THE VIRUS HUNTER

HIV, Ebola, and the vast majority of other killer diseases have passed from animals to humans. So Nathan Wolfe is searching for the next AIDS *before* it makes the leap — and is revolutionizing the way the world tries to control diseases in the process.

by **TOM CLYNES** *photographs by* **J CARRIER**

GETTY IMAGES

IT'S NEARLY MIDDAY WHEN BRICE BIDJA STEPS out of the tangled forest surrounding the African village of Messok in southeastern Cameroon, gripping a Russian 12-gauge shotgun in one hand and the limp body of a mustached monkey in the other. Bidja usually returns alone after his hunts, but on this morning a handful of foreigners tags along with him as he approaches his mud-brick hut. Among the researchers, logisticians, and documentarians is American virologist Nathan Wolfe.

Wolfe stands just outside as the others duck through the low doorway; inside, the glare of the tropical sun gives way to an easy reddish glow of firelight on the faces of Bidja's wife Sandrine and their two small children. Bidja sets the monkey down on a palm frond and pulls out a sheet of filter paper provided by Wolfe's organization, the Global Viral Forecasting Initiative (GVFI). Sandrine crouches and picks up a machete, then slices off one of the animal's front legs and holds it over the paper, aiming the dripping blood at five printed circles. Once the targets are saturated, the hunter tucks the blood sample into a ziplock bag filled with silica gel packets and hands the bag to one of Wolfe's colleagues. The group will run tests later to see if the animal that Bidja and his family would soon devour is infected with a particularly nasty virus that could jump to humans, ultimately becoming the next deadly pandemic.

Sandrine thrusts the monkey's leg into the flames, perfuming the hut with burnt hair and skin. She sets it aside and continues the butchery as the foreigners come in closer with their cameras and notepads, documenting the blade's passage through legs and tail and neck. At the doorway, Bidja chats with Wolfe, their simple French

mixing with the sounds of splitting bones and separating tendons. Sandrine begins to open the monkey's rib cage with sharp hacks of her machete, each of which unleashes a fine spray of blood. It's too much for one of the visitors, who darts outside and makes a panicked reach into her backpack, pulling out a bottle of antibiotic gel.

"Oh, good, you brought hand sanitizer," Wolfe says, exaggerating

a stifled smirk. "That'll protect you, don't worry."

Meanwhile, Sandrine uses a smaller knife to finish readying every part of the monkey, except the entrails, for her family's use. Seeing the children growing restless, she reaches into the animal's chest cavity and cuts out its heart and liver. She tosses the floppy organs to the kids, who roll them in their hands like Silly Putty, showing them proudly to Wolfe.

SOLIDLY BUILT, WITH CURLY HAIR AND PLUMP, whiskered cheeks, Wolfe, 38, is at the muddy-boots vanguard of an ambitious movement that seeks to shift the way the world approaches disease control, from containing outbreaks to launching preemptive strikes against emerging viruses. "If we look at AIDS or smallpox or Ebola, or any of the really bad

HEART OF AFRICA Clockwise from top left: Villagers prepare a feast of monkey; a hunter inspects his bush-meat haul; Wolfe chats with villagers in Ngoila.

shit that has emerged over the past century," says Wolfe, "the vast majority of these pathogens has passed from animals to us. What we're trying to do now is get upstream, way upstream, and catch the next HIV before it can explode into a killer pandemic."

To do that, Wolfe has spent much of the past decade running alongside hunters like Bidja, collecting blood from them and their prey. That he chose the wilderness of southeastern Cameroon — one of the most challenging environments on Earth — is no accident. It was here, scientists now believe, that a chimp virus that would mutate into HIV made its first foray into the blood of a hunter like Brice Bidja. From its unwitting first host it would fan out around the world with a deadly, methodical efficiency, infecting more than 60 million people.

Now Wolfe is taking his "viral surveillance" project on the road, fueled by a burst of grants that will allow him to set up shop in other tropical hot spots that have histories of spawning deadly viruses, including cholera, bird flu, and SARS. Eventually he aims to create a worldwide infrastructure to supply researchers with a steady stream of blood from "sentinel populations," such as bush-meat hunters in Africa, poultry farmers in southeast Asia, or vendors in the Chinese "wet markets" where live animals are bought and sold for food.

