Washington Roundtable on Science and Public Policy
William C. Patrick III:
The Threat of Biological Warfare
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William Patrick:

The sample case I brought with me today holds glass bottles containing exact simulants of the weaponized form of anthrax and the virus causing Venezuelan equine encephalitis virus. Now, I've carried this case through a number of airports on my way to meetings over the last 12 years, but no one ever stopped me and asked, "What are these peculiar- looking powders?"

Then I started carrying crude disseminators, like this small plastic spray bottle. It's just a single-fluid nozzle, and it doesn't generate a great deal of pressure; the liquid it sprays produces large particles that fall out of the air very quickly. But a liquid agent is very easy to make. It's something that a terrorist might attempt to use. Yet when I travel through airports, no one has ever stopped me.

And then I started carrying around this big, metal, hand-held spray duster. A duster like this sprays a fine powder. That's important in a biological weapon, because an effective BW agent must produce very small particles, on the order of 1 to 3 microns. Particles this small can avoid your respiratory tract's defense mechanisms, get down in your lung sacs, and cause a deep-seated infection. Such a powder, with the right properties is difficult to prepare, but once a terrorist has it, dissemination is easy.

Now after I began carrying around this duster with these bottles, I thought surely somebody would stop me. But I have been through all of the major airports in the country; I have been through the x-rays at the CIA, the DIA, the State Department and the House of Representatives; and nobody has ever stopped me to ask what I'm carrying. The guards at the security points do a good job of stopping people with knives or pistols. But they don't have a clue as to what a BW terrorist might be carrying around.

Today, I'm going to condense a lot of material on the four components that are required for successful biological warfare: the agent, the munition, the delivery systems, and (for outside targets) the meteorological conditions. I don't think terrorists today in our country have that capability. But a rogue country like Iran or Iraq certainly does, as does a group like Japan's Aum Shinrikyo.

<u>Meteorological Conditions</u>

Let me start with meteorological conditions. A BW aerosol agent has to remain at ground level to be effective. You don't have a problem on a day when, for instance, factory-stack smoke rises straight up into the atmosphere. To keep an aerosol hugging on the ground, the flow has to be downward. This requires an atmospheric condition called an inversion.

Inversions typically occur in the morning, at sundown, and, most frequently, at night. So we can conclude, first, that a BW attack on an outside target is most likely going to be at

night, when you most easily find the necessary condition for the aerosol to remain on the ground.

In a 1950 environmental test in the San Francisco area, we distributed a line of aerosol two miles long, two miles off the coast, and sampled the coverage. With an inversion and a ten-mile-an-hour wind, the result was considerable; without an inversion, and with sporadic wind upsetting atmospheric conditions, we could not pick up any organism within half a block of the wharf area. This demonstrates quite clearly that in an outdoors environmental attack, meteorological conditions must be favorable. You can have the best agent and the best munition, but if you don't meet the requirement regarding good environmental conditions, the attack will simply fail.

Another test (and both these tests are declassified now) simulated an attack on Eglund Air Force Base. Our mock attack was expected, and guards and guard dogs were posted around the perimeter. But we did not have to go on the base. We attacked from a road about a mile outside the security fence, behind a thicket of scrub pines between us and the base. If you've been down to the Carolinas or Georgia, you know how thick these pine trees grow. Yet the aerosol passed through them without any diminution, went through the housing area, and contaminated the hangars and the airplane cockpits. Samplers showed high levels of contamination.

This test, although conducted many years ago, still has significance. Consider the recent focus on embassy security. Concrete barriers and other means of hardening buildings to bombing attacks don't mean a thing if you've got a BW agent and a good way to disseminate it. I can go upwind of the target ten, fifteen kilometers, and I can hit it, providing the wind is right. I feel our embassies should be equipped with proper filter systems – I recommended this some years ago, and I hope they are.

Munitions and Delivery Systems

There are two methods of delivering BW agents to the target. One is "point source delivery" – little biological bomblets about the size of grapefruit, that are released from aircraft or missiles. They call these little bomblets "individual" aerosols but after a short period, they become contiguous.

Point-source delivery is not a very viable option today. I don't think anyone has the capability. But there's a second method of delivering a BW aerosol, which is "line source." In this method, a biological agent is sprayed in a line perpendicular to the wind, and the energy of the wind takes the aerosol downwind to do the damage. Line-source delivery could be carried out in all sorts of ways – from a moving train, or just by walking along a line pumping and spraying with a two-gallon bar sprayer.

