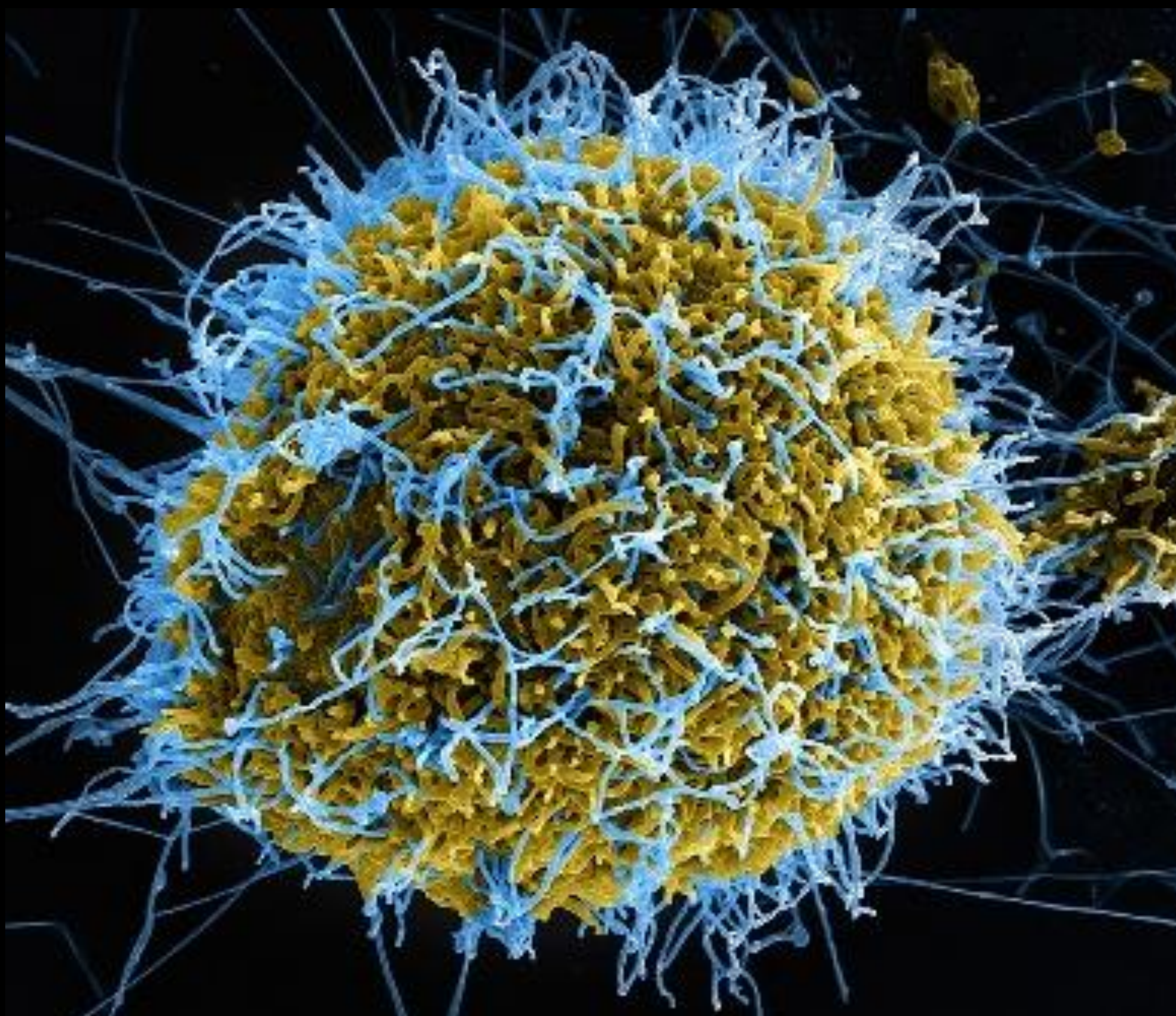
Invisible Scourge

The Danger of Chemical or Biological Attack on America is Growing Fast



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Results in Brief

- The federal government spends little on preparing for chemical or biological attacks against the U.S. homeland, even though the risk of such attacks is rising.

