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INTO THE HOTZONE

IN THE WAKE OF SEPTEMBER 11, SCIENTISTS AT CANADA'S NEWEST AND MOST SECURE BIOSAFETY LAB WERE INUNDATED WITH SUSPECTED ANTHRAX CASES. NOW, THEY'RE PRIMED FOR THE WORST.

AT THE HEIGHT OF LAST FALL'S anthrax scare, scientists at Canada's new National Microbiology Laboratory in Winnipeg came in to work to discover that the FBI had been calling. This was quite a thrill -- in the way a grocer mounts his first dollar over the cash register. It was the lab's inaugural call from the Federal Bureau of Investigation. And it was a warning. As anthrax spores were germinating in who knew how many people in the United States and mailrooms across North America were on guard, the FBI was phoning to say that special attention should be given a letter sent to a hospital in Saint John, N.B. Its postal lineage, agents thought, was similar to an anthrax-positive package sent to Chile.

In mid-October, another suspicious parcel was on its way to the Winnipeg lab from hazardous-materials workers at the Calgary airport. Customs officials there had detained a man arriving from London, England. He had previously been granted status in Canada as a Pakistani political refugee but was using false documents, including a bogus passport, to travel surreptitiously back and forth to the country he had fled. (Visits home can cause political refugees to lose their status.) When authorities checked his luggage, they found more fake-passport photos. And, at a time when all powder was considered bad powder, they also came across one very damning "package of white powder."

These are only two of hundreds of incidents that contributed to the chaos at Canada's newest biocontainment lab a year ago. Police were calling not just from Saint John and Calgary but from points in between and beyond. Local law enforcement officers were driving suspicious parcels right up to the lab's front door. Hand delivery is not exactly official protocol for dangerous packages. But at the time of the anthrax scare, Canadian policy for these situations had just been circulated in draft form to provincial public health authorities. And so it happened that when the police arrived at Winnipeg's high-tech biocontainment

facility, they, like every other visitor, had to wait for clearance in the lobby.

THE ANTHRAX FRIGHT has faded somewhat from our collective psyche. But at the Bureau of Microbiology—one of an elite 19 high-containment biosafety complexes around the world that are equipped to handle the deadliest pathogens known to humankind — Canada's world-class bioterrorism experts are preparing for the worst. They took last year as a lesson and are readying themselves to cope with various lethal bacteria and viral scourges, from West Nile to Ebola.

Situated a few kilometres from the banks of the Red River in Winnipeg's north end, a couple of streets over from a neighbourhood of bungalows, the gleaming white, five-storey building displays a sign that reads: The Canadian Science Centre for Human and Animal Health. Inside is the country's newest and most secure microbiology lab, which is run by Health Canada, as well as the National Centre for Foreign Animal Disease, operated by the Canadian Food Inspection Agency. It is the first facility to accommodate both human- and animal-health laboratories under one roof. And, with that responsibility, it had to be fail-safe. The building's foundation is embedded in the Precambrian Shield. The laboratory walls are made of specially formulated non-porous cement, which engineers watched cure for an entire year. Then the walls were scanned by X-ray to ensure there were no cracks — no crevices for anthrax spores to creep into and go to sleep, only to awaken 50 years hence, as they are capable of doing.

"They are just trying to survive," Kathy Bernard says of the pathogens, with some mock gravitas. One of the centre's chief bioterrorism experts, Bernard has a healthy respect for the hazardous organisms she works with every day. One of them — *Arcanobacterium bernardiae* — was named for her. It might seem a dubious accomplishment to have your name attached to life-threatening bacteria, but it is a rare honour, bestowed only upon people who have an international reputation in their field. At 48, Bernard, a Windsor, Ont., native, is one of very few microbiologists in Canada with such an accolade.

