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Subcommittee on Emerging Threats and Capabilities

COMMITTEE ON
ARMED SERVICES

UNITED STATES SENATE

HEARING TO RECEIVE TESTIMONY ON
BIOLOGICAL THREATS TO U.S. NATIONAL SECURITY

Wednesday, November 20, 2019

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U.S. Senate
Subcommittee on Emerging
Threats and Capabilities
Committee on Armed Services
Washington, D.C.

The subcommittee met, pursuant to notice, at 3:04 p.m. in Room SR-222, Russell Senate Office Building, Hon. Joni Ernst, chairman of the subcommittee, presiding.

Subcommittee Members Present: Senators Ernst [presiding], Fischer, Cramer, Blackburn, Hawley, Peters, Shaheen, Hirono, and Heinrich.

OPENING STATEMENT OF HON. JONI ERNST, U.S. SENATOR FROM IOWA

Senator Ernst: Good afternoon, everyone. I want to thank you all for joining us today.

The Emerging Threats and Capabilities Subcommittee meets today to receive testimony from Dr. Julie Gerberding, Co-Chair of the Center for Strategic and International Studies' Commission on Strengthening America's Health Security; Dr. Thomas V. Inglesby, Director at the Center for Health Security at Johns Hopkins Bloomberg School of Public Health; and Dr. Tara J. O'Toole, Senior Fellow and Executive Vice President at In-Q-Tel.

Our focus today will be to gain a deeper understand of the nature and severity of biological threats to our national security, as well as the preparedness of the U.S. to defend against and respond to these threats.

I thank our witnesses for being with us today.

The 2018 National Biodefense Strategy identified biological threats, whether naturally occurring, accidental, or deliberate in origin, as among the most serious threats facing the United States and the international community and capable of causing catastrophic harm to the United States.

Despite the severity of this threat, I note that a recent report by the Center for Strategic and International Studies' Commission on Strengthening America's Health

Security states that the United States remains woefully ill-prepared to respond to global health security threats. I find this deeply concerning, given the potential devastation of a biological event, and look to our witnesses to provide their candid assessment of the U.S. posture and programs focused on dealing with this challenge.

Of particular interest is the role of the Department of Defense in providing sufficient biodefense both abroad and at home. DOD has had many biosecurity successes such as securing laboratories in allied countries, providing surveillance of especially dangerous pathogens, and developing lifesaving vaccines for our warfighters. And while this subcommittee is principally focused on the Department of Defense's role in countering the threat, this does not stop at a vaccine. It requires constant research, investment, and planning across federal, State, and local governments.

While advancements in biotech research and development have provided innovative solutions for treating disease, developing alternative fuels, and promoting food security, they have also generated new security risks. For example, gene editing technology, new targeting methods, and vaccine-resistant disease could all be used for nefarious purposes by state and non-state actors alike.

Another particular area of concern for me in my home

State of Iowa is the potential impact of a biological incident in the agricultural sector. A biological attack targeting specific types of crops or livestock could be devastating to Iowa farmers and have a severely negative impact on the Iowa economy. Such an event would not only impact Iowans. Indeed, folks across the country would potentially feel the effects of food shortages, and the American economy as a whole would suffer if our agricultural industry was to be the target of such an attack.

Again, I thank our distinguished witnesses for being with us, and I look forward to their testimony.

And I will now turn it over to our ranking member, Senator Peters, for his opening statement.

STATEMENT OF HON. GARY PETERS, U.S. SENATOR FROM MICHIGAN

Senator Peters: Well, thank you, Chairman Ernst for holding this very important hearing here today.

And I want to thank each of our witnesses for taking time to come before us and present your thoughts, as well as answer our questions.

There is no question that the threats that we face in the area of biosecurity are vast, they are complex and evolving. Adversarial nation states still retain the capability to produce biological weapons in spite of the Biological Weapons Convention. And now even non-state terrorist groups like ISIS can recruit technically trained scientists to weaponize pathogens as instruments of terror.

We are in the midst of a technological revolution in gene editing with CRISPR, which will give scientists an unprecedented ability to modify the genetic code.

Finally, we must safeguard against threats to our agriculture and food supply, such as the African swine fever that is spreading at a very rapid pace through Asia and Europe.

In recent years, Congress has worked to address these serious threats. The 2017 National Defense Authorization Act required the President to develop a comprehensive biosecurity to recognize the spectrum of threats that we

face from natural occurring outbreak of Ebola to its use by ISIS.

Published in October of 2018, the strategy is the first acknowledgement of the continuum of threats that we now face. Dangerous pathogens know no international borders, and a public health biosecurity incident is just as dangerous as an attack by a bioweapon.

More importantly, the strategy coordinates efforts across the Federal Government to better detect and prevent and, if necessary, respond to a biothreat.

While we have made significant progress in the area, we still face a number of gaps in our country's biological defenses. The bipartisan Commission on Biodefense identified numerous recommendations to strengthen those defenses and protect our country from the vast array of biological threats.

The Department of Defense plays a key role in supporting the biosecurity strategy, and I look forward to exploring the Department's contribution and hearing today about how we can improve those efforts.

So once again, thank you for your testimony here today. I look forward to it a great deal.

Senator Ernst: And now we will go ahead, and we will do our witness testimony. Dr. Inglesby, if you would go ahead and start. We will have about 5 minutes for your

statement. Thank you.

STATEMENT OF DR. THOMAS V. INGLESBY, DIRECTOR, CENTER FOR HEALTH SECURITY, JOHNS HOPKINS BLOOMBERG SCHOOL OF PUBLIC HEALTH

Dr. Inglesby: Thank you. chairman Ernst, Ranking Member Peters, and members of the committee, thank you for the chance to speak with you today.

My name is Tom Inglesby. I am the Director of the Center for Health Security at Johns Hopkins and a professor of public health and medicine at Johns Hopkins University.

The country faces a range of biological threats that could emerge without warning, whether from nature, deliberate attack, or accident. These threats could include a global pandemic of avian influenza, lethal emerging infectious diseases spreading from person to person, bioweapons threats like smallpox or anthrax, or newly engineered biological threats. Epidemics could be caused by accidents from labs working with viruses like smallpox or SARS or MERS, which are no longer circulating in the world, or from research aimed at creating novel potential pandemic strains of pathogens. The country also faces the potential for deadly large-scale animal outbreaks or plant epidemics that kill important crops.