- Biological threats such as bacteria and viruses potentially can kill millions; recent advances in the life sciences now enable researchers to fashion lethal pathogens in laboratories.

- Skills to inexpensively synthesize pathogens are identical to those used in other areas of biological research, and have become increasingly available to extremists through global commerce.

- The precursors of lethal chemical weapons such as nerve agents are manufactured at thousands of sites around the world, and have been weaponized by countries such as Syria and North Korea.

- Treaties banning chemical and biological weapons have been signed by many countries, but it is difficult to control the spread of relevant technologies and there are no agreed standards on sharing information.

- Researchers have recently synthesized a virus similar to that causing smallpox -- the most lethal virus in history -- and published information on how they did it in a public forum.

- Federal preparations for detecting and responding to chemical or biological attacks are under-funded and fragmented between many agencies and congressional committees.

- New technologies have been developed for countering the threat of chem-bio attack, but the government needs a central coordinating mechanism to assure those technologies are deployed in timely fashion.

- Some of the new technologies cut the cost of identifying threatening agents to a small fraction of that required by traditional methods and greatly reduce the time needed, potentially bolstering chem-bio defense efforts.

- The government should strengthen homeland defenses against chemical and biological threats, including the accidental release of pathogens from laboratories -- a process that requires relatively little additional money but more leadership.

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Cover: Ebola virus emerging from a cell.

Introduction: The Crisis No One Sees

The United States spends over $700 billion annually on national security, far more than any other country. Most of that money is allocated to preparing for conventional combat with weapons such as warships and tanks. Almost all of the remainder is spent on nuclear deterrence and defeating global terrorism.

Very little money is spent on preparing to cope with chemical or biological threats -- dangers that have existed for many years but are now becoming more likely thanks to the spread of recent innovations and the resulting empowerment of extremists at home and abroad. The deliberate use of toxic chemicals such as nerve gas or virulent pathogens such as anthrax is potentially so lethal that both technologies are considered "weapons of mass destruction." In the popular mind, though, that phrase is largely reserved for nuclear matters.

The reason is clear: Americans have never felt endangered by chemical or biological attack in the way that they have been threatened by nuclear weapons since the early days of the Cold War. If they hear at all about chemical or biological warfare, it is usually in the form of limited aggression in faraway places. But the likelihood of mass attacks using such means against the American homeland is growing fast. It is nearly inevitable that various state-based or non-state actors will contemplate such aggression in the future.

The precursors for chemical weapons -- choking agents, blister agents, blood agents, nerve agents -- are manufactured at thousands of sites around the world, and the knowledge of how they are made is shared by millions of people. The technology needed to edit or synthesize organisms so that they can be used to spread disabling disease is now widely available in global commerce, and inexpensive. To quote the Director of National Intelligence from congressional testimony delivered in March of 2018,

Biological and chemical materials and technologies -- almost always dual-use -- move easily in the globalized economy, as do personnel with the scientific expertise to design and use them for legitimate and illegitimate purposes. Information about the latest discoveries in the life sciences also diffuses rapidly around the globe, widening the accessibility of knowledge and tools for beneficial purposes and for potentially nefarious applications.

Against that backdrop, the neglect of chemical and biological threats in U.S. national security plans is a crisis waiting to happen. Unfortunately, it is a crisis in the making that almost no one in official Washington sees. Responsibility for preparing is fragmented among dozens of agencies and congressional committees, with no central coordinating body. Countermeasure and response programs at the state and federal level are poorly funded. It will not be long before some enemy of democracy moves to exploit these weaknesses.

This report is an attempt to concisely characterize the nature of the chemical and biological threat to America. It describes the key features of chemical and biological agents, explains how emerging technology makes their use more likely, and explores the federal preparations currently in place to deal with such an eventuality. It then provides examples of inexpensive countermeasures and initiatives that Washington might implement to make the nation more resilient in the face of looming danger.