Bernard's official title is head of special bacteriology. She is a compact woman with short, auburn hair and a restless energy. While she sips from a drink box, her fidgety fingers — moving to punctuate her words — inadvertently squeeze the box too hard. Juice splashes out onto the table, and she makes an absent-minded attempt to sop it up. When she answers the phone, she takes a couple of seconds to divert her mind from the task at hand, then blurts out, as though she's just been woken from a nap, "Uh ... Bacteriology, hello?" Bernard is also known for including her work number on nearly every piece of bioterrorism literature published by the lab. At about this time last year, however, it was her cell phone that was jammed with calls about bacteria — *Bacillus anthracis*, of course. "It seemed as if every police department in the country had this number," she says, producing the phone from her pocket and looking puzzled about how quickly her private number got around. In total, Bernard and her team evaluated nearly 300 suspected anthrax samples from mid-October through Christmas of last year, compared to just four the previous year.

Of all these packages, the specimen from Calgary was considered one of the more credible threats. The fellow with the bogus passports was already in a predicament made much worse by the container of white powder in his luggage. "They opened it," says Bernard, "and this flaky powdery stuff fell on them." At that point, three people had been confirmed positive for anthrax in the United States. Ottawa's Parliament Hill had been evacuated. And this incident was one of 10 suspected anthrax cases reported in Calgary the same day. (Nine were quickly ruled false alarms.) "That guy," says Bernard, "was in deep, deep trouble."

The local hazardous-materials team cordoned off the customs area of the airport. The eight customs officers exposed during the incident were decontaminated. One incoming flight was diverted, and another cancelled. If the still-in-draft protocol had been in effect, the next level of response would have involved an assessment of the specimen at the provincial public health lab. Then, if it still looked suspicious, it would be sent to the federal lab in Winnipeg. At the time, however, Bernard says, "We were set up for anthrax study, and most labs in the country were not." As a result, a plane was chartered, and the powder — lodged inside bags within bags that had been decontaminated with alcohol and sealed with evidence tape — was dispatched to Winnipeg.

WHEN CANADA'S EQUIVALENT to Atlanta's Centers for Disease Control and Prevention officially opened in 1999, after five years of construction, it got a tepid welcome from some Winnipeggers, even though every possible scientific precaution had been taken to ensure its security. Bernard's colleague Harvey Artsob is the chief of zoonotic diseases — diseases that can move from animals to humans — and another

of the centre's chief experts on bioterrorism. When he moved to town from Ottawa for the chance-of-a-lifetime job at the lab, Artsob – who lives alone in a big house with Boots, his cat – joined a curling team to make new friends. Word quickly spread about his place of employment, and he arrived at his first practice to find his teammates wearing masks. It was a joke, but rumours were circulating among the city's ill-informed that the centre was much less sterile and safe than its gleaming white exterior symbolically suggests. Artsob recalls one occasion during the lab's early days when a bus driver harassed an employee as he dropped her off at work. Clearly, he had never been inside the building.

No visitors are permitted beyond the centre's lobby and auditorium – and past the 24-hour security guard – without an escort. Even employees must enter their access codes on a Star-Trek-like keypad column before they are allowed in. And this is just one of hundreds of electronic checkpoints that monitor and restrict every movement throughout the complex. "It gives me a certain amount of comfort," says Bernard during a presentation to high school students, "to know, doing work on these agents, that this building is very secure."

Tours of the facility, even for young future scientists, are strictly limited. And you can forget about getting permission to try on one of the blue spacesuits worn by the scientists who work with Ebola, although Bernard once did. The experience made her thankful that anthrax and the other pathogens she works with are rated level-3. By comparison, biosafety level-4, the strictest level of containment that exists, seems like a prison. "I didn't mind the suit so much," she says, "but I think I would mind being in that room and not being able to leave readily. To go in and out is a huge deal. You have to plan your day carefully; you have to limit your intake of fluids so you don't have to go to the bathroom. And in the back of my mind, there is a little bit of concern that there is no treatment for Ebola, that it easily kills."