In major human epidemics, there would likely be an urgent need for medicines and vaccines and ventilators, possible pressure to close borders, and the potential for

hospitals to collapse under pressure. There could be serious impact on national security and to the Department of Defense with risks to health and life in the force and their families, a surge in need for medical supplies, big challenges to deployments, interruptions to logistics lines, and economic shocks, and other disruptions to the country.

The 2018 National Biodefense Strategy sets national priorities for addressing this range of biological threats, and this is forward progress. But now the challenge will be implementation across the government. I have described a few of DOD's important biodefense programs in written testimony. A few brief words about them here.

The Joint Program Executive Office for Chem Bio Preparedness works to accelerate the development of new medical countermeasures. DARPA's Bio Technologies Office runs programs seeking disruptive change in biotechnology, including new ways to manufacture critical molecules and building safety into the work of biological science. And the Biological Threat Reduction program is helping build safe, secure labs in parts of the world where new outbreaks could emerge with efforts in 29 countries. I think all of these programs should be supported.

Here are my other recommendations to you. The DOD, together with HHS BARDA should substantially increase efforts aimed at accelerating vaccine and medicine

development for new threats. This will require strong programs in government working in close partnership with biopharma.

DOD planning assumptions for pandemics should anticipate great disruption to decision-making and operations. The recent Clade X and Event 201 exercises showed how pandemics could affect national decision-making around travel and trade, the use of medical and scientific assets overseas, troop deployments, civil liberties around quarantine, and the national and international allocation of scarce supplies of vaccine.

The U.S. Government should reestablish a biological threat assessment process, which used to be in place. It should include not only a focus on bioterrorism, but on state programs as well, as well as the possibility of omnicidal or apocalyptic groups seeking biological weapons.

The U.S. Government should plan for the possibility of global catastrophic biological risks. These are events that could lead to sudden widespread disaster beyond the capability of national governments and the private sector to control with potential for great loss of life and disruption of governments, economies, and global security.

I would urge you to strongly support the Biological Weapons Convention. It is a critical international norm against the development and use of biological weapons.

We should strengthen the U.S. agricultural biodefense planning and programs. The USDA has made substantial progress in recent years around strengthening its programs, but there are priorities that should be addressed, including stronger crop surveillance, animal wildlife surveillance, more support for animal vaccine development, and more funding for ag biodefense overall.

We should increase planning with the private sector on biothreat initiatives. The private sector is the maker of vaccines and medicines and diagnostics. It is also the key driver in maintaining travel and trade in major epidemics and in supply chain management, communication channels, and many more essential missions.

And finally, we should focus on strengthening the U.S. bioeconomy, which underlies a lot of this. And that includes medicines and vaccines, food production, energy production, and industrial processes. The success of the bioeconomy is important to national security just as in the way that U.S. manufacturing in Silicon Valley have been to U.S. have been to U.S. national security as well.

So in conclusion, there are a range of serious biological threats facing the country. It is critical that DOD continue to invest in and prepare for biological threats, particularly high consequence threats, even catastrophic ones, that could have major national security

implications.

Thank you.

[The prepared statement of Dr. Inglesby follows:]

Senator Ernst: Thank you, Dr. Inglesby.

Dr. Gerberding, please.

STATEMENT OF DR. JULIE L. GERBERDING, CO-CHAIR, COMMISSION ON STRENGTHENING AMERICA'S HEALTH SECURITY, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

Dr. Gerberding: Good afternoon and thank you. Chairwoman Ernst, Ranking Member Peters, and all of the staff of the subcommittee, thank you for paying attention to this really important national issue.

I am pleased to discuss with the subcommittee the recommendations of a report from the Center for Strategic and International Studies Commission on Strengthening America's Health Security. The full report was released today, and it is entitled "Ending the Cycle of Crisis and Complacency."

I co-chair this commission with former Senator Kelly Ayotte. Members of Congress who serve as commissioners include Senators Murray and Young and Representatives Bera, Brooks, Cole, and Eshoo. We also are served by several biosecurity experts from around the country, and their commission work is still ongoing.

We began our work with an indisputable premise, and that is that biological threats, whether from natural, intentional, or accidental causes, are occurring more often and have the potential to cause unprecedented harm to Americans and to people around the world.

The world we live in now is amazingly insecure,

violent, and disordered, and it is exactly in these circumstances that these biologic threats emerge and spread. And all we have to do is look at the DRC situation with Ebola to understand the complexity and the opportunity for emergence.

Not only is our disordered world more conducive to the emergence of biothreats, but we are also, of course, increasingly connected and interdependent. Globalization, international trade and travel all mean that an outbreak in one part of the world can very quickly be a threat to us here in the U.S. In other words, a threat anywhere is a threat everywhere.

In that context, health security threats truly are national security threats, and that brings them right into the domain of the subcommittee.

Unfortunately, despite the fact that policymakers know to invest in threats when they emerge, all too often the recognition occurs only after a health crisis strikes. And I certainly experienced exactly that in my government tenure with the anthrax, SARS, West Nile, avian influenza outbreaks. And my successors at CDC have experienced the same thing with an influenza pandemic, MERS, Ebola, Zika, and so forth.

When biothreats are recognized, policymakers do allocate emergency resources, but critical time, sometimes

weeks to months, pass before these resources are available, and in that time, lives are lost.

Once the crisis fades and public attention subsides, urgency morphs into complacency, investments dry up, attentions shift, and a false sense of security takes hold.

So the commission asserts that the U.S. Government has to end this cycle of crisis and then complacency. And we need to replace it with a doctrine that can guarantee continuous prevention, protection, and resilience.

In that spirit, we commend the release of the National Biodefense Strategy last fall and the Global Health Security Strategy this year. These do provide a solid foundation, but we need action.

So what the commission has presented in its report today is an agenda for specific actions that the Congress might undertake to try and strengthen our ability to be prepared and respond to health security threats.

I do not have time to go into all of these. They are outlined in the summary report. But we do have a couple that we wanted to highlight because we think they would be especially germane to the subcommittee.

First and foremost, we think it is important that we clarify what leadership at the National Security Council is accountable for the overall government engagement in health security threats. Right now, it is unclear who would be in

charge. Strong, coherent leadership at the National Security Council is essential to guaranteeing effective oversight long before crises emerge.

We also recommend actions to augment the important role that the Department of Defense plays in health security. One important area is DTRA, and we believe that DTRA should have extended authority to operate in all continents where health security threats exist.