I'd like to talk a little bit about the physics of the aerosol, because this is one of the most misunderstood problems in biological warfare or biological terrorism. Immediately after you spray an aerosol, no matter how you spray or disseminate it, there is very short period of time called the period of equilibration when large particles drop out. The aerosol that remains, composed of particles that are 1- to 5-microns in size, is called the primary aerosol.

Those 1- to 5-micron particles are very efficient at getting to the alveoli of the lung. A classic Fort Detrick experiment compared the effect of various particle sizes in aerosol agents. For an aerosol of a live biological agent, tularemia, composed of very fine, 1-micron

particles, it takes only two and a half cells to kill a guinea pig and fourteen cells to kill a monkey. In contrast, when an aerosol of tularemia is 6.5 microns, much larger numbers of cells are required to do the same thing. That result isn't limited to tularemia. All the organisms we worked on demonstrate the fact that the smaller the particle – as long as it's in the 1- to 5-micron range – the number of organisms required to infect is much, much lower than when the particles are larger.

(Obviously, the issue of contagion raises a whole different order of problems. When you select a contagious agent such as smallpox or plague, your primary infections might be small in number, but they keep on giving: one infected patient gives rise to twenty secondary infections and then those twenty infections give rise to another twenty, so it's a geometric progression.)

An important characteristic of primary aerosol is that it behaves as a gas. That means it goes around objects. In the test at Eglund Air Force Base, the aerosol passed through the scrub pines without any diminution; without hanging up on all those branches and needles. Moreover, as the primary aerosol goes downwind, very little residue falls out. (Remember that the big particles have already dropped out.) So there is no need to decontaminate the areas the aerosol passes over, because there is nothing to decontaminate. People become infected because the human body is nothing more than a vacuum pump pulling in that aerosol.

To demonstrate how an aerosol behaves as a gas, I'd like to tell you about a naval test off the coast of Alaska. We sprayed BG spores about twenty miles upwind of ships with samplers. When the aerosol reached the ships, it was pulled in by the air system and remained at very high concentrations for about an hour and a half. We found especially heavy concentrations of spores in the engine room, which pulls in very large amounts of air to dissipate heat. But the exterior and interior surfaces of the ships were only very lightly contaminated: the same air system that brought the aerosol in removed the organism with very little residue having fallen out. There were similar findings in other tests where a building was contaminated with a primary aerosol: it comes in at a high concentration, gets you infected and then departs, leaving a very low residue.

Now, most sheriff's departments believe that if terrorists hit a building with a primary aerosol and introduce the organism into the air-handling system, you have a contaminated building that must be burnt down or flooded with hydrochloride or what have you. That's not true. They are confusing biological aerosols with chemical agents. When a chemical agent passes over an area, you have to decontaminate it, but that's not necessarily true for a BW agent.

Now, the big particles that fall out of the aerosol onto the ground during the period of equilibration: This *is* contamination. But, as we saw in the classic Fort Detrick experiment, the number of these big particles required for infection is large. So ground contamination is there, but it is not necessarily infectious. Wagner and others later found out that only when you reach a concentration of 10 million spores per square meter do you start having real problems requiring decontamination.

These facts mean that in an open-air environment, a terrorist has problems to overcome. There is also the wind and the ultraviolet light of the sun to consider. But a smart terrorist will hit us in an enclosed environment – a building; an airport; a subway system. My greatest fear is that a country such as Iran or Iraq would bring in a powder

through the auspices of diplomatic channels or the United Nations and place it in the Washington D.C. Metro system. Just 230 grams would cause us grave concern. And I can carry 230 grams on my person. That is a realistic scenario.

The point I am making is simply this: you can have the best agent in the world, but the physics of dissemination mean that unless you have good conditions and a good delivery system to get that improved agent on target, you're going to fail.

BW Agents

To discuss BW agents, let me say a word about the Soviet program. The Soviets weaponized plague, which we did not; they weaponized smallpox, which we did not. We would not have weaponized a contagious agent. We felt we had enough problems with control just with meteorological conditions being so fickle without introducing a contagious factor. They had armed their ICBMs with plague in a liquid form and because of the non-stability of the plague agent in liquid, they had to recycle that material every sixty days – that is, pull it out of the ICBM and fill another ICBM entry vehicle with it. Can you imagine the dangerous activity associated with that procedure? This was in 1991.