When the level-4 lab is hot – that is, operational – it takes a minimum of 20 minutes to enter or exit. Its box-within-a-box layout of rooms has been likened to a submarine within a bank vault. In fact, a Vancouver submarine-door manufacturer made the double-airlock, stainless-steel doors that open from the antechamber onto the lab itself. The purpose of the spacesuit is to provide a fail-safe physical layer of protection for scientists. Once in the lab, scientists are tethered to a bright yellow hose that curls down from the ceiling. It fills the suit to a positive air pressure – more air particles per million than the air in the lab, which is kept at an ear-popping minus 150 pascals. As a result, the suit is puffed up and held away from the skin. That way, if it is accidentally punctured, air would continuously rush out, preventing Ebola particles from making their way in. One disadvantage is that the constant rush of air makes the suit loud – inside, it sounds as if you have dunked your head in a bath when the water is still running. Contact with colleagues inside the lab involves a lot of lip reading; communication with those outside occurs through a headset and is electronically encrypted. The scientists also use dry-erase memo boards to scribble such messages as: "Are we having fun yet?" or "Please do not feed the fish."

The level-4 microbiology lab takes up a mere one percent of the space at the Winnipeg complex. The vast majority is occupied by levels one, two and three. (Scientists reduce the biosafety levels to acronyms and rip them off as BSL1, BSL2, BSL3 and BSL4). BSL1 is the equivalent of a high school lab and handles harmless organism such as yeast. BSL2 is found, for example, in hospitals and deals with urine and blood, checking for organisms like *E. coli*. Level-3 labs contain agents that can cause lethal infections but are not highly contagious, including tuberculosis, West Nile and anthrax. It was here, in BSL3, that Bernard and her crew were run off their feet with the anthrax scare last fall.

STANDING IN FRONT of an auditorium full of high school students, Bernard starts her presentation with a bit of a history lesson. "You may think that bioterrorism as you've been reading about it in the papers is something relatively new," she says, "but in fact, it existed in antiquity." In the Middle Ages, rats were used to spread the plague on enemy ships. The British put smallpox pustules on a shipment of blankets before they traded them with North American natives in the 1700s. And during the Second World War, Bernard says, Canada collaborated with the United States and Britain in creating an anthrax bomb. It was dropped in a test on an island near the coast of Scotland that was uninhabited by humans but stocked with sheep. The animals all died, and it wasn't until about 10 years ago that the island was finally decontaminated.

One of the earliest references to the use of anthrax can be found (by interpretation) in Homer's *Iliad*, with Apollo and his "burning wind of plague": "Pack animals were his target first, and dogs / but soldiers, too, soon felt transfixing pain from his hard shots / and pyres burned night and day."

THE PACKAGE FROM CALGARY arrived at the Winnipeg airport just after midnight. To preserve the proper chain of custody, a police officer, rather than a cabbie, drove it to the lab. Bernard was still at work, waiting and fielding calls. At the loading dock, the package was X-rayed — a standard procedure to ensure it didn't contain anything electronic, like a bomb. Meanwhile, Bernard and a technician were stripping down to their birthday suits. They had just punched in their security codes and walked past the universal symbol for biohazard — an angry red rendering of a trillium — into a locker room. Here, they donned the equivalent of surgical scrubs, with the added accessory of a HEPA (high-efficiency particulate air) filter mask. Now, they were ready to enter Bernard's suite in BSL3. It is tiny, she is quick to point out, smaller than half a one-car garage and much smaller than BSL4. "We can barely fit two people in here," she says, adding that she is lobbying for more space. Like the other labs in the complex, though, it has a window looking onto a hallway — in level 4, that glass is double-paned and bulletproof.

Once inside her lab, Bernard inspected the Calgary package to make sure nothing had broken or spilled during transit. Then, in case the specimen became evidence in a criminal proceeding, she documented its arrival both in writing and with a digital photograph — digital so it could be sent out electronically, thus avoiding the hassle of disinfecting the film. With the paperwork done, Bernard set to work.

"We did a microscopic processing with stains and looked at it under the scope to see if we could see any bacteria visually," she explains. The stain is Gram, with which any high-school biology student would be familiar, says Bernard. In this instance, she saw nothing through the microscope. But bacteria did show up in other samples she processed. "There are all sorts of bacteria in the environment," she says. "If you cultured this table top, you'd find bacteria; if you cultured your skin, you'd find bacteria. Most of it is friendly, but just to be sure, we were handling [each specimen] as if there was anthrax in there."