Furthermore, the support for the military's infectious disease research laboratories should be strengthened. During my tenure, I had the opportunity I think to visit all of the Navy and Army laboratories around the world, and I saw firsthand how critical they were in the front line of influenza preparedness, but also the broad investment in developing and researching other infections diseases that are not necessarily studied by other agencies or for which countermeasures would not be developed at all. I think these laboratories are a national treasure, a critical front line of our global surveillance and response, and we must continue to support them.

The last point I would like to comment on is the importance of our ability to rapidly respond to emerging threats and mitigate harm to affected people. The contingency fund levels for CDC and USAID should be increased and sustained. In addition, we should establish a

U.S. global health crisis response corps, which is based on existing CDC and USAID capabilities, but to have this team with the trained and exercised ability to deployed and work with local partners in health crisis settings, even when those settings are insecure.

So in summary, the commission urges Congress to invest in biothreat reduction as the national security imperative. We believe the long-term costs of strategic protection and prevention are but a tiny fraction of the astronomic costs of episodic and too often chaotic responses to emerging crises. These smart investments would draw support from all.

Thank you for the opportunity to testify. It is really my hope that we can end this cycle of crisis and complacency, and I request that the CSIS report on Ending the Cycle of Crisis and Complacency be submitted for the record. Thank you.

[The prepared statement of Dr. Gerberding follows:]

Senator Ernst: Without objection.

[The information follows:]

[SUBCOMMITTEE INSERT]

Senator Ernst: Dr. O'Toole, thank you.

STATEMENT OF DR. TARA J. O'TOOLE, SENIOR FELLOW AND EXECUTIVE VICE PRESIDENT, IN-Q-TEL

Dr. O'Toole: Thank you, Madam Chairman, ranking member, for the invitation to talk about this very important and --

Senator Ernst: Do you have your mic on?

Dr. O'Toole: Thank you for having me here today and for holding this hearing on this very important, complex, and I think relatively neglected topic.

As my two eminent colleagues have described, these biothreats are various, and all of them are quite terrifying. But I would like to suggest a hierarchy of biothreats that is a little different.

First of all, we do live in an age of epidemics, and this is not going to change. It is a consequence of trade and travel patterns and the rise of urbanization in situations where people live in conditions of poor sanitation, nutrition, et cetera.

Secondly, we have the deliberate bio-attack threats. And bioweapons have been with us a long time, but because of the revolution in biology that is going on, we have the capacity to make new, more powerful bioweapons that could evade all of our capacity to diagnose them and to treat them. And it is very unlikely, given the difficulty of gathering intel on these programs, that we will have advance

tactical knowledge of what weapon we might be facing or even where it might come from because I think, as the ranking member said, more and more people are going to have access to this technology as it becomes a foundational technology of the 21st century economy.

The third threat and in my mind in some ways worse than the first two is that we will fail to win the economic competition for the biorevolution. And there is no question that we are in a geopolitical competition to wield these new technologies which I believe are going to undergird much of the 21st century economy. And I want to spend most of my time talking about that.

We are in the situation today with regard to bioweapons and the threat of bioterror because of the advances that have been made in the life sciences in the past 40 years and the convergence of those advances in biology and biotechnology with digitalization.

What we now understand is that biology is programmable. Life runs on code. It is not 1's and 0's. It is nucleic acids that make up the code, but we are beginning -- we are past beginning. We are now able to read, write, and edit that code. And our ability to do so is improving exponentially, faster than Moore's Law.

This is going to be phenomenally beneficial. It is going to impact multiple different industries, not just

biomed, not just agriculture. And that is because one of the industries that are rising is that of synthetic biology. Organisms are becoming programmable manufacturing systems, and we are already using organisms to make flavors, fragrances, new fabrics, materials with totally previously unknown properties, et cetera. Biology is likely to become the fundamental manufacturing platform of the future.

We in the United States are the innovation engine of this new technology, and it is really several families of technologies. But China has said repeatedly and very forcefully -- and they are backing up their words with actions -- that they intend to own the biorevolution. And they are building the infrastructure, the talent pipeline, the regulatory system, and the financial system they need to do that. And that is before we even talk about the secrets and the information and the intellectual property they are stealing from us, which is a small trickle of the contributions that they are building for their own economy.

They have good reasons to go after the biorevolution. They have a huge population. They have the highest incidence of cancer on earth. Their population is aging. They are going to need to deal with challenges like Alzheimer’s, just as we are, and they have to find an affordable way to deliver health care to their rising middle class.

But I do want to note that the United States has not done a good job at translating biology into products. Most of this is happening -- our translational infrastructure for biology is mostly coming from small startup companies in the private sector, which is where In-Q-Tel does its business. Those are the innovation engines for biology and much else.

And we need to think about how we would build a more robust infrastructure particularly to manage epidemics, whether they are deliberate or natural. So, for example, we need to have the capacity to, once an epidemic is noted, immediately create diagnostics that could be used like pregnancy tests by the people themselves to determine who is sick and who is not. That would be strategically invaluable in managing the epidemic. We need to be able, as Dr. Inglesby suggested, to rapidly develop a new vaccine in response to an epidemic. We are within reach of technologies that can do that. We need to get much more ambitious as a country in how we are going to prepare for bioattacks and for natural epidemics. But we also need to tend to building infrastructure for securing and promoting the bioeconomy.

Thank you.

[The prepared statement of Dr. O'Toole follows:]

Senator Ernst: Thank you, Dr. O'Toole. And thank you to our witnesses.

We will begin with 5-minute sessions of questioning, and I will go ahead and reserve my time after we get done with our first round here. So I will go ahead and allow Ranking Member Peters to start with questions.

Senator Peters: Thank you, Madam Chair.

Actually I want to pick up on some of the comments you made, Dr. O'Toole. This question will be for the panel to expand on this.

The U.S.-China Economic and Security Review Commission recently released its annual report to Congress, and in that report, the commission highlighted that following the 2001 anthrax attacks, the U.S. was reliant on a single foreign source of the active ingredient, doxycycline, which the U.S. sought to treat possible greater exposure to anthrax.

In another capacity, I am the ranking member of the Homeland Security Committee, and we are actually in the process right now of drafting a report on our reliance on foreign pharmaceuticals in this country as a national security issue that we need to think about and the fact that in many cases it is 100 percent or 80 percent of critical drugs are manufactured off the shore of the United States.

It is my understanding that China is currently the world’s largest producer of active pharmaceutical

ingredients, known as APIs, which we rely on to make drugs, including those that would treat a biological weapon attack or a pandemic, as you mentioned, Dr. O'Toole.