The Biological Threat

Biological threats differ from other forms of warfare in that they rely on living organisms -- bacteria, viruses, fungi -- to attack enemies. They are even more indiscriminate in their effects than chemical or radiological weapons, because they spread and mutate unpredictably. Thus, unlike other mechanisms of mass murder, their lethality does not necessarily dissipate with time. It may actually grow worse as a pathogen (a disease-producing microorganism) evolves.

That is what happened during the Spanish Flu pandemic of 1918, an outbreak of influenza that originated in Kansas but then spread to the rest of the world. As the highly transmissible virus mutated, it became more dangerous. Victims had little resistance to the new strain, and there were few effective countermeasures. Eventually 50-100 million people were killed by the disease and its complications. Nearly half of all deaths in the U.S. at the height of the pandemic were flu-related, and average life expectancy fell by twelve years.

Humanity has suffered throughout its history from the ravages of diseases spread by pathogens, from malaria to yellow fever to smallpox. Smallpox may have killed 300 million in the centuries before it was finally eradicated in 1980. This history by itself would justify sustaining a robust response capability against future pandemics. What has changed today is that scientists now have the tools to create and multiply such pathogens, for use as weapons.

The current U.S. National Security Strategy warns that, "biological threats to the U.S. homeland -- whether as the result of deliberate attack, accident, or natural outbreak -- are growing and require actions to address them at their source." The Director of the CIA warned in 2016 that the international community's response to bio-threats is not keeping up with the new technologies that make them possible, and the Defense Advanced Research Projects Agency lists the development of better biosecurity measures as a top priority.

However, new tools and training in the life sciences are proliferating so fast that it is nearly impossible to regulate who gains access to them and how they are used. North Korea is known to have developed an extensive capability to weaponize biological agents, and as a result U.S. soldiers deployed on the peninsula are routinely given vaccinations for smallpox and anthrax. The intelligence community has repeatedly reported efforts by terrorist groups to acquire the means for mass-producing lethal pathogens.

What matters for U.S. policymakers is not so much the current state of play or the motivations of potential perpetrators, but the simple fact that knowledge of how to fashion biological weapons is spreading rapidly. Inexpensive kits and instructions for genetically modifying microorganisms are available on the Internet, and a wide variety of potentially pathogenic agents can be obtained in open commerce or surreptitiously. Remote delivery of pathogens against target populations is facilitated by the advent of cheap drones.

These troubling trends occur because recent breakthroughs in the life sciences for treating diseases and genetic defects are readily adapted to nefarious purposes. The ongoing revolution in microbiology and genetic engineering (see box) relies upon dual-use technology that can just as easily be used to spawn pandemics as to combat them. Policymakers have barely begun to think through what such developments may mean for the future security of the nation.

The Rise of Synthetic Biology

The genetic information of almost all life forms is contained in a molecule of deoxyribonucleic acid (DNA) that is found in the nucleus of each cell in an organism's body. Without the information carried on this microscopic strand, the organism could not express its characteristic traits or reproduce. The role of DNA in transmitting inherited traits between generations of a species was first illuminated in 1953.

During the 1970s, scientists began to discover methods of manipulating DNA so that traits could be added or removed from an organism's genetic makeup (or "genome"). The practice came to be called synthetic biology, because it involved fashioning features not known to exist in nature. One of the earliest applications of such gene editing was the modification of crops to make them less susceptible to drought or disease.

At its inception, synthetic biology was difficult and expensive. That, plus safety and ethical concerns, limited the spread of knowledge concerning the emerging field. Over time, though, the tools for splicing and reassembling DNA became accessible to a broader array of users. Eventually, scientists learned how to create wholly new biological components and organisms. The most important breakthroughs came in 2009, in the form of a new gene editing tool known by the acronym CRISPR.

To quote the National Human Genome Research Institute, "CRISPR is simpler, faster, cheaper, and more accurate than older genome editing methods." Unfortunately, the vast improvement in laboratory practices enabled by advances like CRISPR comes at a price. It has become much easier for users with destructive intent to apply synthetic biology to their work. For instance, a scientist sympathetic to extremist causes might create an organism combining the lethality and transmissibility of multiple pathogens to generate horrific effects.