Scientists in BSL3 and BSL4 do all their work with hazardous agents in a biosafety cabinet that is open only on one side, where they sit. Its cover works like a stove's ventilation hood, sucking the air up and into a filtering system on the floor above. The system for the BSL4 wing of the centre takes up an entire floor, a veritable factory of humming pipes and ducts. This is also where the cylinders of oxygen are kept, and the tanks of disinfectant, which is sprayed onto the scientists' blue suits before they exit the level-4 antechamber. Even BSL4 light bulbs are changed from above. Liquid and solid waste, meanwhile, is excreted to floors below, where it is heat-treated for one hour at 125 Celsius to ensure that all level-4 organisms are dead. After this decontamination process, waste can safely be sent to the city landfill, while exhaust can be released through shiny silver pipes sticking up from the centre's white rooftop into the Winnipeg sky.

When Bernard saw nothing bacteria-like about the specimen, she called Calgary's medical officer of health and told him the good news. She was out of her lab by 2:30 a.m. (Luckily, her husband also works at the centre, in BSL2.) Before she left, though, she took one extra precautionary step. "It was one of the first weeks in October, really early on, [the anthrax cases in] Florida had hardly happened," she says. "It was around the scariest." So just to be sure, she smeared a little of the powder onto a Petri dish filled with sugar and nutrients and left it to grow. One of the telling differences between bacteria and viruses is that viruses require a living organism to grow, while bacteria do not. "Anthrax grows rapidly," she says. When, 24 hours later, nothing had happened, Bernard reported the Calgary substance to be unquestionably sterile. "That particular specimen had no growth at all in the five-day period that followed," she says. "It looked to me like a rather innocuous product that you would use to keep your skin soft." It was a cream that had dried into powder in the top of a jar — "Crud in the lid," she says.

This case, Bernard says in hindsight, was a bit of an overreaction. But a spate of specimens was arriving from all corners of the country. She and her ad hoc team, many on loan from other labs in the Winnipeg complex, were working seven days a week, sometimes around the clock. The same scenario was playing out across the globe. Bernard had e-mails from Australia and Europe asking what to do. Whoever sent the anthrax letters "hijacked microbiology labs around the world," Bernard says. She estimates her lab processed 75 to 80 percent of the hundreds of specimens they received, rejecting those which were not at all suspicious, like a letter from a mother to her son that had no return address. Another package contained powder from a doughnut; a few had glue from the spine of Chatelaine magazine. Some letters contained written threats, however, including one sent to a Wal-Mart in British Columbia — and to Wal-Marts across the United States. "Powder, powder, powder, it all looked the same, but we had to treat each one seriously," she says. "Because it could be the one; it could be the one where they looked up Canada in the book."

The suspicious letter from New Brunswick that got the FBI's attention was also, in the end, anthrax-free. "Canada had no positive cases," says Bernard, "or you would have heard about it." Nevertheless, the New Brunswick scenario did turn out to be worthwhile. The package missed the one commercial flight that could guarantee it would get to Winnipeg in time to be tested over the weekend. Saint John has its own level-3 lab, but Bernard says, they had no experience with anthrax. "So the question was, 'Do we let this lab with zero experience handle this, the most interesting case we'd had?'" The answer was no. Instead, within four hours that Saturday, three Winnipeg staffers had thrown together a mobile test unit and were on a plane heading east. A formal unit has since been formed and was stationed in June at the G8 Summit in Kananaskis, Alta. "Our Canadian network went from being theoretical to jelling into something that's real," says Bernard. "We acquired a great deal of expertise very quickly."

The anthrax scare also prompted Artsob in BSL4 to revise the lab's policy on smallpox. Prior to last fall, he says, Canada figured it didn't need to acquire a smallpox specimen or the capabilities to diagnose the virus. After all, smallpox was eradicated from the population in 1979. Officially, only two labs in the world, one in Russia and the other in the United States, have specimens for research purposes. However, lingering concerns in the international BSL4 community – concerns that at some point in the past, rogue scientists may have sold smallpox to buyers with misanthropic intentions – resurfaced. (Recently, a Russian scientist who defected to the United States claimed that the former USSR had tried to splice an Ebola gene and smallpox together to produce a pathogen with destructive powers hitherto unimaginable.) "Our thinking had been," says Artsob, "that if there was a naturally occurring case of smallpox, we would just rely on our neighbours [for help]. The anthrax scare made it evident that if smallpox recurs, it will very likely be bioterrorist-related. And if that's the case, there could be massive outbreaks, there could be many people exposed, and we couldn't rely on anybody else to do our diagnostics." Winnipeg's BSL4 lab now has its own smallpox diagnostic tests and a three-tier laboratory network trained to deal with all infectious agents.

