

A conversation with Dr. Philip Russell on December 16, 2013

Participants

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Note: These notes were compiled by GiveWell and give an overview of the points made by Dr. Russell in the conversation.

Summary

Dr. Russell has served as a senior advisor at the Office of the Assistant Secretary for Public Health Emergency Preparedness at the US Department of Health and Human Services and as commander of the U.S. Army Medical Research and Development Command (USAMRDC).

GiveWell spoke to Dr. Russell as part of its investigation of biosecurity as a charitable cause. Conversation topics included the threats posed by different classes of pathogens, the government's management of biosecurity, and the role of philanthropists and academics in improving biosecurity.

Defending against natural pathogens

Smallpox

The US government knows the location of most of the smallpox virus stored around the world. When Dr. Russell worked at the US Department of Health and Human Services (HHS), he oversaw the rebuilding of the US smallpox vaccine stockpile. The government has stockpiled enough smallpox vaccine to contain almost any attack with smallpox virus or accidental escape of the virus. However, if smallpox were deployed as a powdered aerosol, the vaccine stockpile might not be enough to contain the attack.

The government is currently stockpiling a new modified vaccinia virus Ankara (MVA) smallpox vaccine to allow for the vaccination of immunocompromised people. However, the vaccine is extremely expensive, and it requires a waiting period between the first and second doses, which makes it ill-suited to outbreak control, so it is unclear how it could be useful in practice.

There is little else that the US can do to prepare against smallpox, and there is little international interest in creating a global stockpile.

Pathogens weaponized during the Cold War

Some pathogens, such as the smallpox variola virus (a respiratory virus), and anthrax spores, are naturally stable enough to survive being made into bioweapons. Before artificial stabilization techniques were developed, bacteria such as tularemia died soon after being aerosolized, preventing them from being made into highly dangerous weapons.

In the late 1960s, the bioweapons programs of the US and USSR discovered that they could stabilize many pathogens and proteins by freeze-drying them with certain sugars and amino acids. The US and USSR used stabilized pathogens and proteins to produce a number of dangerous weapons. These included dried powdered aerosols of tularemia and of staphylococcal enterotoxin B (SEB), a bacterial toxin. Tularemia is not transmissible between humans, but it is 1,000-2,000 times more infectious than anthrax. It is treatable with conventional antibiotics following exposure to low doses but progresses quickly following high dose infection. During the Cold War, the US demonstrated its ability to put a lethal dose of the bacterium over about 30,000 square miles. SEB can easily be made in large quantities, acts very quickly, and is fatal in high doses.

HHS would rely on antibiotics to protect the public against a tularemia attack, but antibiotics are unlikely to be sufficient to prevent serious harm from a large-scale high dose attack. The Department of Defense (DoD) has tried without success to develop a vaccine for tularemia. Although HHS and DoD claim to have planned comprehensive countermeasures against tularemia and SEB attacks, the agencies have not planned carefully enough for a possible strategic attack from a small group of terrorists. Dr. Russell is more worried about such an attack than he is about any other threat to biosecurity. HHS and DoD should devote more resources to protecting against tularemia and SEB. Specifically, they should develop a treatment for SEB poisoning.

Biomanufacturing has continued to improve dramatically since the 1960s. Contemporary biomanufacturing and bioprocessing, including spray drying and stabilization techniques, enable small groups of people working outside of formal laboratories to have bioweapons manufacturing capabilities more sophisticated than the US and USSR had during the Cold War. Advances in biomanufacturing and bioprocessing have been reported in the scientific literature, so potential attackers can learn about these techniques.

Compared to current risks from synthetic biology, advanced biomanufacturing and bioprocessing present a greater threat.

Emerging pathogens

Emerging natural pathogens are a smaller threat overall than pathogens that are already widely known, but they still present a significant biosecurity risk. Novel influenza viruses are a serious threat. There will likely be influenza epidemics in the future. Influenza strain H7N9, an avian flu that was found in humans for the first time in 2013, could conceivably cause a global catastrophe if it became readily transmissible between humans.

The US government has spent a large amount of money to help create a multi-billion-dollar influenza vaccine industry. All major pharmaceutical companies except Merck make influenza vaccines. The pharmaceutical industry is prepared to develop and manufacture vaccines to treat the next influenza epidemic. The industry stands to earn millions of dollars from an epidemic, so it has a profit motive to remain prepared to respond to epidemics. Given the industry's response capacity, we are in a good position to respond to an epidemic.