The result would be a super pathogen threatening the survivability of large populations, and even civilizations if no prompt countermeasures were available. This is no fanciful speculation: some scientists believe that humanity is only two mutations of the influenza virus away from species extinction. Unlike any other time in human history, it is now feasible to artificially spawn such mutations, and then loose them on unsuspecting targets.

That is the danger of widely deploying dual-use technologies in synthetic biology. The same methods that might be used to defeat cancers could be used to destroy adversaries through virulent pandemics. That outcome might not even be deliberate: if super pathogens escape laboratories to reach the outside world, they might cause just as much damage even though their release was accidental. The federal government and scientific community have sought to fashion standards to minimize the likelihood of such catastrophes, but as knowledge spreads so does the danger.

This would not be the first time emerging technology had unforeseen consequences, but it might be the last. Nicholas G. Evans of the University of Pennsylvania department of medical ethics and health policy observed in 2015 that "certain broad elements of synthetic biology, driven by the aim to create a predictable engineering discipline out of the life sciences, have the capacity to deskill the life sciences in a way that enables malevolent actors." Breakthroughs in microbiology might thus become major threats to national security.

Anthrax bacilli on the tissue of a monkey that has inhaled bacteria. Anthrax in one of 11 high-priority biological threats currently listed by the federal government's Public Health Emergency Medical Countermeasures Enterprise. Others include botulism, Ebola hemorrhagic fever, Marburg hemorrhagic fever, pandemic influenza, plague, smallpox, tularemia, and typhus.

The Chemical Threat

Chemical weapons consist of highly toxic substances such as nerve gas combined with a method of delivery, such as a missile, artillery shell or drone. Like biological threats they kill silently rather than through kinetic effects, and the processes making them possible are widely utilized in industry for other purposes. Thousands of industrial sites around the world manufacture chemicals that might be used as ingredients in such weapons, and restricting access is thus a challenge.

Toxic substances have been used in war for thousands of years, but chemical weapons in the modern sense did not appear on the battlefield until World War One. Germany, seeking to compensate for a shortage of conventional munitions, turned to its chemicals industry for other ways of disabling large numbers of enemy combatants. Several widely produced chemicals proved to be effective when released in sufficient concentrations, most notably chlorine and phosgene. Once Germany initiated “gas” warfare, Britain and France responded in kind. Over a million soldiers were blinded, disfigured or killed during the war by gas weapons.

Initially, chemical weapons tactics focused on choking agents like chlorine, blister agents like sulfur mustard, and blood agents such as hydrogen cyanide. All three of these can be lethal depending on the degree of exposure and their persistence over time. Even when not fatal, they can cause permanent disability. After the war, scientists in several countries developed a new type of chemical weapon now referred to as a nerve agent. Nerve agents were so potent that they came to be the weapon of choice for those countries choosing to stock chemical munitions.

Most of the recent incidents involving chemical weapons involve one or another form of nerve gas, although Syria in particular appears to have used several types of agents including chlorine. The Chemical Weapons Convention that took effect in 1997 commits most of the world's nations to avoid manufacturing chemical weapons and seeks to regulate potential precursors. However, substances that might be turned into lethal tools of war are so commonplace in modern industry that diversion to illicit purposes is difficult to prevent.

For example, hydrogen cyanide, a blood agent that can also be processed to produce the nerve agent Tabun, is widely used in the manufacture of nylon. Other cyanide compounds are used in the dye and pigments industry. Phosphorous trichloride, a precursor to the nerve agent VX, is used to produce insecticides and lubricants. Phosgene, a choking agent used in World War One, is extensively employed in the manufacture of plastics, pesticides and pharmaceuticals.

