Testimony

of

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on

Fighting Bioterrorism: Using America's Scientists and Entrepreneurs to Find Solutions

Before the Subcommittee on Science, Technology, and Space
of the Senate Commerce, Science, and Transportation Committee

February 5, 2002

Senator Wyden and Distinguished Members of the Subcommittee:

Good morning and thank you for this opportunity to appear before you and discuss the work of the Virginia Bioinformatics Institute (VBI). The resources of the Institute and, university research in general, provide powerful tools and assets to combat bioterrorist threats.

The Role of Academe and Research

The federal government has a long, rich tradition of funding research in our nation's colleges and universities. For the past 50 years, federal funding has provided continuous support to develop the fundamental science and technology that pushed disciplines, such as genomics and bioinformatics, to new frontiers. Federal support began, in large part, as a result of the significant role that scientists played in winning World War II. Our accrued knowledge from decades of research support already serves new objectives brought about by events that began on September 11.

Since 9/11, the need for increased scientific and engineering knowledge has become abundantly clear. Every discussion—whether about airline safety, failure of communication links, contamination of food and water supplies, bioengineered weapons, and countless other concerns—depends on our nation's scientific and engineering knowledge and expertise. In times such as these, we are acutely cognizant of living in a society defined by, and dependent on, science and technology.

Once again, the experience, research, and measured debate conducted by academe can bring both historical context and analytical order to elucidate public discussion and public policy, and marshal technologies and tools needed to mitigate the threat of bioterrorism. As OSTP Director John

Marburger III said in his keynote remarks before AAAS last December, "Harnessing the nation's collective S&T expertise is critical for long-term success in the war on terrorism." VBI's interdisciplinary approach—marrying bioinformatics, biology, information technologies, and mathematical modeling—is positioned to play a pivotal role.

Threats of Infectious Disease and Biological Weapons

It is generally agreed that 21st century biotechnology and bioinformatics herald a new era for science and engineering, promising healthier and longer lives and further advances against infectious diseases. But like a double-edged sword, technologies with the potential to control disease might also be used to develop an arsenal of bioterrorist weapons.

We are also aware that new antibiotic-resistant pathogen strains sometimes evolve faster than we develop new therapies. For instance, the resurgence of tuberculosis in the United States in the early 1990s was associated with the emergence of a multi-drug resistant tuberculosis strain. Many other diseases currently overwhelm our preventative and therapeutic measures—HIV, Ebola, West Nile virus, and malaria—just to name a few. Infectious disease concerns are global in scope. In today's world of rapid travel and large migrant populations—diseases of humans, livestock, and crops, regardless of introduction mode (intentional or accidental)—pose a growing threat to our health, agriculture, and economy.

Impacts on Human Health

Even before the anthrax attacks that followed September 11, many public health and national security officials voiced their concern over the potential threat of biological weapons. In the March 25, 1999 Senate Public Health and Safety Subcommittee meeting, the American Society for Microbiology warned that: "National security measures against biological warfare must include building up the nation's public health infrastructure to respond to bioterrorism." The Dark Winter scenario reinforced this position by illustrating the catastrophic potential of smallpox if used as a weapon. It underscored the need to inform the comprehensive medical and healthcare community about the symptoms, behavior, and virulence of known pathogens if millions are to have any chance of survival. Early identification and intervention are pivotal to both control and abatement.

For each of the biological weapons considered by experts to be the most serious threats to America — anthrax, botulism, plague, smallpox, and tularemia — modern medicine has some effective means of responding, whether by vaccination, antibiotic, or antitoxin. To inhibit the spread of a biological attack or a "normal" disease outbreak in humans, livestock, or crops, we must have rapid diagnostic tools, a public health system to track disease as it evolves, and epidemiological data to determine the origin. Fundamental research and expertise provided by universities will be essential to complete these tasks. It will provide the foundation to deliver the tools with which we will prevent, detect, protect, and treat victims of biological terrorist attacks.

Impacts on Agricultural Productivity

We have already experienced direct threats to human life through bioterrorism using infectious disease, but what about indirect threats? Though we must certainly take precautions against human diseases, we must also consider indirect threats on our food and water supplies. We now know, for instance, that Al Qaeda plotted out landmarks and public water supplies of most major American cities. We also know that many countries considered to be epicenters of terrorist activity have experimented extensively with agro-terrorism. For example, Iraq was developing wheat cover smut as a weapon in the late 80s, most likely to use against Iran.

A single agricultural terrorist could launch a pathogen that, spread by wind, water, or soil, could cause an irremediable chain reaction. The food supply and industries involved directly in food production and distribution are especially vulnerable. The agriculture sector accounts for roughly one sixth of the total US Gross Domestic Product. A terrorist wishing to cause severe and reverberating financial consequences could simply introduce a foreign disease into American livestock or crops that would set off a chain reaction touching virtually every segment of this nation's economy.