"Nathan's work will help us fill major gaps in our understanding of what viruses are coming out, on an almost real-time basis," says Mark Smolinksi, director of the new Predict and Prevent Initiative from Google.org, the tech giant's philanthropic arm, which backs GVFI. "It's not going too far to say that Nathan could find the next

THE SARS OUTBREAK IN '03 INFECTED 8,000 PEOPLE AND KILLED MORE THAN 700, BUT IT COULD HAVE BEEN FAR, FAR WORSE.

HIV — hopefully while it's still circulating in animal reservoirs and hasn't fully made the transition into humans."

WHAT'S DRIVING INTEREST IN WOLFE'S WORK — and money to his projects — is the terrifying prospect that a new and unstoppable infectious disease could burst out of the jungle, blindsiding healthcare professionals and killing millions before an effective response can be organized. Of the more than 300 new infectious diseases that have struck humans since 1940, almost three-quarters have jumped from wild animals. The risks are increasing as modern societies stack the decks in favor of opportunistic microbes, with our closely packed cities, our changing climate, and our growing numbers of elderly.

Although science optimists predicted that serious infectious diseases would be conquered by now, the potential for outbreaks is growing as more global travelers carry viruses across borders. And as loggers and miners slash deeper into microbe-rich rain forests, more humans are coming into contact with animals that host rapidly mutating viruses.

Meanwhile, there is concern that global warming may be pushing "tropical" pathogens into temperate latitudes and mountain regions. Established scourges such as human monkeypox, dengue, and tuberculosis are staging comebacks, occasionally in drug-resistant strains that target people and places once thought to be exempt. West Nile virus, ensconced in Africa for thousands of years, first appeared in New York in 1999. Within three years it had made its way across the continent, becoming one of North America's endemic diseases. In November of 2007 a biologist at Grand Canyon National Park in Arizona died of pneumonic plague — part of the Black Death that transformed medieval Europe into a vast, open-air morgue — after performing a necropsy on a mountain lion.

Even without factoring in potential bioterror agents, modern humans have created what Wolfe calls the ideal recipe for microbial emergence. And yet, though the next hemorrhagic fever may be just an intercontinental flight away, the global public-health system remains largely focused on responding to epidemics after they've taken off. That's not rational, says Wolfe, who compares the current approach to that of cardiologists in the 1950s "just waiting for heart attacks to happen, then patching up the survivors with bypass surgery."

WOLFE GREW UP IN SUBURBAN DETROIT AND studied biology at Stanford and Oxford before heading to Harvard for a Ph.D. in immunology and infectious diseases. In 1998 he was in Borneo, researching orangutans, when the head of the U.S. Army's AIDS research program tracked him down and invited him to Cameroon to run a study of hunters in remote villages.

When Wolfe arrived here in 2000, researchers hadn't yet pinpointed this corner of Cameroon as the likely birthplace of HIV/AIDS. In fact Wolfe and his colleagues knew very little about the scope of pathogens in the animal kingdom, or the way they entered human bloodstreams and spread. But he and others had a hunch that hunters like Brice Bidja might have played a big part in the HIV transmission story.

Though HIV and AIDS came to the world's attention in the early 1980s, when a mysterious illness began to cut a deadly swath through gay communities in California and New York, the pandemic's roots

HOUSE CALLS Clockwise from above: Staffers draw blood for Wolfe's fast-growing collection; sophisticated software helps his organization track viral trends by computer; Wolfe's team gathers a blood sample from an antelope.

were planted much earlier. New genetic analysis techniques and discoveries of old tissue samples have pushed back the probable date that HIV's predecessor jumped from chimpanzees to humans. The most recent insight came late last year, when University of Arizona researcher Michael Worobey analyzed a preserved biopsy of a lymph node taken from an HIV-positive woman in 1960. Worobey's genetic analysis of the tissue — discovered in a university storage room in the Democratic Republic of the Congo — moved the likely date of the chimp-to-human jump back to about 1900. The findings also reinforce mounting evidence that it took decades — more than half a century — before HIV was able to gain its pandemic-producing momentum.

"This tells us that concerted prevention efforts can prevent local epidemics from gaining a foothold," says Worobey. "If we had known then what we know now, we could have stopped it."