According to the Organization for the Prohibition of Chemical Weapons -- created by the 1997 convention -- 32,000 different chemicals are potentially applicable to the manufacture of choking, blister, blood or nerve agents. Controlling those that have no peaceful purpose is a relatively straightforward matter, but the majority are dual-use chemicals produced at commercial sites that might be diverted to destructive ends. Nerve gas, for instance, is lethal in very small doses, so it would not require large stocks of precursors to accomplish catastrophic goals.

Why Control Is So Hard

Chemical and biological weapons are often grouped together with nuclear and radiological threats in U.S. policy, since all are considered weapons of mass destruction. However, the challenges of controlling chemical and biological weapons are very different from those concerning nuclear weapons and fission products. Few nations possess nuclear weapons, which are costly and complex to acquire. Radiological devices are difficult to construct, and their presence can be readily detected.

None of this applies to chemical or biological weapons. Minute quantities of nerve gas or pathogens can cause vast numbers of casualties, and detection is difficult until effects are manifested. The technologies and skills by which each category of weapon is created are widely possessed and spreading steadily. Many of the processes used in fashioning chemical toxins or synthesizing virulent pathogens are dual-use, meaning they have important civil and commercial applications.

As in the case of nuclear weapons, there have been numerous international initiatives to limit the production, stockpiling and use of chemical and biological weapons. Comprehensive treaties banning each type of weapon have been signed by the vast majority of nations -- over 190 in the case of chemical weapons, over 180 in the case of biological weapons -- but those conventions have not stopped rogue states and non-state actors from continuing to pursue the acquisition of banned items.

One distinguishing feature of biological weapons is that because of their transmissibility and mutability, the danger they pose from accidental release is potentially as great as that posed by their deliberate weaponization. There are numerous cases of accidentally released pathogens around the world every year, and the problem will presumably increase as more scientists undertake synthetic biology. The top 100 academic institutions engaged in microbiology are located in 20 countries on five continents.

Chemical plants capable of producing lethal toxins are also common; the Organization for the Prohibition of Chemical Weapons identifies thousands of sites that must be monitored, and there is no guarantee it will detect all diversions of chemicals to nefarious use. Not only are the tools and skills required to fashion chemical or biological weapons spreading, but so are the technologies for delivering then against remote targets. For instance, inexpensive drones are now available in global commerce that could carry toxins or pathogens.

Another feature of chemical and biological agents impeding control is that the kind of tight restrictions on publication of research findings imposed in the nuclear community do not generally prevail in chemistry or biology. In fact, it is customary for laboratory breakthroughs to be published so that other scientists can replicate findings. In January of 2018, Canadian researchers published details of how they synthesized the horsepox virus -- details that could be applied to spawning smallpox, the most lethal pathogen in history (see box).

Although chemistry is generally regarded as a mature field today, the life sciences are continually covering new ground thanks to innovations in synthetic biology. Professional standards and regulatory mechanisms have not kept pace with the scientific progress being made. Many experts believe that the uncontrolled proliferation of new biological tools and training could set the stage for a catastrophic pandemic that kills millions -- either unwittingly or by design.

How Smallpox Could Reappear

Smallpox is the most lethal infectious disease in history. Hundreds of millions have died as a result of smallpox and its complications, and hundreds of millions more have been permanently scarred or disfigured by its ravages. A vaccination to prevent spread of the disease was discovered in 1796, but it was not until 1980 that smallpox was fully eradicated following a global campaign led by the World Health Organization.

Today, the smallpox virus is known to survive at only two repositories, one in Russia and one in the United States. According to Tom Inglesby of the Johns Hopkins Center for Health Security, the disappearance of smallpox from natural environments has resulted in very few people today having resistance to the disease, and vaccinations being in short supply around the world.

Against that backdrop, in January of 2018 researchers from the University of Alberta published findings in an online science journal that could enable rogue scientists to recreate the smallpox virus, and once again let it loose in nature with the goal of accomplishing malevolent ends. The findings explained how the researchers were able to synthesize horsepox virus in a laboratory setting.