There is little room for more funding to buy greater capacity to respond to influenza with conventional vaccines. The need to show that influenza vaccines are safe and effective limits how quickly they can be developed. New technologies can shorten the vaccine development process, but new vaccines still have to be shown to be safe and effective before they can be used.

Additional federal funding could productively support development of vaccines that cross-protect against many strains of influenza or research into more effective influenza vaccines. Current influenza vaccines are not very effective in the elderly and only about 60-70% protective in younger populations.

Synthetic pathogens

DoD and HHS are very concerned about synthetic pathogens. In reality, however, the threat posed by synthetic pathogens is relatively limited for now and for the foreseeable future. Currently, the main danger posed by biotechnology is the creation of antibiotic-resistant bacteria.

It is difficult to see the strategic rationale for a terrorist or other group to release a highly virulent transmissible pathogen such as a pandemic influenza. Damage to less developed countries including family and friends likely to be far greater than damage to the US

Additionally, it is very difficult to make pathogens more virulent and transmissible. Natural selection has already optimized pathogens for reproductive success, so there is little room for humans to further modify them in order to make them more dangerous. The influenza virus is relatively simple and is one of the best-studied viruses, but researchers still have limited insight into what makes the virus virulent and transmissible. Bacteria are more complex than viruses, so it is likely even more difficult to engineer them to make them more dangerous. Finally, it is difficult to test whether genetic modifications make pathogens more dangerous. Small animals are used as models of human infection, but a pathogen may behave very differently in humans than in animal models. Without the ability to easily test the effects of genetic modifications, it is harder to engineer pathogens to make them more dangerous.

There may also be a natural tradeoff between virulence and transmissibility. Russian researchers inserted an interleukin 4 gene into a pox virus, making it so virulent that a vaccine could not protect against it. However, the insertion caused the virus to lose its transmissibility. In nature, similar tradeoffs frequently occur.

Researchers have little specific knowledge about how to protect against the threat posed by synthetic pathogens. It does not make sense to invest in mitigating this threat until it is better understood.

Government management of biosecurity

The White House has no senior official who deeply understands biosecurity and who can coordinate the biosecurity efforts of different government agencies. Senior officials at HHS and DoD exercise weak oversight of their agencies' biosecurity efforts. HHS gave out three multimillion-dollar contracts for advanced development and manufacturing of vaccines and biologicals, then DoD gave another company a contract for the same work. As far as Dr. Russell has heard, neither HHS nor DoD gave contractors specific directions about which diseases to develop vaccines for.

There is little accountability for US biosecurity spending, so spending has sometimes been corrupt and inefficient. Powerful senators and committee chairs should more deeply investigate biosecurity spending to hold the officials who oversee biosecurity accountable. US management of biosecurity may be so deeply flawed that it will not significantly improve until a major disaster exposes its weaknesses.

The DoD spent billions of dollars on its Transformational Medical Technology Initiative, which was designed to improve technology for defense against bioterrorism. However, the program was unsuccessful, and DoD ended it. HHS recently reviewed its efforts to develop medical countermeasures to bioterrorism but did not make large changes to its acquisitions based on the review, in spite of significant problems.

The federal acquisition process does not work well in general, and it is especially unsuited for biosecurity. Previously, when government scientists developed the basic science for biosecurity and worked with contractors on product development, projects were more successful. Now, acquisition specialists who lack subject-matter expertise handle contracts, so there is a firewall between scientists and contractors. Biosecurity procurement should be fundamentally reformed.

Other countries

It is hard to know much about other countries' biosecurity programs because they are classified. Israel's program is likely better managed than the US's, while the UK acknowledges that it lags behind and depends on the US.

Role of philanthropy and academia in biosecurity

The Sloan Foundation made a large contribution to biosecurity by funding studies and increasing the field's visibility. Now that Sloan no longer funds biosecurity, there is a vacuum for philanthropic involvement.

Philanthropists have typically funded research to inform policymakers. However, policy papers are unlikely to be enough to convince the government to change the acquisition process for biosecurity, because companies that are currently receiving government contracts employ powerful lobbyists. Philanthropists should think about how to convince the government to accept promising outside policy ideas. They should also attempt to interest scientific leaders in biosecurity issues and offer opportunities for advocates for improving biosecurity to develop their skills. The UPMC Center for Health Security has an "Emerging Leaders in Biosecurity" program that is a good example of the results that kind of effort can achieve.

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