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Transcript

Bioterrorism: The Threat of 'Dual-Use' Technologies

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BIOTERRORISM: THE THREAT OF 'DUAL-USE' TECHNOLOGIES

Nigel Lightfoot:

Good afternoon, ladies and gentlemen. I'm Nigel Lightfoot. I work at the Centre on Global Health Security here in Chatham House. I'm also the executive director of CORDS, which is Connecting Organizations for Regional Disease Surveillance, based in Lyon, France. I've spent the last 15 years working with bio-security, security, bioterrorism planning, etc.

I'm delighted today that we have three young women who are going to, I hope, refresh the discussion about bioterrorism and dual-use technologies. First we have Laurie Garrett, who is from New York. She is a senior fellow at the Council on Foreign Relations. She supervises the Council's global health programme. She's written several important books and some recent ones, and you should have a good read if you find them. We have Filippa Lentzos, who is from King's College London, who is a sociologist by background but is working closely with the issues and social issues around the Biological Weapons Convention. We have Petra Dickmann, who is a communications expert first of all, then did medicine, then did a PhD on bio-security. She's working on that area now. She's worked with the laboratories in Germany, the BSL-4 laboratories.

So I think we've got all aspects covered for this discussion on dual-use technologies and bioterrorism. I've asked them to cover those things in about 5-7 minutes each and then I'm going to open it up to you for any questions and discussions that you might want to have. The event is on the record, which means it is being recorded and will be available on the Chatham House website later on. So ladies, no swearing, please. Comments can be made on Twitter via #CHEvents. Thank you all for coming, I hope we have a wonderful discussion. Petra Dickmann is going to start. Petra, over to you.

Petra Dickmann:

Thank you very much, Nigel. Hello. I would like to open this discussion with three thoughts I would like to introduce here. One is about the context sensitivity of risk assessment. The second point I would like to make is about the new dual-use dilemma. The third point is what I always talk about – about risk communication and crisis communication.

To start with my first point about the context sensitivity of risk assessment, I brought something with me. I would like to take you to the 1990s. Thanks to

climate change, researchers could make a new discovery. They discovered a virus in a body in the ice – since it got warmer, they could isolate a virus in this body. This virus is an influenza virus, the influenza virus of the 1918 influenza. They isolated this virus and reconstructed it and said: voila, look – H1N1, wonderful. We have this here. This was in the 1990s.

Then we had 9/11 and everything got very threat-y. So research on influenza virus was dangerous. So no way to do this, it was dangerous. Of course they thought if you can reconstruct and build this virus you can spread it out, you can use it as a bio-weapon. So no good is this. Then 2009, exactly the same virus came by: H1N1. High popularity again – good that we had this research.

The point with this – it's a bird, not a swine. I'm triggering my next point with my avian influenza, but I'm glad you got it. The point is: the risk assessment depends on the context in which you make this assessment. Ten years ago, it was a high threat to work on this. Twenty years ago, it was a good opportunity, great. In other days, it's a bit ambivalent. Why is this ambivalent?

So I would like to come to my next point. I put the bird back again. My next point is about the dual-use dilemma. I think you are all familiar with this. Dual-use – it is a difficult decision whether something is good or bad. I would like to demonstrate this with my toys here. This is a firefighter. You know exactly what he is doing and what he is about. So nothing ambiguous about this. A firefighter can do things. This is basically the one use. Dual-use is when things are getting a bit ambivalent. So Lego, building blocks. You can build different things with the same blocks. You can build a racing car or an ambulance or a tank with the same blocks. This is the particularity of bio-medical sciences. They do only these building blocks. They don't do these firefighters any longer, where you can tell this is bad or good, depending on what they do.

This is a new challenge because it's not about the material – you can get these building blocks everywhere. You have different colours, you can ask scientists – it's a red block, it's a yellow block, that's fine. It's about the way you put them together and the knowledge to do this. So dual-use has developed a different layer, a different dimension. It's a new dual-use because it's information-sensitive. It's the information and not the material itself.

So here we are with this context sensitivity of risk assessment and then we have this new dual-use dilemma where sort of everything is about the information you share in an information society. So what do you do about this? You do a lot of communication, but to be honest you do a lot of this here

– firefighting, crisis communication. You start communicating when it's too late. You come to a distinct fire. I would suggest to go to a risk communication attitude, to talk about the different ways you can assemble a car, an ambulance, a tank. To talk more broadly and involve more people in these things. This is the risk communication I would like to encourage in this debate about risk assessment and dual-use, because at the moment I feel that we have pretty much ad hoc communication, like this firefighting, crisis communication – what to do now? We feel that we had this mutant bird flu discussion – that biologists engineered a new influenza virus, a mutant one – and they said it's dangerous, you shouldn't do this. The reflex was to stop the virologists and scientists from doing this. Our reflex is to limit and restrict this because we feel it's dangerous, from our current risk assessment.