So my question to the panel is, to what extent is the U.S. reliant on foreign services for key drug products and medical supplies such as syringes and needles and other critical medical supplies that we would need to respond to a biological attack today? What is your assessment of that? Dr. O'Toole, if you want to start.

Dr. O'Toole: We are critically dependent on China for a lot of drugs, and we have been shipping our manufacturing capacity to Asia for over a decade now. There is not a CEO of a major pharma company who has not been recruited by China to build facilities there.

You know, biology is not part of the DNA of the national security community in this country. We have not been paying attention to biology as a national security asset or as a possible threat, and that has to change.

The fragility of our supply chain in terms of drugs is a real problem. I would say that we have begun exploring the possibility of using synthetic biology to make these active pharmaceutical ingredients, at least some of them, which I think deserves serious consideration. If there were a natural pandemic in which the entire world needed drugs, I am sure China, as we would, is going to take care of their

own people first. We do not have the surge capacity we need even to produce enough of a very common, well used medicine like doxycycline in time to deal with an epidemic.

It was also said after H1N1 that if we actually had been able to vaccinate the entire population of the United States with the flu vaccine that we eventually got against H1N1, though it was late for the epidemic, it would have taken 4 years' worth of needles to do that. I mean, we have very insecure supply chains for some of the most critical elements of what would be required medically.

Senator Peters: Thank you.

Any other panelists like to join in, please?

Dr. Gerberding: I will just add that I think our medical supply chain is vulnerable even under everyday circumstances. So, of course, in the context of a global health threat, we would be severely challenged for not just countermeasures but for all kinds of medical products.

One area that particularly concerns me is the area of antibiotics because we know we are facing antimicrobial drug resistance on an accelerating scale. CDC just published its update last week outlining the severity of that threat, and we do not have a robust supply of antibiotics today.

One of the ways that we do invest to support that potential situation is through the Strategic National Stockpile, which is a very important U.S. asset, and I think

it needs to be reexamined in light of the now known realities of market failures and the shortages of the durable goods that we are going to need for any significant threat.

Senator Peters: I think it is important when you said we have some challenges right now because we see drug shortages across the board of many drugs that are simply not available, and it forces practitioners to move to a different drug that tends to be a whole lot more expensive, but it may not be any more effective clinically. Antibiotics as well. I understand we have critical shortages in antibiotics today without a biological crisis. You can imagine under a biological crisis, it would be catastrophic. So it is something that we should be focusing on immediately.

Dr. Inglesby, would you like to add?

Dr. Inglesby: Yes. I would just add that I completely agree with what you have just been saying, and I do think that we treat medicines too much like commodities that can be sourced for the lowest price somewhere in the world. But if we think about medicines we would need in a crisis when every part of the world would be looking for them at the same time, there should be at least a strategic examination of the kinds of things that we must have, and we should consider how we could bring some of those medicines back to

the U.S. Obviously, that cannot be done for all medicines. We are a very connected world, but there are some products that are important enough for national security, for public health crisis that we should be thinking about making them here.

Senator Peters: Thank you.

Senator Ernst: Senator Hawley?

Senator Hawley: Thank you, Madam Chair.

Dr. O'Toole, let me come back to something you said just a moment ago, that China wants to own the biorevolution I think you said. What steps do you see China taking to succeed in that endeavor?

Dr. O'Toole: China has created for itself a -- first of all, they have a very detailed 5-year plan, and biotechnology is in that plan in many different ways.

First of all, their goal is to make biotechnology 5 percent of their GDP by 2020. They have changed regulations for their own FDA to be more like ours so that they can more easily market to the world. They have created a talent pipeline that incentivizes their own students to go into the life sciences and to bioengineering. They have at least 20 different programs, according to the House Oversight Committee, intended to bring scientific talent from the rest of the world, mostly the United States, back to China using very attractive incentives to bring even very senior

American scientists back to do research in China.

As I said, they have enticed a lot of pharma companies both using incentives, as well as doing a lot of, I will call it, confiscation of IP once they are over and operating in China.

They have changed their financial regulations to benefit Chinese biotech companies.

They have also -- and this is, I think, important to understand because they have such a long-term well thought-out plan. They are building infrastructure in the form of whole universities, incubators, bio-office parks, primate research facilities, high containment labs very deliberately in order to give themselves the capability of basically being the major biopharma power of the world. But they are not just aiming at biopharma.

So we did an examination of their capabilities in synthetic biology. If you map synthetic biology and the different pieces of science and technology that you need to do this to make organisms into manufacturing plants, you will see that the United States is all over the map. We have all kinds of creative companies who are working in all aspects of synthetic biology. If you compare that to China, what they are doing is building from the bottom up, from the fundamental infrastructure up to the more creative parts, and they are doing it at scale. We have nothing like this.

And this is something that I know DOD is getting interested in at this point. We ought to encourage that. We ought to take on synthetic biology as a national security priority in view.

Senator Hawley: What other defensive measures would you suggest? Or maybe “defensive” is the wrong word. Maybe “proactive” is better. But what measures from a policy perspective would you suggest and recommend that this country take in order to not only prevent China from owning the biorevolution but making sure that we do, for lack of a better expression?

Dr. O'Toole: Well, this has been called the Sputnik moment in terms of the biorevolution. And what we did back then worked pretty well. I think taking a look at the National Defense Education Act and really revving up science and technology education in this country -- I would love to do it pre-kindergarten through whatever. But I think we need talent fast. So I would look at incentives to encourage young people to go into biology and biotech, but I would also look at how we get them into government because government really needs more technical expertise than it has easy access to right now. These people have a lot of options in terms of jobs. So that is where I would start, is the talent pipeline.

I also would consider making one of the national labs

responsible for advancing some of these foundational biotechnologies, particularly the analytical part, the big data part of biology, so that we can strengthen the foundational technologies of genomics, and AI applied to biology is going to be a very big deal. And I could go on, but I do not want to take the whole hearing.

Senator Hawley: That is very helpful. Thank you very much.

Thank you, Madam Chair.

Senator Ernst: Yes. Thank you.

And this is a very helpful discussion today. I really do appreciate it.

I know there are a number of other committees that might have jurisdiction over these types of topics, whether it is USDA, whether it is Homeland Security. Here in the Senate Armed Services Committee, we have not had a hearing on this topic for 20 years. So, yes, pretty shocking. It is time. It is time to do this. So, again, thank you for doing that.

And the reason I get very excited about this and so interested in it is the fact that every time I do meet with different ag commodity groups, in particular our Iowa pork producers, when I am back in Iowa, one of the key concerns that they have is actually how do we secure and protect our livestock against biological threats.

