developing.

"For many years, we ranked things by particular agents -- which gas, which bug, are we most worried about? [Today] ... we try to look at that holistically," he added.

The program doesn't put all its efforts into just one virus or chemical agent. It's impossible to know which one could be developed as a weapon or could arise in a pandemic.

"Wherever possible you try to [create] an integrated system, so that mask will protect an individual against as broad a spectrum [as possible] of chemical agents. Or [making] sure a vaccine can protect against as many strains as possible," Hassell said.

"For some organisms, if we develop a vaccine for one specific strain and then it mutates, the vaccine may no longer work, and that wouldn't be practical," Hassell explained. "You'd have to vaccinate against every bug, every year, for every person."

Ebola Defense

That was the case in 2014-2015 when the Ebola outbreak surged through West Africa and no vaccine or drug was available. But as part of the DoD medical countermeasures program, scientists at the U.S. Army Medical Research Institute for Infectious Diseases at Fort Detrick, Maryland, had been working for years on vaccines for historically rare and fatal diseases such as Ebola.

By 2014, the USAMRIID scientists had created and begun testing a three-strain vaccine candidate that contained the Ebola Zaire strain that caused the West Africa outbreak, the Sudan virus Ebola strain, and Marburg virus, another lethal virus in the same filovirus group as Ebola.

To save lives, the scientists spun off Ebola Zaire in a separate vaccine candidate program to move it quickly forward.

Diagnostics and Drugs

The countermeasures program also developed Ebola diagnostic kits and did early work on the Ebola drug ZMapp.

"We provided a lot of the initial funding [for ZMapp] and we did a lot of the earlier technical development in it," Hassell said, noting that the U.S. Department of Health and Human Services and the Canadian government were involved in testing and fielding the drug in its early stages.

The National Institutes of Health National Institute of Allergy and Infectious Diseases and DTRA also invested in ZMapp and the vesicular-stomatitis vaccine that is now in clinical trials.

ZMapp, being developed by Mapp Biopharmaceutical and on a fast track for FDA for approval, is an experimental drug made from monoclonal antibodies licensed from USAMRIID and a Canadian biodefense company. The drug's proteins are grown in the cells of tobacco plants, a technology funded beginning in 2009 by the Defense Advanced Research Projects Agency.

Future Threats

To prepare for future threats, Hassell said, CBDP seeks to develop sensors and other detectors, diagnostics, drugs and vaccines that are as broadly applicable as possible.

To understand future threats, Hassell said, he works closely with intelligence organizations such as the National Center for Medical Intelligence at Fort Detrick.

With NCMI and others, Hassell "sees the current threat environment, how [it's] changing as far as different chemical compounds, different organisms that someone may be taking an interest in, who is taking an interest and what's our relationship to them," he added.

"We continually look at that evolving picture," he said. "We just need to make sure we stay abreast of that [and] prioritize our efforts so they respond to the highest risk elements, buying down the risk."

(EDITOR'S NOTE: This is the first in a series of stories about the Defense Department biosurveillance enterprise and technology development effort.)

(Follow Cheryl Pellerin on Twitter: @PellerinDoDNews)