I would like to encourage broader risk communication about these aspects and not this ad hoc firefighting. This involves a broader perspective. It's not just the scientific perspective, and I think this is the reason why we're all here. It is a political and economic dimension in these areas. We can't tell exactly what is good and what is bad and it's up to society to decide on this. This is what I would like to encourage, a risk communication discussion in a broader dimension.

Filippa Lentzos:

Thank you, Nigel, I'm delighted to be here. Thank you for the invitation. To be here on an all-female panel is a great pleasure.

I'm a political sociologist and, like Petra, I'm also interested in risk. Particularly, I'm not so interested in the risk communication aspect – what my interest is more focused on is the way in which certain risks become things that we focus on or become problems that we then decide to respond to. So in the words of the French philosopher Michel Foucault, what I'm interested in is the process of problematization – or, in the words of the American anthropologist Mary Douglas, I'm interested in how certain risks come to be placed higher in the risk portfolios than, for example, other risks. I start from the starting point that there's nothing inevitable that says certain risks – that there is a risk hierarchy. I start from the premise that it's contextually based.

So for me, the interesting question to ask today is about how the threat or the risk of bioterrorism has emerged over time. That's what I will talk a little bit about in the next few minutes.

Bioterrorism is a relatively new concept. Of course, biological weapons have a longer history themselves that stretches back to the interim between the two world wars, when they started being developed in state programmes and tested. Since that time there have been international treaties that Nigel referred to in his opening remarks – the Geneva Protocol, the Biological Weapons Convention – that ban their use, that ban their development, production and stockpiling.

The use of biological weapons was for a long time sort of held in check by nuclear weapons, by the threat from nuclear weapons during the Cold War, by these international treaties. But at the end of the Cold War something happened. A new security threat came to be identified by security analysts in the United States, particularly those on the right of the political spectrum and with ties to the Pentagon. This new threat was terrorists linked with weapons of mass destruction. That included bioterrorism.

If you analyse early political discussions on bioterrorism, you will see that there were many different perspectives about the risks, about the occurrence of the threat, about the possibility of their use, about the imminence of their use. You can broadly divide the people speaking about this into two groups. On the one hand you'd have alarmists, who would emphasize in their discussions the vulnerability of populations, who would talk about apocalyptic scenarios or apocalyptic attacks where you would see the deaths of thousands of people with exceptional consequences. On the other hand you'd have sceptics, who would sort of question this scenario and focused their discussions around bioterrorism less on those sort of technical things about what was possible and talk more about what was probable. They focused more on, who were the terrorists? What were their intentions, what were their capabilities? What were their interests in using biological weapons? So you would have these two groups.

As this debate was playing out, you could analyse the different places, the different events, the different characters that in the end resulted in the alarmists triumphing over the sceptics and money pouring into bio-defence programmes. I'm sure you will all remember a number of the events that happened around the time – this was in the 1990s. These debates were primarily taking place in the United States. Some of the events were the Aum Shinrikyo attacks on the Tokyo underground – that was with sarin, not biological weapons, but the Aum Shinrikyo group was also trying to develop anthrax (with little success, but that was still a key event that was very much influencing the debates at the time). Other events – Iraq and the weapons of mass destruction that were found in Iraq. The discovery of the enormous

Soviet bio-defence and offensive bio-weapons programme that they had there.

Some of the key actors or the central actors that were taking part in the debate and that pushed the alarmist strand were the executive and the legislative branches, prominent members of the scientific security communities and bio-technology communities, as well as the media. The media was certainly a place where some of these debates played out. I'm sure we all remember [US] Defense Secretary [William] Cohen very publicly saying on ABC News – holding up a five-pound bag of sugar and saying, if this was anthrax and it was released over Washington, half of the population would die. There were also a number of scary novels around this time – *The Cobra Event*, for example, is often one that people remember. But these debates were also taking place, of course, in government settings, between departments, in testimonies and hearings, in academic articles and table-top exercises, etc.

Then 9/11 came along and the anthrax letters that followed. The attention paid to bioterrorism increased dramatically. The idea of bioterrorism as super-terrorism was spread then from Washington to security communities around the world and back to capitals from those different security communities. This idea of super-terrorism had the effect of – thinking about bioterrorism as super-terrorism has the effect of empowering certain groups of people. So people in war, people in defence, people in international order and strategy were empowered by thinking about bioterrorism like that. Also other groups connected with crime, connected with internal security, with public order and police investigations were empowered.