Larry Madden of Ohio State University perhaps captured it best when he said, "It would be a continuing, recurring problem, like a permanent bomb going off." The recent UK foot-and-mouth disease debacle is a case in point. Nearly four million (3,915,000) animals were slaughtered. The UK cattle industry was still reeling from the approximately $6 billion of lost agricultural revenue from the mad cow disease outbreak starting in 1996. This estimate does not include the billions in revenue lost by the tourism industry. Many farmers, their livelihoods destroyed by the disease, committed suicide. As in other parts of the world, we are ill-prepared to cope with an epidemic, whether a biological weapon, an accidentally introduced exotic pathogen, or a naturally mutated pathogen. In this country, we have little experience dealing with epidemics of any proportion.

If an indirect agricultural bioterrorist strike does occur, we must also be cautious when deploying emergency personnel. An attack might be used as a feint to divert resources from critical command posts, leaving them vulnerable. For instance, a major livestock disease outbreak in Texas would shift our primary command and control emphasis there, as well as large numbers of military personnel. This would leave cities like New York, Washington D.C., and Fort Knox open to assault. We must be prepared to ensure that no potential targets are at risk.

Role of Virginia Bioinformatics Institute and Partners

To handle such a scenario, a common place where molecular data about pathogens, their host's responses, and computational analysis tools come together and are made available to all stakeholders is paramount. At VBI, our recent efforts to create a comprehensive pathogen information system parallel national necessity. We recognized—prior to 9/11—the need for a common language to assess biological threats; avoid information, research, and analysis duplication; and facilitate interagency cooperation and coordination.

At the numerous and diversified agencies playing a role in national biological security, the underlying scientific research to support detection, identification, forensic attribution, risk assessment, and mitigation is very similar. However, this fundamental science is conducted in a slightly different context or syntax in over 40 federal and state agencies, at multiple colleges and universities, in several non-profit organizations, and throughout industry. Thus, an interface and infrastructure to connect and organize the molecular biological databases in these various sectors is critical. This "science portal," or comprehensive pathogen information system, will be able to draw on already available resources to completely characterize known pathogens and their near relatives. This comprehensive and easily accessible system will serve as a fundamental knowledge and decision-making tool.

VBI will provide genetic sequencing of pathogens as needed, but our primary mission is to create a single bioinformatics interface to access the already available information required for a comprehensive surveillance program. We integrate, and provide when necessary, molecular information regarding pathogens, their hosts, and their interactions within the environment. Our goal is to create a common language that can be understood by all accessors. To reiterate, we are not a comprehensive storehouse of information, but we are like a tour guide and translator who can also exchange currency.

With access to such a system, researchers, public health workers, and security officials could quickly assess threats and options for mitigation. Platforms for detection and identification of pathogens are ultimately dependent upon distinctions between pathogenic and non-pathogenic organisms and the distinctions of one pathogen from another. Therefore, bioinformatic interpretations of disease-host-environment interactions are crucial in finding solutions.

Although we have comprehensive bioinformatics capabilities in-house, the completion of the information pipeline—from basic research, to data interpretation, to useable information, to knowledge, to applications and technologies—requires a strengthened partnership between government, academe, and industry. We realize that connectivity is a critical first-link in our endeavor. Therefore, we are drawing upon diverse research expertise that is only available through partnerships. VBI will actively promote inclusion; there can be no prima donna in a system that will act as a common asset serving such a crucial national need.

As a case in point, our biological resources are IT integrated and we rely on partnerships with both IBM and SUN Microsystems. We have already established partnerships with industry that will ensure the necessary technology for translating and routing information and making it accessible. In addition, since we are not a medical research facility, we have recently established a partnership with Johns Hopkins Bloomberg School of Public Health to study many major infectious diseases, including AIDS, malaria, measles, and tuberculosis. In the malaria study, for example, Johns Hopkins researchers—working in collaboration with local health officials where malaria outbreaks occur—will provide the needed field data to integrate in our pathogen database.

Along with our partnerships to fight human infectious diseases, VBI is in a unique position to help defend against agro-terrorism. As part of Virginia Tech, a land-grant university, we are among the top five agricultural research universities in the country. We have already identified a list of high-priority livestock and crop pathogens, which would form another contingent of our pathogen science portal.

Using bioinformatics as a tool, we can integrate genomic and other databases with information on pathogens that will allow for rapid detection, attribution, and mitigation. VBI's primary role will be to integrate the molecular (genomic, metabolomic, proteomic) and toxicological signatures for pathogens and host responses. Overlaid field data records will be geospatially accurate to identify the origin of each strain, primarily through additional partnerships with users of Geographic Information Systems (GIS). At present, some molecular data exists but it is often incomplete, insufficient, or in formats that need to be translated. As these data are brought together, they will be translated, completed where necessary in-house, and integrated. This will enable work on threat assessment, pathogen detection, attribution, medications, vaccines, and disease prevention. We will create a common source of fundamental scientific information that has been fragmented to date. Integration on this new level will promote proaction rather than reaction.