Apart from Brice Bidja's missionary-imported T-shirt, it's not hard to imagine him as the villager who stepped out of his mud-brick hut one morning a century ago, destined to become the inadvertent first human host of HIV, a disease that would spread to every inhabited region of the world, claiming the lives of more than 25 million people.

The hunter must have counted himself lucky to bring down a chimpanzee, which would provide a feast for a small village. But maybe the wounded chimp bit the hunter as it struggled. Or maybe its infected blood dripped into an open wound on the hunter as the carcass was hauled home. Maybe the hunter's wife cut her hand while butchering, or one of his children put organ-bloodied fingers into their mouths, as I watched Bidja's children do. One way or another, blood infected with simian immunodeficiency virus (SIV) came into contact with human blood.

Viruses consist of genetic material — DNA or RNA — that is up to 100 times smaller than bacteria, far too tiny to be seen through anything but an electron microscope. Despite their small size, they carry an incredible amount of genetic machinery. They can respond to stimuli in real time, and they mutate extraordinarily fast. This last trait has made them the most diverse — and by many measures the most successful — class of organisms on the planet.

Unlike other organisms, though, a virus can't live on its own. A virus needs to get inside a living cell, then commandeer that cell's resources to reproduce and infect other cells. If two viruses happen to infect the same cell at the same time, they can swap genetic material in a process known as recombination.

THE SCARIEST MICROBES ON EARTH

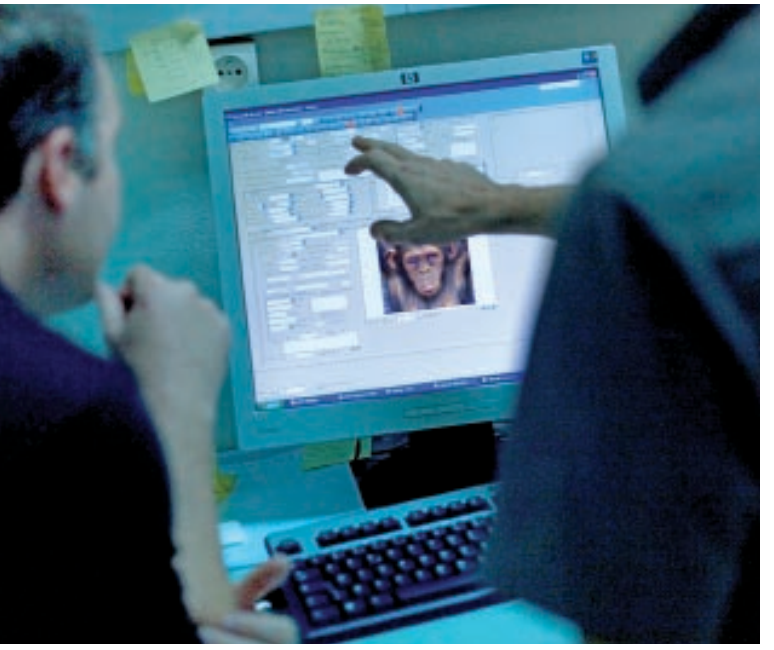
The emerging diseases that keep Wolfe up at night

PANDEMIC INFLUENZA
(worldwide)
Although the flu doesn't sound all that frightening as diseases go, it can kill millions in a really bad year. The new H5NI avian virus occasionally infects humans; if it were to become more easily transmittable it could lead to a devastating pandemic.

HTLV-3 AND HTLV-4
(Africa and elsewhere)
Human T-lymphotropic viruses are AIDS-related viruses that can cause leukemia and lymphoma. These two new retroviruses may be spreading in ways we aren't aware of. If they are, they could have a very substantial human health impact.

PLASMODIUM KNOWLESI
(Asia)
This malaria variation mainly affects monkeys but recently has entered the bloodstreams of humans. This is a good example of an emerging pathogen cross-transmitting; it has caused a majority of the human cases of malaria on Borneo.

SARS
(mainland China)
Severe acute respiratory syndrome causes flu-like symptoms, but its mortality rate is much higher than the flu's. After a near-pandemic in '03, it seems to have retreated back into the wild, but there's little to prevent it from jumping over to humans again.



In the case of pandemic HIV, scientists now know that the virus appeared in humans many years after it had recombined in chimps who had eaten two smaller species of monkeys. It subsequently spread from one person to another, reproducing so aggressively that within a month of infection a single teaspoon of a host's blood plasma can have 500 million copies of the virus.