And so my question to all of you is, with agriculture being such a significant part of not only our Iowa economy, but also the American heartland, how significant of a threat is there, and what can we do to mitigate that?

Dr. Gerberding: I will start by just acknowledging that mother nature is a really good terrorist. China today is experiencing a dreadful outbreak of swine fever that has probably the caused the death or culling of at least 50 percent of their entire population of pork, which is the major source of protein for people in China. So this is a major socioeconomic threat to the stability of the state of China today, and that is mother nature.

So to my knowledge, every state that has engaged in offensive weapons development has also looked not just at human terrorism or human biologic, but also animal and agricultural biologic capabilities. And we have to assume that that is still an ongoing issue in state-based efforts, not to mention what might be cooked up in the garage of a terrorist somewhere along the way. These are easy things to do. We have very little surveillance and very little capacity in most of the vulnerable places in the world to do anything about it. So I think it is a huge and unrecognized, under-mitigated threat.

Senator Ernst: Thank you.

Yes, Dr. Inglesby.

Dr. Inglesby: Yes. I completely agree with Dr. Gerberding. I would say that the first alarming statistic is that we spend probably about 100 times less on agricultural threats than we do on human threats. I think there are many reasons for this, but one of them includes a kind of a reluctance in the U.S. Government to talk about this threat until quite recently. I think if you go back 5 years or 10 years in the interagency discussions around bioterrorism, USDA was not a strong player because USDA has a mission of promoting the food industry, and I think people felt at the time that that was kind of giving mixed messages and concerns and fears. I think that has changed, and I have been impressed with how USDA has been stepping out and really kind of being a serious player in the interagency around the national biodefense strategy development. I think programs are stronger than they were.

But still they are small compared to the size of U.S. agriculture, the crops and the herds and the animals around the country. And as Dr. Gerberding said, there are many natural threats that in terms of terrorism, simply moving a natural threat from one place in the world with some simple sample transfer into U.S. herds or crops would be relatively straightforward to do. There is a long list of diseases both for animals and for crops that could cause a terrible impact in our country.

And so, in general, I think there needs to be greater emphasis, greater funding for this problem. There is not an integrated risk assessment list for USDA. There are programs that focus on different diseases, but we could raise the entire enterprise by having a more organized list of what the biggest problems are: a stronger national veterinary stockpile, better surveillance programs for crops and wildlife. There are a number of concrete things that can be done, but building on recent successes in USDA -- I think they are showing that they can really step up their programs, but they just need the support of the Congress.

Senator Ernst: Yes. Dr. O'Toole, do you have a comment?

Dr. O'Toole: I agree this is a big threat. The same forces that are driving natural epidemics are driving epidemics among animals. And what is happening with African swine fever moving around the world is certainly going to happen again and again.

What we need to do is the same. We really, really, as a matter of national security, need to get better at managing epidemics. We keep making the same mistakes again and again and again. And the technologies to change this either exist or are within reach. So for animals, we need rapid, cheap, easily manufactured pen-side diagnostics, as they are called, to figure out if pig A is sick and pig is

not, as opposed to killing all the pigs within a certain radius of an animal who is diseased. We can get those kinds of options if we are willing to invest in them.

In agriculture, one of the advantages is you have a commercial push for these kinds of technologies if the U.S. were to lead some of the basic research that you do not have as easily in human outbreaks where the opportunity costs for the drug companies are so wildly out of sync that they are not going to develop new antibiotics, et cetera, as we have seen. But we can do a much better job at managing animal disease then we are doing now.

Senator Ernst: So my message back to Iowa is we can get there. We just need to step it up. Is that right?

Dr. Inglesby: Yes.

Senator Ernst: Okay. Thank you very much.

Ranking Member Peters?

Senator Peters: Thank you, Madam Chair.

I think I will continue the line of thought by Chairman Ernst, protecting the agricultural industry. Michigan is also a big agricultural State, in fact, the second most diverse agricultural State next to California, with all sorts of crops. And as ranking on Homeland Security, we just -- I authored a bill to increase our agricultural inspectors at the border, which is critically important to protect that industry, as well as public health. We are

understaffed when it comes to agricultural inspectors. We will hopefully change that if the House acts on the bill that we just passed out of the Senate. Not only human inspectors but probably the most sophisticated tool you can use, which are canine teams. Sophisticated noses of dogs is pretty amazing as to what they can pick as things are crossing the border.

So my question is -- and especially, Dr. Inglesby, you are talking about how we need to do more -- I will get the assessment of the panel. What sort of coordination is going on between USDA, the Department of Defense, the CBP, or Homeland Security folks? We have to be able to identify where some of these outbreaks are around the world, alert folks here who are on the border protecting us. We have got to have a real coordinated system. What is your assessment of how coordinated that is? And do we need to do a lot more, and what would be your advice? Whoever would like to start. I would love to have all your thoughts.

Dr. O'Toole: Well, I will start.

I spent 5 years in Homeland Security. People do try to coordinate, but they do not have the tools they need to make this a very reassuring process.

Without the technology -- dogs are great. Love dogs, have one. It is really hard to --

Senator Peters: We need more than dogs you are saying.

[Laughter.]

Dr. O'Toole: We really need more than dogs.

Senator Peters: But they are great.

Dr. O'Toole: They are good for some things. It is very difficult to quantitate how good they are or whether the dog is having a bad day. So they are great as a first line of defense. They are not very reassuring as the line of defense.

But CBP, for example -- if you go to a port and you see what CBP is faced with day after day in terms of trying to figure out whether exotic pests are coming in, a big threat to agriculture, for example, they actually disassemble trucks, loaded trucks, and go through them box by box, packing straw by packing straw to find bugs and then compare them to the charts on the wall, what bug is this. We need more technology to do this more effectively. That is all there is to it.

So I think people are trying to coordinate amongst the agencies. I do not think they have the tools that they want. I agree with Dr. Inglesby. Agriculture has been late to the table. They need a much bigger research budget. I do not think you can do much about that from this committee. But again, we are under-investing in these areas in terms of R&D and the translational science that has to come out of it. These things now are in the arena of national security.

Senator Peters: Does anybody else want to add?

Dr. Inglesby: Yes. I would just add just a couple of sentences.