Science as Prediction and Protection

VBI can serve as the "integrating hub" of knowledge among government, law enforcement, healthcare professionals, and local communities nationwide. We can become an information nexus for identification of pathogens, their origin, and their signatures. In addition, our outreach mission could be expanded to serve as an educational arm for first responders, i.e., law enforcement, doctors, community officials, to biological crises. Intensive two-day sessions could be developed to familiarize first responders with identifying data. Knowing symptoms and the most effective antidotes in times of outbreak—including isolation, vaccination, and treatment—can help prevent panic and save lives. Preparation is paramount in these cases, as is reaction time. In the post-September 11 era, university researchers should not only teach and expand the frontiers of knowledge, but also serve the public by providing an understanding of the science and engineering that affects their lives. Director of the National Science Foundation, Dr. Rita Colwell, recently called this, "science as patriotism." It is time to further extend this capacity.

Today, science is our common path to generate new knowledge or to solve an existing problem. With bioterrorist threats especially, the preferred solution is always prevention. However, it is impossible to prevent what we do not fully understand.

In all research scenarios we are trained to ask questions and hypothesize. This "scientific method" is also an important tool for what many specialists call the prediction/prevention approach. Although scientific knowledge is the most powerful force for knowledge-based prediction, the research community needs to become increasingly proactive in that direction. With the advent of serious bioterrorist threats, prediction/prevention is critical.

For many years, defense specialists have used a technique called scenario-building to anticipate and plan for even the most unlikely circumstances. The most successful results are achieved by bringing together thinkers and doers from diverse perspectives–everything from philosophers to practitioners. Anticipating "what if" situations leads to mechanisms for an event to "not occur" or, at a minimum, to have a carefully crafted response plan if it occurs.

Once a pathogen is released into the environment—whether the postal service, a ventilation system, our water supply, or any number of other scenarios—it is extremely hard to combat and isolate. With advances in sensors, many researchers and entrepreneurs could collaborate in scenario-building sessions and in developing sensor-based alarm or warning systems. No one need remind the Senators whose offices are in the Hart Senate Office Building of this need.

The VBI integrating hub can play an important part in both the identification/remediation of bioterrorism as well as the anticipation/prevention of a bioterror fall-out. We can pinpoint a pathogen and describe its known qualities so that remediation can be swift and pathogen-specific. We can be partners in scenario building to anticipate or forewarn about biological incidents and help in suggesting and developing mechanisms for prevention and protection.

Paradox of Publicly Available Information

I realize that as we discuss science and technology fixes, solutions, or preventions today, we are also talking about an issue of societal ideals and the public's will.

Let me add at this time what I believe is an important overarching understanding on these issues. Alexander Hamilton expressed the opinion that "to be more safe, [people] at length become willing to be less free." This is not an idle concern for the most democratic nation in existence today.

We must recognize that if information is publicly available, it is by definition available to would- be terrorists. If requests for proposals are publicly solicited, then the description of the project and the solution sought will give both well- and ill-intentioned applicants vital information. For terrorists, open information is like a window on someone else's thinking.

For example, after the 1993 World Trade Center attacks took place, some hearings and investigations were open to the public. The informative descriptions of the Towers' structure provided key information for the September 11 terrorists.

History provides other lessons. In the 1950s, physicists were pivotal. They possessed the primary knowledge to create new weapons of mass destruction. However, these experts needed sophisticated facilities to carry out their work. In contrast, biological weapons can be manufactured in relatively simple facilities by a single individual. To detect and destroy bioterrorist facilities, new tactics will be needed.

We understand that public access to useful knowledge may arm a potential enemy. Limiting accessibility to scientific information may be the only blockade we possess. At the same time, science thrives on open discourse. Measures that inhibit dialogue will impede progress. We cannot limit scientific interaction without limiting scientific progress. This presents a conundrum.

It would be naïve, however, to not anticipate problems with access and build in safeguards. Once again, collaboration among government, industry, and academe will be essential as we make access decisions regarding science and technology that will ensure both scientific progress and national security. We all agree the whole world has benefited from science, engineering, and technology conducted in our public institutions.

Summary

We have been gathered today to contemplate collaborations among the various sectors of our society and, in particular, the vital role university research can play. This pattern of integration will also be translated into a peacetime counterpart which will not merely familiarize our armed services with the progress made in science and industry, but also draw into our planning for national security all the civilian resources that can contribute to the defense of our country.

At VBI, we are developing a flexible, collaborative infrastructure applicable in times of peace. Broad connectivity will allow access to a comprehensive knowledge source that will be key to tackling a host of complex problems: human, animal, and plant disease; environmental degradation; and economic recession.

In summary, the federal government has provided continuous support to our nation's universities. Academe has much to offer this partnership in terms of knowledge, research, and resources. University experts should be engaged in shaping public policy on the critical issues pertaining to biological weapons. Virginia Bioinformatics Institute, one such example, will provide a unique and centralized source for data compilation to help understand, mitigate, and control infectious disease pathogens, whether intentionally or accidentally introduced. This "scientific portal" will integrate underlying scientific research, genomic and other molecular data, and epidemiological information to support agencies addressing biological threats to humans, livestock, and crops. To accomplish this task, VBI has forged, and will continue to promote, crucial partnerships among universities, industry, and government agencies. Partnership among the three will be vital as we balance the access of scientific information to protect our country but not hinder the scientific engine. Access to information by the scientific community will be critical as we develop strategies to prevent biological attacks—the ideal solution.