Once it had infected a critical mass of humans, the virus took advantage of a series of opportunities — emigration patterns, urbanization, a boom in intercontinental travel — to transform itself from a local mysterious disease to a worldwide killer that still claims more than 2 million lives each year, and that continues to confound efforts to develop vaccines and other preventive measures.

WOLFE'S CAMEROON VIRUS-HUNTING OPERATION was initially a spare one. For the first couple of years, says Matthew LeBreton, an Australian who is now GVFI's ecology and rural site coordinator, the team relied on a single vehicle — a run-down Toyota Land Cruiser — to collect samples from 17 villages. When the truck broke down or roads washed out, they traveled by foot, bicycle, or rattletrap public bus, racing to get blood to the lab before its 48-hour spoiling point.

According to LeBreton, Wolfe thrived on the obstacles. "Give him the most difficult, complicated, logistically challenging environment, and Nathan will figure out a way to make it work."

Says Wolfe, "I'd tell my team that if nothing was going wrong, we weren't asking hard enough questions."

Every few months Wolfe would tail his blood samples back to the Centers for Disease Control and Prevention laboratory in Atlanta, where he would analyze them himself. In 2004, while looking at a blot of a hunter's blood work, Wolfe did a double take. The readout showed clear exposure to a simian foamy virus (SFV), so-called because the cells look like soap suds under a microscope.

Like HIV, foamy viruses are retroviruses. Because they inject their own genetic material into the cells they infect, retroviruses are tough foes. Once one gets in, it's impossible to eradicate.

Wolfe's discovery of simian foamy viruses in humans cemented his reputation as a viral-epidemiologist wunderkind. The National Institutes of Health awarded him its prestigious Director's Pioneer Award in 2005. His findings also turned traditional thinking in epidemiology — which had held that transmission of retroviruses from animals to humans is rare — on its head. "The fact that we found SFVs with such a small sample was the shocking thing," says Wolfe, "because it confirmed that viruses were passing from nonhuman primates to humans on a fairly regular basis."

Could human SFVs — or the two other new AIDS-related viruses Wolfe found in his Cameroon hunters — become the next HIV? It's still too early to say. So far none of the SFV-positive hunters have any glaring symptoms, though Wolfe's team will continue to monitor the hunters' health because of the possibility that they may become sick after a long incubation period. The team also takes regular blood samples of the hunters' families and sexual partners, looking for signs that the virus is spreading.

FOR WOLFE, WHO NO LONGER BOTHERS TO KEEP an apartment or a permanent academic affiliation, Cameroon is the third touchdown in his latest series of round-the-world flights. "I spend most of my time in cars and planes with my head bobbing, drooling on my chest," says Wolfe, who cultivates an air of omniscient nonchalance. Arriving late for our morning departure, wearing a T-shirt and flip-flops, he looks none the worse for his grueling agenda. "I finally figured out that coffee is a shitty drug-delivery system," he tells me. "It's not efficient, and the dosage isn't standardized." Now he toggles between the sleep aid Ambien and the antisleep drug Provigil. "Jet lag," he says, "is no longer a problem."

Then again, Wolfe could well have been high on the news that Google.org had just awarded GVFI a $5.5 million grant — Google's largest grant ever. The grant would be matched by another $5.5 million from the Skoll Foundation, which backs the work of social entrepreneurs.

Though Google.org program director Frank Rijsberman has described Wolfe as a field-virologist "rock star," there would be no helicopters or jelly beans on this tour. With a 10-hour drive ahead of us, our caravan of three vehicles motors out of Yaoundé, past the jagged skeletons of unfinished high-rises, some still standing apocalyptically years after construction ceased.

At one village, we top off with diesel sold in two-liter soda bottles, noticing fresh-killed porcupine on the menu du jour. It is tempting, but Wolfe is champing to get to Ngoila, about 30 miles north of the Congolese border in southeast Cameroon, before nightfall. "We can either stop here for lunch, or we can burn," he said, pausing for a mock-democratic microsecond. "I say let's burn."

We cross the Dja River on a rickety cable ferry and burrow deeper into the jungle. Army ants stream across the roads, forming living tunnels that look just like speed bumps.