In the last minute or so that I have, I just want to focus on how we think about bioterrorism today, because there has been a real shift in how we think about bioterrorism today. Along with that shift comes a different way of responding to bioterrorism, a different way of intervening with bioterrorism. Today, bioterrorism is no longer thought about as this one standalone threat. Bioterrorism is thought about as one element of a spectrum of disease threats that also includes natural outbreaks of disease. There's a very clear link these days between security and health. Other elements of this spectrum are unintended releases, which Laurie might be talking about later on, I imagine. Also negligence, also sabotage. Unintended consequences of laboratory work, which I suppose you touched on a little bit, Petra, in your talk as well.

This way of thinking about bioterrorism has, as I said, consequences for how we think about how we should respond to bioterrorism. Groups that are now

being empowered are those related to health, to healthcare, to medicine and so on. I think I'll leave it there for now.

Laurie Garrett:

Since Petra showed us a prop, I'll be mostly talking about a lot of things that some of you have probably read already, so forgive me if it's repetitive to something that you've already read. Main message is: we've gone from an era where we were looking at controlling substances, controlling key microbes, special pathogen lists – somehow everybody was supposed to keep track of who had test tubes of what. That is all irrelevant now. We're now in an information age, and we're not doing a good job of tracking information in any context, much less in the context of biology.

We're in three great revolutions in biology right now that are unfolding at lightning pace and are completely turning biological research upside down. They're all made possible by the plummeting costs of genomic sequencing. So the first human genome was sequenced, it took ten years, 160 laboratories, a net cost of well over \$10 billion if you combine the public and private sector costs. Today, most scientists in the rich world consider the actual sequencing costs to be pretty trivial in their budget requests for biology research. We're now down to full human genome sequence can be done for about \$900. The latest bio-technology magazine forecast is that by 2016 that's going to have fallen all the way into the under-\$100 range. You can buy a home sequencer, do your own sequencing, sequence your own genome overnight. The sequencer itself right now costs you about \$5,000 but there's newly advertised products coming out later this year that are going to take it down into the \$2,000 range. I'm ready to predict that it's going to defy Moore's Law (on the computer side) – all of this is just plummeting at a dramatic pace. In fact, Craig Venter just announced last week that he's creating a whole new subsidiary company with the goal of sequencing 10,000 human genomes a year and doing complete analysis of relevant sequence genes, with a goal of ramping up to 40,000 a year and creating the ultimate human genome database. It's all gotten so cheap that we're outsourcing much genomic sequencing to one single place: the Beijing Genomics Institute, which – you can decide if this is a good idea or not, but it now has the world's largest genomic repository of information, larger than any government repository (except to the degree that nothing in China is completely outside of Chinese government influence or control).

So this incredible decrease in the cost of actual sequencing has made three things possible – I'll touch on them briefly: first, metagenomics; second, synthetic biology; and finally, gain-of-function research.

Metagenomics. We're now shotgun sequencing the entire world. We're shotgun sequencing everything around you, everything you breathe, everything you eat, everything inside of you. In the 1990s, for example, marine biologists were capable of telling you about a handful of microbes and what role they played in the ocean system, the general ocean ecology. That started to transform in the early 2000s with some key genomic work but it was still slow, it was expensive. We didn't know much. In the last five years, the field has exploded to the degree that we now recognize there are 100 million microbes per square centimetre in the oceans – which by the way, it's about 1 million per square centimetre inside your body. The computer systems, mass computational, all over the world cannot keep up. Cannot possibly begin to digest the information that's pouring in. We're looking at about 10^{29} microbes in the oceans and the numbers of species involved is so vast that we're discovering entire phyla are playing a role that ten years ago nobody even really knew about. By the way, that's true inside your body. We're now discovering that your body will not work without archaea. Who knew that archaea were inside the human body? They were called archaea because – arcane, old, ancient. We didn't think they played any particular vital role in modern contemporary lifeforms, and indeed you cannot live without them inside your body.

So we're sequencing, we're learning, it's exploding. In the process, of course, what's the first target a biologist wants to know about when they look at a new microbial species that they've sequenced? What are the virulence genes? What are the genes associated with transmissibility? What makes this microbe capable of infecting this range of species out there? What would it take to fine-tweak it and make it infect something else, or transmit this virulence or toxin to something else?

This database is building at lightning speed, which leads to the second great revolution. You used Lego, I love that, because a lot of people in synthetic biology talk about bio-bricks, which are often seen as analogous to building with Lego. You can now order which nucleotide sequence you're interested in, what DNA you want to swap, build, pile around, jerry-rig as you will, create microbes in your lab – previously non-existent lifeforms. We now have a teenage competition that involves about 38 countries in the world where the goal of the competition is to create a previously non-existent lifeform. The

best new lifeform wins the prize. If you don't know about all this, you need to talk to your teenagers, because they do.