I would say one very encouraging thing was when the National Biodefense Strategy was getting developed in the lead up to 2018 fall, there were four agencies that were co-conspirators or co-leads on the effort, and USDA was one of them, alongside DHS, HHS, and the Department of Defense. That was surprising to many people in the field because USDA had been kind invisible before. So that was a sign of them really being either pulled or stepping up into the interagency. They are part of an integrated lab network that looks at CBRN threats alongside HHS and EPA laboratories. So there is some kind of interaction there. They definitely do engage internationally with the Food and Agriculture Organization, which is the big organization around food safety in the world. So I think there is some interaction, but I completely agree with Dr. O'Toole that they are on the rise, but they are still kind of starting from a lower position in terms of research and budget.

Dr. Gerberding: I would just add a very small but important perspective, and that is the vast majority of the new or reemerging infectious diseases that are being evolved naturally are zoonotic diseases, meaning they arise from animals. And so the criticality of the integration between

USDA and the CDC for infectious disease surveillance and adding into that the EPA because some of these diseases also involve the ecosystem -- we really need a one-health approach to understanding emergence. And again, the technologies are sorely lacking because there is not an investment in that kind of not just interagency but interdisciplinary research and tech translation.

Senator Peters: It is clear we need a whole-of-government approach here, and we are far from actually doing that now. So I think that is certainly a big takeaway from that exchange from you, which I appreciate.

I was just at the Detroit Metropolitan Airport seeing a demonstration of those dogs and others.

But the one thing that was particularly concerning to me is the amount of actual biological material and viruses and others that are coming across. The people who are researchers -- they are bringing all sorts of agents in, which they should not. In fact, I understand half of all the biological material that is stopped at the border is at Detroit Metropolitan Airport. And I said is it because it is Detroit or because you are really good at it. The answer was probably a little bit of both. But it is concerning as to what are we not stopping. For whatever we stop, I am sure there is a lot that is getting through, which is why this is so critical that we put that together.

If I may, I am a little over time, Madam Chair. If I may just ask another question.

Dr. Gerberding, you mentioned the study, the Cycle of Crisis and Complacency. And in your testimony here today as well, your oral testimony, you talked about where pandemics are occurring or where they start -- the outbreaks are occurring around the world -- they are usually places of great disorder, a lot of things happening there. The security issues are incredibly challenging where they come from. The Ebola outbreak in Congo is an example of that occurring in a place with regional conflict.

In 2014, in the Ebola outbreak, the United States was able to deploy upwards of three -- a real massive, kind of a heavy lift of folks to help deal with that situation. 3,000 combat engineers, mobile hospitals, and marshaled a combined team of medical professionals from the Army, the Navy, the Public Health Service. Actually the Michigan National Guard was engaged in Liberia, our partnership state there. We had a number of our guards people there that forward deployed as well.

So my question to you is to what extent do you think the DOD, when responding to these issues, really has to be doing more than just providing medical services? They are going actually have to stabilize a region. That is a broader mission than we normally think about when we are

dealing with a potential outbreak of a pandemic, and yet the consequences of not containing that pandemic can be catastrophic. How do we square all that, and how should we think about deploying DOD assets in these kinds of emergencies?

Dr. Gerberding: I think it is a very complicated set of issues. In the case that you cited in Liberia, our military was welcomed into the environment, and the mission there was primarily logistics, building infrastructure to support the relief efforts that were ongoing, hospitals, infrastructure, et cetera. And our Department of Defense is accustomed to providing that kind of humanitarian logistic support in all sorts of natural disasters, et cetera.

But we were not there to provide security. And generally, we would like to think that the UN security forces or the local governments would have that responsibility, but as we have seen in the DRC, that is not always the case nor is it always successful. So I think that challenges the role of the Defense Department in providing the security when the threat in one region could extend to be much broader or a threat to the United States. So I think that is an area where we need a lot of strategic policy work on an ongoing basis.

The other side of the coin and part of the reason why the commission report recommends the development of this

ready corps is because we need to bring a certain kind of technical expertise, which is not the military's forte, but the surveillance, the epidemiology, the tech transfer, the diagnostics, et cetera, et cetera, that we need deployable troops who are trained to be able to go in and instigate those capabilities in environments that are not intrinsically secure. And we do not have that capability right now. That is why it has been so challenging for the CDC, for example, to be in the DRC because we do not have the security context and we do not really have that kind of deployable, well trained, well exercised unit to serve in that sort of environment. It is an unmet need and one that I hope we would really put a higher priority on addressing going forward.

Senator Peters: Thank you.

Dr. Inglesby: I would maybe just add a comment.

Senator Peters: Yes, please.

Dr. Inglesby: In the West Africa Ebola response in 2014-2015, in my view and I think the view of many, it really was a threshold moment when the President decided that the Department of Defense would become fully engaged in the operations around response. DOD did not send doctors and nurses, but they sent heavy lift. They sent their ship. They started building things. They already had laboratories there that were working on diagnostics. And so that was a

real threshold moment.

And I think in the aftermath of that, as people have reviewed the DOD experience in West Africa, there still is a tension within the Department of Defense about the extent to which the Department of Defense should be involved in foreign operations around infectious disease crises. In my view, they are indispensable in terms of operations. If you really want something to be done by the U.S. Government, DOD has by far the most operational capacity, and there are going to be moments to do that. But I understand that in DOD leadership in the command leadership, that there is reluctance to have doctors and nurses, in particular, involved because of the way that it will affect overall operations.

So I think it is an open issue. I would urge the DOD to be involved in those kinds of operations, but I do not believe it is resolved within the strategy.

And the second thing I would say, just to echo Dr. Gerberding, is that in the current DRC Ebola response, the CDC has been indispensable in the last 20 Ebola responses since Ebola was discovered. In this response, they were held back by the U.S. Government for safety and security reasons because we had no way for the U.S. Government to determine that there was no safe way to have them in the field for a long period of time. That is beginning to

change.

But it does show that we will need in the future, since more and more outbreaks are happening in disordered, broken places in the world where things could spiral, get a foothold and then create chaos in the region -- we are going to need, as Dr. Gerberding said, ways to operate in unsafe environments, ways to have our scientists and experts and public health officials be in places where outbreaks are out of control even if they are unsafe. So I do think it is an important issue that we have not really resolved.

Senator Peters: And probably new specialized units that are specifically trained for that.

Dr. Inglesby: Yes. Units that are part of that that are on the DOD side, units on the CDC side, scientific side. I think they will need to be able to work together in ways we have not sorted out.

Senator Peters: Thank you.

Dr. O'Toole: May I comment on that?

Senator Peters: Yes.