The radio rhythms have shifted from frenetic Cameroonian *bikutsi* to the flowing beats of Congolese *ndombolo* by the time two of our caravan's trucks roll into Ngoila. The third truck sputters and dies a few miles outside the village. As the drivers locate a mechanic, Wolfe and I trudge off to pay respects to the *(continued on page 96)*

VIRUS HUNTER *continued from page 75*

village chief, the gendarme, and the subdivisional officer.

We stop to clown around with some local kids, then walk back toward the GVFI field office, arriving just in time to see the broken-down truck being towed in.

As the sun sets we repair to the porch of a small house that serves as GVFI's headquarters in Ngoila to drink warm beer and feast on rice, chicken, fried plantains, and *ndolé* (greens with nuts and salty fish or goat and palm oil) slathered with *piri-piri*, Cameroon's fiery salsa.

For Wolfe, it is a chance to bullshit with his staff — LeBreton, deputy director Ubald Tamoufe, chief operating officer Karen Saylors, and director of laboratory science Brian Pike — about the new, expensive toys that promise to ease logistics and narrow the time between specimen collection and results.

Now, Wolfe's Cameroon team — 27 public health specialists, wildlife ecologists, laboratory technicians, nurses, and community liaisons — are clearing space in their labs and field sites for new high-tech equipment. Cameroon will be getting nitrogen generators to cool blood at field sites, GPS-trackable motorcycles, and possibly a state-of-the-art phylogenetic sequencer, which would give GVFI the first world-class viral discovery lab in Central Africa.

EARLY THE NEXT AFTERNOON, AN elderly woman winces as a syringe pierces her vein, opening a flow of blood from her arm to a collection vial held steadily in a nurse's meaty hand. Standing in line behind her are several dozen local villagers. Apart from the needle's prick, no one seems the least bothered by the bloodletting or the waiting. "The success of this approach depends on having a long-term engagement [with the locals]," says study leader Tamoufe. "We're sharing knowledge, we're explaining the goals of what we're doing, we're being honest."

After the blood draw, study participants step inside a thatch-roofed pavilion for medical checkups. Then they're sent away with packets of milk, cans of sardines, condoms, and any prescription medicines they need.

GVFI's method flies in the face of the "parachute science" approach that has long typified data collection in the Third World. Wolfe thinks he's got the system down, and he believes that, with the right collaborators, his model can be scaled up and repeated anywhere in the world.

Maybe. But the unpredictable places Wolfe is targeting — Congo, Madagascar, China, Malaysia, Laos — have a way of making a mockery of the noblest goals and the most elegant logistics. Even here, where the team has an eight-year track record of trust and collaboration, nothing can be taken for granted. Today, for instance, Wolfe's team will attempt something unprecedented, with a high potential for misunderstanding. "This will be tricky," Tamoufe says. "There are certain cultural sensitivities surrounding masturbation."

The GVFI team wants to get semen samples and vaginal swabs from at-risk hunters, as well as their primary sexual partners. Here's why: Every virus needs to use its host cell's resources to make copies of itself, which then go out to infect other cells. But a virus that infects a cell in a liver or lung — or, indeed, almost any other cell in an animal's body — can't carry on to the next generation of its host. In other words, if you were to contract influenza, or SARS, or Ebola, and then have a baby, you wouldn't normally pass the virus on to your offspring. But some infectious diseases can be transmitted sexually.

Tamoufe's team approaches 17 hunters and their sexual partners, asking them to participate in today's "special study." The chief adds his own encouragement. "We are hunters here," he says, "and this is how we help. We know that there are some bad things inside some of the animals we kill. If we can help our friends discover how to protect people, that's good."

Both Tamoufe and ecologist LeBreton confide that they have doubts about this working. "But whether or not we get these extra fluids," LeBreton says, "we'll get plenty of blood."

LATE THAT AFTERNOON THE TEAM meets back at GVFI's headquarters in Ngoila, where night drops quickly. Within a matter of minutes the kerosene lamps are lit and the abundant butterflies are replaced by fireflies — one of which finds its way inside the screened-in porch, zigzagging among the team members. "We Cameroonians say that it's a lucky thing to have fireflies in your house," says Tamoufe.

Indeed, it has been a good day. Of the people approached, three men and four women provided semen samples and vaginal swabs — a pretty good start, all agree. That's in addition to the 100 blood samples collected.