Horsepox and smallpox are closely related members of the orthopox family of viruses. Research findings describing how horsepox virus was synthesized could be applied to similar work on the variola virus that causes smallpox. Although it is common practice in the life sciences to publish research findings, there was extensive debate in the scientific community about the advisability of publicizing such sensitive information. In the end the decision was made to publish in an outlet with broad readership.

This is not the only time such a decision has been made. Two studies appeared in 2011 detailing how avian influenza could be genetically altered to allow transmission between mammals. In its naturally occurring form, avian influenza can only spread from birds to humans, but the modifications reported would enable scientists to fashion a form of the influenza transmissible between humans. The mortality rate for people contracting avian influenza is nearly 60%.

That case too led to controversy, but in the end the research was published -- albeit with revisions. Proponents of publication typically argue that revealing such findings will alert the scientific community to potential dangers, and also aid in the development of countermeasures. However, now that skills for performing gene editing have become widespread, the benefits of sharing knowledge must be balanced against the threat that extremists will seek to weaponize the research.

The dual-use nature of work in the life sciences thus presents a challenge to policymakers as the revolution in biology progresses. Thousands of research reports are appearing in open sources disclosing techniques for performing genetic engineering, and dozens of companies are selling genetic material without examining transactions carefully.

There are no generally accepted norms in the scientific community for curbing the disclosure of dangerous research, and few laws governing how genetic materials might be sold or used. So, the eradication of smallpox outside laboratories may only being a passing phase in human history. Someday soon, millions of researchers will understand the mechanics of how to synthesize the variola virus, and some of them undoubtedly will.

Smallpox virus killed hundreds of millions and disfigured millions more before it was eradicated in 1980, but recent scientific breakthroughs enable researchers to recreate the virus in their laboratories.

Under-funded Federal Defenses

U.S. National Security Strategy acknowledges the danger posed by unconventional threats such as chemical and biological attack. In the case of biothreats, for instance, it states "we will strengthen our emergency response and unified coordination systems to rapidly characterize outbreaks, implement public health containment measures to limit the spread of disease, and provide surge medical care -- including life-saving treatments." A network of federal agencies exists to accomplish these ends.

However, the system is fragmented and inadequately funded. A Blue Ribbon Study Panel on Biodefense warned in December 2016 that "our nation remains woefully under-prepared for dangerous biological incidents." The panel faulted the Obama administration for failing to implement most of the remedial steps it recommended. More recently, the Trump administration has downgraded the role of global health security on the National Security Council staff and proposed closing two unique facilities in the chem-bio arena.

The two targeted facilities are the Chemical Security Analysis Center and the National Biodefense Analysis & Countermeasures Center, both of which were established by Congress to serve as national focus points for research on the kinds of threats described in this report. Proposing their elimination implies that coping with chemical and biological threats to the homeland is not a top political priority.

One reason is that responsibilities for preparing and responding are divided among dozens of Executive Branch agencies and Congressional committees, most of which view chemical and biological defense as a "lesser included case" in their areas of responsibility. For instance, the Federal Emergency Management Agency is postured mainly to deal with natural disasters while the Defense Department's Northern Command manages military responses to all forms of attack on the homeland.

There is nothing wrong in principle with assigning multiple functions to the same agency, but in the case of chemical and biological threats, no high-level coordinating mechanism exists to manage a timely and integrated response. For example, research on biosecurity measures is conducted by the Centers for Disease Control, the Defense Advanced Research Projects Agency, and other federal organizations, but these efforts are often directed to divergent ends. There is no whole-of-government oversight of programs.

One particularly critical federal activity is the Public Health Emergency Medical Countermeasures Enterprise managed by the Assistant Secretary of Health and Human Services for Preparedness and Response. That enterprise is the closest thing Washington has to an inter-agency coordinating mechanism for addressing chemical and biological threats. It oversees development and stockpiling of medical countermeasures for over a dozen chemical and biological agents, plus radiological threats. CDC, the National Institutes of Health, and many other agencies participate in its deliberations.

The countermeasures enterprise has done a good job of stocking vaccinations and other therapies for mitigating chem-bio dangers and has put in place a logistics network that prepositions vital supplies to quickly reach victims of an attack. However, the Strategic National Stockpile (as it is called) receives only one hour of federal spending annually and relies heavily on state or local authorities to be distributed.