Dr. O'Toole: I am all for training the special units, but I think the situation on the ground is going to outrun even the U.S. Government’s ability to take care of it unless we have better technologies. We are much better off trying to figure out how we could make vaccines on demand and then distributing those than we are sending thousands of members

of the armed services just to quell disorder. We have to get a strategic approach to epidemics that has got to look very different from what we are doing now. And I think technology is the way through. Because of the biorevolution, there are possibilities out there that we could make good on if we invested in them.

Senator Ernst: Thank you, Dr. O'Toole.

I want to continue on a little bit with some of that technology. You had mentioned that the integration of artificial intelligence is important in staying ahead of various biothreats. And so if we can just discuss that briefly, I think that would be very helpful for me. Can you elaborate on how this type of technology would impact both the potential offensive and defensive applications with respect to biotech?

Dr. O'Toole: So artificial intelligence of different kinds, machine learning, deep neural networks, and so forth, is already being used, for example, in drug discovery to hasten drug discovery. It is being used in medical imaging and in digital health in many different ways. But it is going to have, I think, the greatest near-term impact in biology on these foundational technologies, on genomics and synthetic biology in particular.

If you think of genomics as you are trying read a code of a single genome -- and today we are trying to understand

what a particular gene does by comparing it to many genomes and trying to figure out this person is sick because that gene there is missing, to take a simple case. In that case, the bigger your library, the more genomes you have sequenced and put into a library that keeps things accurate and easy to access, you are advantaged. What AI is going to do is not only make it faster to sequence genomes, but they will be done so more accurately. Google has already done this and shown one way to do it, mostly using machine vision.

What you then want to know is you want to understand how to read and write the genome once it is sequenced. And what AI allows you to do is intelligently go through all of these multitudinous possibilities much faster and more accurately. And then you can iterate on it.

So it is going to improve sequencing. It is going to improve DNA synthesis, and it is going to improve DNA editing. And there are already basic science experiments going on in all those fields.

China, for example, has of course a philosophy that the state and the private sector are one and the same. The military and the private sector are one and the same. And they have combined their big Internet giants, Alibaba, Tencent, and so forth with their biotech companies. So Alibaba is investing in biotech. Tencent is helping BGI, Beijing Genomics, Inc., with their sequencing problems. And

they have recognized and are industrializing this combination of AI and biotech. It is mostly going to be beneficial. It is going to help us get new medicines faster. It is going to help us understand toxicity earlier. It is going to create whole new realms of products that we have not imagined yet. But they, as I said, are institutionalizing it. We are experimenting with it.

Senator Ernst: I appreciate that. And again, we need to step up in this area and find those solutions.

So your estimation -- and I am drawing from that that there is a lot of work that we need to do. But how well postured is the Department of Defense in leveraging AI in a biodefense strategy?

Dr. O'Toole: I do not think they have thought about it yet.

Senator Ernst: I would probably agree with that assessment.

Anybody else care to comment on that?

[No response.]

Senator Ernst: And, Dr. Gerberding, if we could go back a little bit. We were just talking about the collaboration between different governmental agencies. And the Health Security Commission report released today by CSIS recommends restoring health security leadership at the White House National Security Council. And when was this position

established? And then why was it eliminated?

Dr. Gerberding: So in my experience in the context of some of the most difficult and threatening infectious disease outbreaks, inevitably someone is pulled to be the czar of the occasion for that particular situation. But in 2016, the White House did appoint a senior White House official reporting through the National Security Council to be responsible for a directorate that was charged with the preparedness and response to biologic threats. That directorate was established. It began its work, and then in 2017 it was disbanded. So I do not know why it was disbanded. I think there were lots of changes. The administration changed and so forth. But I think the mentality often has been that these are important during a crisis, but the need for them dissipates once the acuity of the crisis has subsided.

Senator Ernst: But the recommendation would be that it needs to be a consistent, stable position within the National Security Council.

Dr. Gerberding: It has been an essential role for cross-government collaboration in every single infectious disease situation I have ever observed.

Senator Ernst: And do you believe then having that position in place, that person would be able to assist maybe in orchestrating the breakdown of various silos that exist

between agencies?

Dr. Gerberding: That would be a primary function, and that applies both to the planning and strategy that we have been talking about is missing across a number of our agencies, but also in the actual operations and in the aftermath. So it is a continuous cycle, and it needs that constant strategic, iterative improvement over long arcs of time.

Senator Ernst: Okay. We are going to go ahead. Senator Peters will have just a couple more questions.

Senator Peters: Thank you, Madam Chairman.

Dr. Gerberding, this was in your report as well. As you know, the Department has used the Cooperative Threat Reduction program, which is also known as the Nunn-Lugar program, for the past 20 years to help us reduce some of the danger of biothreats in the United States. The program started out in the former Soviet Union to secure bioweapons stockpiles in their program, but we have continued to use that program. And your study specifically calls out this program as something that should be protected and sustained. Dr. Inglesby, I know you were involved in that as well.

So my question to you is what should the CTR program focus on in the future with respect to securing biological threats that could harm the United States in your estimation. If both of you could answer that and, Dr.

O'Toole, if you want to jump in too.

Dr. Gerberding: Yes. I will start.

I had an introduction to this capability a number of years ago when there was an outbreak of plague in one of the countries that was formerly a part of the USSR. So the question was, the plague that we were observing in animals was actually a sign that there was some offensive weapon development and deploying going on, and that resulted in an investigation comparing biologic fingerprints and so on and so forth. So it revealed to me how important this effort was to provide resources and support for scientists to redeploy their technical capabilities in constructive directions and so forth. And since that time, this has come up in a number of other areas of the world.

So my own opinion is this is an extremely important methodology for repurposing scientific know-how and acumen, but also harnessing that expertise in ways that truly can hopefully transition into more constructive biotechnology solutions. So I see it as a high priority for continuation, and I would look forward to Tom’s view because I know we have had this conversation before.

Dr. Inglesby: Yes. I also think it is quite a valuable program, and I think it is a place in the government that helps other labs and research facilities in the world develop biosafety practices and biosecurity

practices that increase the chance that pathogens will stay safe in their refrigerators and not walk out with people or not be susceptible to theft or diversion.

I think they also do a lot of important training programs to try and train trainers in different parts of the world. I know that CTR BTRP, the bioprogram in CTR, recently had a training program in North Africa which trained biosafety and biosecurity leaders from a variety of North African countries in the context of violent extremist organizations trying to kind of think about the overlap between terrorism and potential diversion of samples. And I think that is the kind of thing that they do very well. I think they are in nearly 30 countries, 29 countries in the world, and are doing things that other parts of the government are not doing.