They had three organisms loaded on their warheads aimed at our major cities, plague, smallpox and anthrax, all three lethal agents. They are all infectious, but only plague and smallpox are contagious, meaning they could start an epidemic. Even if the Soviets didn't hit a city directly, they would start a full-sized infection that would lead to widespread contagion.

Another problems is that you would not necessarily disseminate a single organism with a single symptom. The Russians had three, and the symptoms on each one are quite different. So by using a cocktail of agents, as they did, you would have a multiplicity of symptoms that defy easy diagnosis. The only way you are going to be able to diagnose this material or identify it is by laboratory.

Ken Alibek gave me their potential production capability per year. I will use anthrax as a case in point: they could produce 4,500 metric tons of dry anthrax per year. To put that in context, Washington and its environs would take only about 75 or 80 pounds. Their quality was not as high as ours, but the difference is overwhelmed by the fact that they out-produced us by 4,500 to 1.

Now people ask me: "4,500 metric tons – do you believe that figure?" The answer is, I do, because they dried anthrax with a vacuum drum dryer. When we studied vacuum drum drying, we found you can dry 80,000 gallons of material in a 36-hour period; it would take you months to dry that same amount of material by freeze-drying, the process we used. So I certainly believe these figures to be valid because when you look at their process, it all fitted into a logical sequence.

What is really scary is that they produced Marburg virus. I used to think smallpox was the ultimate weapon but I think that Marburg virus in the hands of the Soviet Union is the most lethal. It is capable of being disseminated as a small-particle aerosol, and according to the Russian data, it only takes 22 viral particles to cause a respiratory infection in man. Where it takes 8,000 anthrax spores to produce an infection, it takes only 22 virons of Marburg.

The Soviets were not able to grow Marburg virus efficiently in tissue culture, which is normally the way it is you do it. So they produced it in guinea pigs. I made some calculations based on what Ken told me and it took 230,000 guinea pigs to produce this amount of material. The guinea pigs were very efficient growth vessels, growing the Marburg in very high concentration.

The man responsible for the work on the disease was infected with the disease and died a very slow, painful death. He was put in the slammer, where no one who goes in comes out. If you examine his daily notebook, you notice that every day the page gets a little more blood-spotted.

I'm asked if I think Russia is still involved in biological warfare. I certainly do. When Ken Alibek came out and told us about the Soviet program, historically we didn't know anything about it. And it was a massive program – 40, 50, 60 thousand people could be working on it at any one time. The program at Biopreparat consisted of six production facilities, any one of which was much larger than our single production facility at Pine Bluff. Ken also believes that there are hidden BW programs among the military. Knowing the Russian psyche, I would suspect he is right, there are programs hidden.

The major point is this: when Alibek came out, he said that their program mirrored our program. Whatever we worked on, they worked on, a little bit after we did, after we started our program. He thought there were spies at Detrick. I had never considered spies being in our program. You know, we do a lot of things well, but one thing we don't do well is keep secrets.

The Soviet Union signed the BW Convention in 1972. That was the year that they increased their program by the greatest amount of money and people, in the history of the program. So, speaking for myself, and not for any part of the U.S. government, I do not think you can give much credibility to anything that they sign. When they sign an agreement, they don't live up to it. Quite the contrary, they express disdain for it, they increase their program by the greatest significance.

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Question and Answer Session:

Q: Contagion could be a problem in poor countries where the public health system is not well developed. But in a country like the United States, would contagion be a problem?

Patrick: Absolutely. Most doctors today have never seen a plague case, unless they are out West. I am sure no doctor in practice today has seen smallpox. Look at the West Nile virus in the pigeons of New York City. Some of the most sophisticated laboratories in the world are located in New York City, and it took them two weeks to arrive at the fact that it was equine encephalitis. Two more weeks of work and they said: "Aha – it isn't equine encephalitis, it is West Nile virus." Here we are in one of the most sophisticated cities in the world and it takes our medical people at least four weeks to diagnose West Nile fever.

Q: Are the Russians selling BW munitions to Third World nations?