New Technologies for Chem-Bio Defense

CIA Director John Brennan was undoubtedly correct when he observed in 2016 that the international response to emerging biological threats has not kept pace with the technologies driving the threat. This is less true of chemical threats, but even there, planners need to cope with the operational implications of technologies such as unmanned aerial systems (drones) that did not exist a generation ago.

However, technology is also advancing rapidly in areas relevant to preparing for and responding to chemical and biological challenges. Powerful computational tools, agile software, multispectral sensors and a host of other innovations are available to researchers and first responders if their activities are adequately funded. These tools can be used to detect, diagnose, assess and address potentially catastrophic threats long before their full destructive effects are felt.

For example, the federal government maintains or sustains "biosafety level 4" laboratories in which pathogens and toxins can be studied as a first step in the development of medical countermeasures. These highly secure facilities apply advanced analytic and forensic methods to understanding the most effective responses to specific agents, while simultaneously assuring that those agents do not escape to the outside world where they might wreak the kind of damage the labs are working to prevent.

Although the array of chemical compounds and precursors that might be fashioned into various types of toxins is well understood, there are tens of thousands of potential combinations with unique features and fingerprints. Being able to apply advanced technologies to their analysis in a secure laboratory setting helps at every stage in the defensive process -- predicting risks, detecting threats, assessing response options, applying countermeasures and the like. The nature of the threat may not change much over time, but the tools for addressing it are advancing rapidly.

In the case of biological threats, the danger is changing rapidly on multiple fronts due to the on-going revolution in the life sciences. Because so much of the breakthrough work is being done in synthetic biology, the new technologies that matter most in addressing the threat have to do with analyzing genetic material for potential danger and assessing how that material might manifest effects in a real-world setting. It is now possible to quickly assign risk levels to novel pathogens by analyzing small segments of DNA.

Contracts for the development of software serving precisely that purpose were recently awarded to several teams by a research activity funded through the Director of National Intelligence. Called the Functional Genomic and Computational Assessment of Threats, or Fun-GCAT, this initiative has the potential to generate technology that will prevent dangerous genetic innovations from ever harming humans -- a threat that inevitably accompanies the spread of synthetic biology.

Two generations ago such work would have been impossible, given the state of scientific knowledge. A generation ago, it would have been possible but very expensive. Today it is both feasible and affordable if the nation allocates a reasonable level of funding to maintaining relevant facilities and databases, and makes the mission of biodefense a political priority (see box). Without political recognition of the threat though, no amount of bureaucratic reorganization or technological investment will be sufficient to avert the impending catastrophe.

REBS: How Tech Can Bolster Defense

A concrete example of how recent innovations bolster the ability of defenders to cope with chemical or biological attack is provided by the Resource Effective Bioidentification System, or REBS. REBS was conceived to cost-effectively accomplish the vital first step in defending against a chem-bio threat -- detecting and identifying the bacteria, virus or chemical agents being used.

In the past, this has been a costly, time consuming and often inaccurate process. Suspect agents required complex analysis, and the results frequently were false positives that misled defenders as to the challenges they were facing. Built by Battelle, REBS dramatically simplifies the task of detecting and classifying threats with a single-box solution that costs less than 1% of what traditional approaches cost to apply in the field. All of the key functions are accomplished in a compact architecture that is portable and simple to operate.

Government tests have demonstrated that using REBS, defenders can quickly detect and identify over a hundred pathogens or toxins by analyzing air samples, including all of the tier-one and tier-two biohazards currently recognized by the Centers for Disease Control. This is accomplished by comparing samples with a database of known pathogens and toxins that is continuously updated. Software updates to the database can be loaded rapidly when new threats are found.

Because the REBS technology is fully automated, it does not require costly handling of samples in a laboratory setting. Users can be trained in a few hours, and then easily move the battery-powered system to wherever protection may be needed. The system is ruggedized for rough field conditions and can be deployed in either fixed or mobile mode. A single operator can physically carry the entire REBS ensemble.