ROUTINE IS GRADUALLY RETURNING to normal at Winnipeg's biocontainment centre. Bernard is catching up on things that were neglected when anthrax became the focus of her attention last fall but says her lab still receives, on average, two suspicious packages a month. Artsob is now busy with mosquito-transmitted West Nile. August and September is when human cases could manifest themselves as the virus moves continually north, south and west. "Clearly," says Bernard, "geography is not going to be respected by these organisms." Sure enough, by late July, four dead birds had tested positive for the virus in Winnipeg, the mosquito capital of Canada.

How the West Nile virus – not reported in the western hemisphere before 1999 – got onto the continent is as much a mystery as the anthrax outbreak continues to be. Rumours that bioterrorism was the cause prompted a lot of talk among microbiologists. The source was reportedly another defector, this time from Iraq – a reputed Saddam Hussein bodyguard who claims to have doubled as a Hussein look-alike to foil assassination attempts. In 1999, he published a book titled *In the Shadow of Saddam* in which he claimed Hussein developed West Nile as a bioweapon. "I still remember the tongue-in-cheek comment at the very first U.S. working-group meeting on West Nile," says Artsob. "It was supposed to be a close-knit group of 25 people, but the press heard about it and demanded to come. In the end, there were over 100 people crammed into the room, buzzing about how West Nile got into North America. It could have been a bird; it could have been Saddam Hussein. One scientist joked we will never know for sure unless one of them confesses.

"One can always speculate," says Artsob. "A lot of people say, 'Why would [Hussein] ever use something like West Nile? How many people could it kill?' I can't get into the head of a terrorist, and I'm not going to try, but you might think terrorists would only want something high-impact that scares people. Well, look back at what happened. Look at all the resources [North America] has put into West Nile – it's been millions since 1999. It did have some impact. People say maybe the introduction of West Nile was just a rehearsal for something in the future."

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PHOTOS (COLOR): Winnipeg's \$172 million federal biosafety complex (ABOVE) houses Canada's first level-4 biocontainment lab, which is specially designed and outfitted for research on the world's most dangerous and contagious viruses and bacteria. The guard posted at the building's entrance (OPPOSITE, BOTTOM) is one of many security features throughout its spacious, naturally lit interior (OPPOSITE, TOP)

and its six-hectare grounds. Before they enter the lab, scientists put on protective suits (PREVIOUS PAGE).

PHOTO (COLOR): A scientist outside the level-4 lab uses a two-way radio to communicate with his headset-wearing colleague inside. For security reasons, the complex does not allow level-4 staff to be identified by name. Before the pair inside can leave, they must take three showers: the first to disinfect their suits, the second to rinse off the disinfectant and the last to wash themselves. Even so, the suits remain in that area.

PHOTOS (COLOR): Safety glasses are required when working with pathogens in a level-3 lab. Here, Kathy Bernard looks out a stainless-steel pass-through into the hallway. Tools can be placed freely into the opening, but before they leave the lab, they must be decontaminated. Lethal viruses and bacteria, such as these two samples of anthrax (BOTTOM, left) and two of smallpox (BOTTOM, right), are shipped to the centre in safety packs that have been shown to survive airplane crashes.

PHOTO (COLOR): Twice a day, engineer Les Wittmeier or one of his colleagues inspects the biowaste system at the Winnipeg complex. It provides secondary treatment for about 13,000 litres of effluent a day. Primary treatment occurs in the lab. When sterile, liquids are discharged into the municipal sewer.

PHOTO (COLOR): Harvey Artsob stands in the chamber of a level-3 lab where staff must shower before they leave. Following the anthrax bioterrorism events in the United States, Artsob and Kathy Bernard helped set up a lab network in Canada with the expertise to recognize such agents anywhere they occur and immediately direct them to the right place for testing.

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Text by Siobhan Roberts

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