They also are trying to help build surveillance systems. That is obviously not their only -- I mean, there are many other agencies, especially CDC that does a lot of very critical disease surveillance. I think with their relationships that they have established in laboratories, they can be helpful to that larger mission.

Senator Peters: Dr. O'Toole, my last question to you, just to pick up on what you were you talking about with the advances in synthetic biology and CRISPR, all these new technologies that are going to change the world

dramatically. It is an exciting time to live, but it is also a scary time to live at the same time.

My question to you is that whenever you are dealing with advanced research in biology, it can often raise a whole host of moral and ethical issues that need to be addressed. And given the value system that we have in this country, we want to adhere to that at every step possible. However, other countries may have a different set of moral and ethical principles. How do you see those different principles in terms of biological research? How do you think about that? Is that a concern for you? As a committee, how should we be thinking about countries that are not going to be constrained in the same way we are likely to be constrained in this country when it comes to biomedical research?

Dr. O'Toole: This is an area of profound questions that I think have to be approached very carefully and very seriously. We will be disadvantaged compared to China in some areas of biology, stem cells for example, because they are moving forward faster than we are. In the end, they may make more mistakes and we may get to the happy place sooner. As a physician, I believe very strongly in doing everything we can to avoid doing harm. Science is very empirical. Sometimes you make mistakes and you have to pull back and think again. So I think this is going to be a knotty

problem that deserves very sustained, high-level attention.

When we started the human genome project in this country, we built in the funding for the project money to pay for research in ethics. And I would recommend that we do the same thing again for synthetic biology, for gene engineering, and so forth. What it did was it laid the groundwork for a national dialogue, which I think was extremely constructive. And all of the anxiety and true fear that popped up when we first started doing recombinant DNA back in the 1970s has proved not to have led to a terrible tragedy I think partly because we moved very thoughtfully forward. We have to create the foundation and the infrastructure for doing that again for these sciences.

I would say about China, though, that they are in a terrible place vis-a-vis the health of their population. The reason they are moving forward so aggressively is that they are desperate for progress. And when you look at the opinions of the Chinese people, they are much more acceptable of risk than I think Americans are in this realm. They are very interested in new technologies that they think could help cure disease, change birth defects, et cetera, et cetera. So I do not read the gene-edited baby episode as China being negligent so much as I think it is a more nuanced view of that particular situation is warranted on our part. They have terrible problems that they are trying

to fix, and that is part of their appetite for risk.

Senator Peters: Thank you.

Dr. Inglesby?

Dr. Inglesby: Yes. I would just certainly agree. I would just add that the U.S. has had the opportunity to set standards in the world around science for a generation, and often when the U.S., especially in the world of science, the NIH, in partnership with other agencies, has taken positions or the recombinant DNA conference back in the 1970s which helped set standards for how to manage recombinant DNA science -- I think those things do have a chance of taking hold elsewhere in the world. So the more that we can kind of promulgate and seek partnerships around this, I think it is real. I think it can help.

I am particularly worried about a very small realm of science, which has emerged in the last few years, which is science intending to create very pathogenic strains of pathogens. I think we have not taken the position we took in other kinds of technologies like gene editing or recombinant DNA science. We have actually gone in the other direction. We have been, I think, way in front of our headlights, and other countries are observing how we are operating and how we are funding that science. So I think there are things that we could do in our own governance of science which would be, I think, a little bit more

responsible. But generally speaking, I think the U.S. is able to help set some standards that other people pay attention to.

I know China, just to speak about China -- there was a meeting this summer where a number of Chinese scientists came over to talk about the gene-edited baby experience. I think there are many leading scientists in China who were shocked and appalled about how that all happened. I think they certainly have to think about their disease risks in their population, but they are also worried about how scientists kind of got out in front of their scientific establishment. So I do not think it is a homogenous national reaction to gene editing. I think there are proponents of it, and there are people who are worried about it as well, even in China.

Senator Peters: Thank you. I appreciate it.

Senator Ernst: And I am going to wrap up the hearing with just a quick question, and all of you can participate in this. In your view -- I am going to give you the big four that we have. Near peer adversaries -- but what is the current estimate of biological warfare capabilities? So, for example, the range of delivery, extent of biological weapons available, amount of biological weapons, so on and so forth. Low, moderate, or high for North Korea. What would your assessment be of North Korea and their biological

capabilities? It is a fun little exercise. Very enlightening.

Dr. O'Toole: I think every country in the world has the capability of delivering a devastating biological weapon, North Korea included. I think they are probably more intent on it. It is very difficult to collect intel out of North Korea. There are indications that they have a BW program. And beyond that, we would have to be in a classified space.

Senator Ernst: Absolutely.

Dr. Gerberding: I would just say it behooves us to assume they do, whether we have evidence to back that up or not. I think it is more likely than not.

But I would also just like to say one more time the best terrorist of all is mother nature.

Senator Ernst: Yes, Dr. O'Toole.

Dr. O'Toole: So that gets said a lot, and I think it is no longer true. I think we have to understand that the capacity to build new, very powerful, very, for want of a better word, sneaky biological weapons has been unleashed, and it is widely accessible. And we have got to start thinking about this in a national security context.

Senator Ernst: Can we say that is probably true then of North Korea, Russia, China, Iran?

Dr. O'Toole: Yes.

Senator Ernst: Dr. Inglesby?

Dr. Inglesby: I agree that any country with any kind of industrial capability, any kind of basic science program, which is almost all countries on the planet, if they chose to make biological weapons, they would succeed. There are not any technical barriers that would prevent a country from doing that.

I think what is really useful at the moment is that we have a Biological Weapons Convention, which creates a very, very strong taboo against it, an international pariah status if you are caught making biological weapons. It is not a perfect treaty, and there are obviously countries that have cheated on it. But it is a helpful norm given that any country could certainly step up and develop and use biological weapons if they chose.

Senator Ernst: Very good.

And on that happy note, I think we will go ahead and wrap up this hearing this afternoon. And I do appreciate the input that has come from our panel of experts in this topic. And it underscores the fact that we as the United States Government, as DOD, also need to truly step up what we are doing on biological warfare preparedness, as well as making sure that we are breaking down those silos that exist between DOD and maybe all of the other agencies that are working in these areas as well.

And with that, I want to thank you once again for joining us today.

And this will conclude our Emerging Threats and Capabilities hearing.

[Whereupon, at 4:17 p.m., the hearing was adjourned.]

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