Chem-bio defenders have never before had a simple automated system that can rapidly and accurately analyze aerosolized bacteria, viruses and toxins, even when they are used in novel combinations. Testing indicates that REBS produces almost no false alarms, so when danger is detected defenders can quickly move to the next steps in containing a threat, confident that they know what they are dealing with. REBS thus helps to overcome the most important obstacle to timely response in a chem-bio event -- the difficulty of determining precisely what challenge defenders are facing.

The system can continuously monitor threat areas for signs of an attack, quickly alerting defenders to the specific nature and location of a problem. REBS will work equally well in assuring that dangerous agents do not accidentally escape civil or commercial sites.

Battelle's REBS technology is just one of many recent innovations that potentially can be applied to enhancing the effectiveness of federal, state and local authorities against chem-bio threats. Others include systems to thwart aerial droes that might dispense such threats and systems to provide rapid detection for food safety.

Chemical and biological dangers are manageable even in a world where threats are proliferating rapidly, so long as promising systems are adequately funded. In this as in so many other areas, innovation is America's most effective answer to impending danger.

A first responder uses the Resource Effective Bioidentification System (REBS) in a field exercise. Detecting and classifying dangerous pathogens or toxins is the vital first step in containing chem-bio threats. New technology such as REBS simplifies and accelerates that process so that countermeasures can be applied in a timely fashion.

Conclusion: What Washington Must Do

The threat of chemical or biological attack on the American homeland is growing. Despite international efforts to ban both types of weapons, the knowledge needed to create novel pathogens and toxins is spreading, and emerging technologies readily available in global commerce put these weapons of mass destruction within reach of even poorly resourced extremists. New methods of delivery such as inexpensive drones exacerbate the danger.

The danger is particularly acute in the case of biological threats. A revolution in the life sciences has spawned low-cost, highly reliable tools for synthesizing microorganisms in rudimentary laboratories. Terrorists and other actors bent on destruction can use these tools to create bacteria or viruses with the potential to kill millions.

Numerous studies have warned that Washington is not adequately prepared for what may lie ahead. The problem is not lack of expertise -- the U.S. government probably has more experts engaged in thinking about cutting-edge chemistry and biology than any other entity in the world. The problem is lack of leadership at the top, combined with a failure to provide sufficient funding for efforts most closely related to the threat.

This deficiency is not the fault of the Trump administration. Previous administrations failed to prepare adequately for chemical or biological attack on the homeland, mainly for one reason: a major attack has never happened. With so many other dangers confronting the nation, it is not surprising chem-bio has been neglected. But warning signs of an impending catastrophe have now increased to a point where more focused action is required.

The Trump administration has acknowledged in its National Security Strategy that these signs are particularly worrisome in the area of biological innovation. It therefore needs to strengthen mechanisms for preventing the uncontrolled proliferation of technologies and pathogens that might lead to global pandemics. That presumably means increasing the authority of the Department of Homeland Security in coordinating preparedness efforts scattered across the government.

Within the department, greater funding needs to be allocated to research and response efforts that could mitigate the effects of a chem-bio attack. DHS has in place a good framework for responding to threats and developing treatments as new pathogens and toxins appear, but it is under-funded. The department in particular needs to rethink efforts to shut down the National Biodefense Analysis and Countermeasures Center, and the counterpart center that addresses chemical threats.

Congress has a crucial role to play in promoting chem-bio readiness, in part because any effective response to an attack will require close coordination between the federal government and authorities at the state or local level. The National Guard is already engaged in the chem-bio challenge but needs greater funding for the mission. Within Congress itself, the committee system would benefit from a reorganization of responsibilities for chemical and biological oversight that would make one committee the lead for all chem-bio preparations.

A few hours of additional federal spending each year would resolve most of the shortfalls in chem-bio awareness and preparedness. The cost of failing to prepare, though, could be nearly incalculable. Biological threats in particular could be the greatest security challenge that America faces in the years ahead.