Patrick: I wish I knew the answer to that. The last report I heard is that you couldn't account for about 200 scientists who were in the former Soviet Union program. They don't know where they went.

Q: Is there any indication that a smaller state or rogue nation might apply its own technology to bioweapons?

Patrick: When I went to Iraq on the UN inspection team, we found the Iraqis had first-rate equipment. They had good fermenters, they had beautiful centrifuges, they had the works. Then I read the UNSCOM technical reports and discovered their products were lousy. The concentration was low and it took too long to get any amount of material. For example, the Iraqis said that they could produce anthrax at a concentration of 1x10 million spores per millimeter after 40 hours of fermentation. Now, if they couldn't produce better material than they say they did, with the good equipment that they had, then something is wrong. They failed miserably at exploiting their process equipment. Of course, the Iraqis lied about everything else, so there is no reason to believe they didn't lie to mislead us about their agent products.

Q: I understand the Soviets produced their techniques and practices in a 25-volume set. Couldn't anyone use these books to duplicate their work?

Patrick: When you're in the fermentation business, as in any process-control business, you write standard operating procedures, which can show a neophyte how to produce the product. It is a little more complicated than that, because some subtleties don't appear in black and white. But certainly, the basis of the production technique is there.

Q: When you talk about Soviet BW, are we talking about research programs or are we talking about production?

Patrick: There is a thin line between research in a BW program and a production facility. For example, a terrorist who can infect two dozen chicken eggs and has the ability to process the chicken eggs properly can attack a building. But the same techniques that allow you to inoculate two dozen chicken eggs and harvest them can also be used to inoculate a million chicken eggs – and you can infect very large areas with that. So once you have the basic structure down, it depends on how many eggs you can process. A million simply becomes a handling problem. The point is this: if we overlooked the massive program that they had, why is there any reason to believe that they would not hide another program of equal mass?

Let's look at Sverdlovsk. In 1979, in the city of Sverdlovsk, a military compound, there was a release of weapons-grade anthrax. Ken maintains that about 90 people died, but the number depends on whom you read. The area was downwind from the production facility. This is a one-hour lecture in and of itself. There are very interesting data that you can glean from that information on the behavior of BW aerosol.

Well, the Soviet Union denied that this was a release from a weapons plant. They said the infections and deaths were the result of contaminated meat being sold on the black market. And a lot of people in this country with good minds, good backgrounds, good education bought it, hook, line and sinker. But those of us in the BW program who had worked on anthrax, and knew how to develop it, said: "No, this is an aerosol release of anthrax."

Q: If the Russians were loading ICBMs with biological agents in 1991, why do you think that our enemies today don't have the capability to deliver a threat by ICBMs?

Patrick: Right now, I don't see any country with ICBM capability delivering a weaponized agent to this country. Based on what I saw of the Iraqi program, they had good equipment, and I think their products are good in spite of the UNSCOM reports; but I didn't see any

evidence of delivery systems and munitions that would be capable of efficiently delivering a BW weapon. Russia still has a lot of ICBMs armed and ready to go, and there is no reason why they couldn't put an agent back into them. But when I say current, I mean right now. And right now, the greatest threat of attack is someone coming in with the right agent.

Q: What do you think about a national inoculation program?

Patrick: I don't think that vaccines will ever be the answer. The anthrax vaccine has gotten all sorts of bad publicity, although as far as vaccines go, it is very innocuous; it is safe and effective. But when you get into agents such as tularemia, killed vaccines do not protect you, which means that you have to use a live, attenuated vaccine. If a woman is pregnant when she receives this attenuated vaccine, she is going to abort or have other problems. Our military is now 10 percent female and we had to change our policy regarding the delivery of live attenuated vaccines to young women of childbearing age because of this problem. And with any vaccine, I don't care how good it is, there will be a certain number of respondents with adverse reactions.

It seems to me that the way to protect against a BW attack may lie in some of the research being directed today toward immuno-modulators, which stimulate the immune system against not one organism but against all organisms. It is this immuno-modulator that, I think, has potential for protecting our population.

Q: What is the outlook for biological warfare?

Patrick: Well, the interesting point has been made that as we diminish our nuclear capabilities down to zero, then biological and chemical weapons come to the front very rapidly. And if an adversary beats us to the punch, then we don't do too well.

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