This, of course, has resulted in Gerald Joyce famously referring to the new era of directed evolution. No longer are biologists sitting back observing life and trying to assess whether if you throw in an antibiotic the lifeform changes in a test tube. Now one is directing the evolution of the lifeform, altering it to determine what its functionality may be and what its risks may be. This allows you to construct whatever you may and it means the information itself – what are the genetic sequences, what are the virulence factors and so on – that's the key now that requires observation and regulation, not the microbe itself.

Now you get to the whole question of gain-of-function research, which sometimes overlaps with what I've been describing and sometimes is actually using kind of old-fashioned forms of biological research. The first idea of gain-of-function comes from Fritz Haber, who famously in Germany before World War I developed a way to do nitrogen fixation as a fertilizing system, but the same capacity allowed you to create chemical warfare. Fritz actually so thoroughly embraced the duality that he performed personally both forms of research and was a supplier of chemical weapons for the German army in World War I. That's the most dramatic example of gain-of-function.

But in most cases when we talk about gain-of-function, dual-use research, we're really talking about fairly innocent intent, or even highfalutin intent – save the world intent. The most dramatic, of course, came forward when Ron Fouchier stood up in Malta in September 2011 and announced to a scientific meeting of European virologists, 'I did a very stupid thing', and then proceeded to describe how he had altered the H5N1 bird flu to turn it into a mammalian-transmissible form of the bird flu virus. Given that H5N1 has a mortality rate in homo sapiens infected to date of 61 per cent, that's a very frightening possibility, that one would deliberately alter this normally only bird-to-human virus to be a potential human-to-human virus. So with that having been performed or announced, Yoshi Kawaoka of the University of Wisconsin – Fouchier, by the way, is at Erasmus in Rotterdam – Yoshi Kawaoka said: I've done a very similar experiment, and I think it's a smart thing to do because we're trying to come up with vaccines in anticipation of a natural occurrence, an evolution. Again, we're talking directed evolution here.

Of course, one big difference between Fouchier and Kawaoka was Kawaoka deliberately crippled the virus he was experimenting on so that it couldn't actually escape the lab, or if it did it couldn't actually harm human beings. Fouchier did not. This has opened up this huge kettle of fish – very stinky fish,

really – and gigantic controversy on both sides of the Atlantic and in fact also in the Pacific. On our side, the US, it brought all sorts of previously unknown committees forth, all sorts of responses from obscure entities saying: you can or cannot publish this, you can or cannot explain this to other people, this is or is not evil, terrible, wonderful, public health, whatever. In Europe the response was slower, but when it came it was perhaps more surprising. Ron Fouchier had already published his work in *Nature*; Yoshi Kawaoka published his, after a long debate in the United States, in *Science*, including materials and methods – which was the question: should you, simply to avoid dual-use catastrophe, tell everybody not to publish materials and methods? Which I submit was absurd because already 18 postdocs had emailed it to 18 friends, which had then been emailed to 45,000 friends. It's utterly irrelevant what is physically published.

At any rate, Fouchier's work – belatedly, or however you want to look at it – was ruled by a Dutch court to have violated European export control law, by publishing the how-to, and it is still under close scrutiny. Quite a divided issue here in Europe, with some European scientific groups saying that's absurd, it will slow down research, it will put Europe at a disadvantage in the general race to invent and innovate – and others saying, absolutely, none of this should ever get published and we should condemn Erasmus University for their behaviour and so on. This has yet to be ultimately sorted out.

Just to quickly get to a wrap-up here, we're now at a situation where – all right, the issue is information. But all legal apparatuses that exist, whether you're talking about the Biological Weapons Convention, the Cartagena Protocol, individual national legislation or the international health regulations, pertain to specific microbes. So they are, shall we say, physical, as opposed to information being ephemeral. You can say this glass has – pick one. Let's say H5N1 in it. But you cannot control or know who is sending information about sequences of H5N1 genes. Now that the Harbin laboratory in China sequenced or made 127 previously nonexistent forms of H5N1 – five of which transmitted readily through the air between guinea pigs, causing disease – the genie is out of the bottle here. But we don't have any system in place for really talking about how to regulate the flow of information, or even concretely of bio-brick sales, and of who has access to what nucleotides to construct what.

My greatest concern actually is less about bioterrorism per se – some nefarious individual or group constructing some horrible microbe – but stupidity, mistakes, the zealous pace of the research, the fact that everybody is sloppily trying to do everything all at once. That everybody sees

metagenomic, shotgun methods as the way to go. I would just simply remind you that the last case of smallpox was not in nature, it was at Porton Down. The last outbreak of SARS did not naturally arise, it occurred in 2005 out of the CDC laboratory run by the Chinese CDC in Beijing, and got out of the lab into the community. Last time I looked, we'd had a total proliferation of Bio-Safety Level III and Level IV laboratories and a proliferation of accidents associated with those laboratories. This is what worries me.

Finally, we have no regulation of the private sector whatsoever. So who knows what's going on at your local biotech laboratory or pharmaceutical plant.