Working like this, one village at a time, Wolfe has quickly accumulated one of the most comprehensive blood collections on Earth, some 25,000 human and 16,000 animal samples that are available to researchers around the globe. "I can guarantee that these repositories of samples will be treasure troves of information for the future," says Michael Worobey, of the University of Arizona.

Even though Wolfe is fundamentally a collector — of blood and exotic microbes and, to a lesser extent, West African art — he's a minimalist in his personal life.

"Almost everything I own is in a storage locker in Los Angeles," he says. When Wolfe was on the faculty at UCLA, he had an apartment in Venice Beach. "I would swim and do yoga and ride around on my Vespa. I was also into rare orchids, but I wasn't there enough, so they died."

He tells me he lives for moments like these, drinking warm beer with his team, listening to the sounds of the jungle as they build into a riotous chorus of grunts and caws and chuckles. But Wolfe, who is single, says that as he nears the age of 40 the urge to drop anchor is getting stronger. "I'm actually thinking that things will begin to calm down in a few months," he says. "Of course, I've been saying this for the last 10 years."

Pike suggests we go outside to toast the almost-full moon. As we do, someone fires up a generator and a radio, sending the warm, liquid guitar lines of Congolese soukous skipping across the courtyard.

"We vertebrates are a pimple on the ass of life on this planet," Wolfe says, to no one in

particular. "But we exist at a moment in history when we have the tools to understand things in a deep way, things that we didn't know existed a few years ago.

"What's still out there?" Wolfe asks, looking up at the moon. "We just don't know. And that's what's fun."

EVERY WEEKDAY MORNING AT 9 AM Central European time, the Epidemic and Pandemic Alert and Response team meets in the Strategic Health Operations Centre, known as the "SHOC room," at the World Health Organization's headquarters in Geneva, Switzerland. After discussing incoming reports, members fan out to verify outbreaks through WHO country offices and local governments.

In the spring of 2003, WHO received a report of a flulike outbreak in southern China — a mutant, fast-spreading virus that would come to be named severe acute respiratory syndrome, or SARS. But by that time, a man from Guangdong province — famous for its "wet markets" selling wild animals for food — had traveled to a hotel in Hong Kong.

That single-night stay in room 911 prompted a SARS "super spreader" event that led to at least 16 SARS cases among hotel visitors. But it didn't stop there. Those travelers departed to Europe, North America, and elsewhere in Asia, spreading the virus to more than 8,000 people in 32 countries.

The SARS outbreak killed more than 700, but it could have been far worse. A massive international containment effort, led by the WHO, averted a doomsday scenario and quickly controlled the outbreak. What worries people like Dr. Michael Ryan, coordinator of the WHO's Global Outbreak Alert and Response Network, is that SARS may have been just a rehearsal for something worse. "We winged it with SARS," says Ryan, "and we got away with it, because the core countries had the capacity to deal with it. But if SARS had happened in rural Africa we'd still be dealing with it. And I think it's inevitable that we'll be hit with something new that will be harder to put back in its box."

Despite the high stakes, the world's outbreak-response agencies are perennially underfunded and underequipped. For instance, the U.S. Centers for Disease Control and Prevention's pandemic preparations budget in 2008 was just $158 million — a fraction of the nearly $200 billion budgeted for the wars in Iraq and Afghanistan last year.

"We don't have any problem investing money in physical security issues," Ryan says. "But epidemics of infectious disease have killed a lot more people than wars ever have." (The "Spanish flu" — which may have actually originated in Kansas — claimed around 40 million lives in 1918–'19, nearly twice the number killed in World War I.)

For its part, WHO is hamstrung by budget shortfalls and international protocols that can slow its response. Until recently, for instance, countries were required to report only three infectious diseases (cholera, plague, and yellow fever), and the WHO couldn't legally consider outbreak reports from nongovernmental sources. As a result of SARS (which was given a head start by the Chinese government's hamhanded response), the agency can now use reports from informal sources. But in places where information doesn't flow freely (think Myanmar, or North Korea), a localized outbreak could potentially smolder until it sparks an uncontainable pandemic.

"Once viruses get going," says Dr. David L. Heymann, the WHO's assistant director-general for health security and environment, "they don't have much regard for borders or politics." Wolfe's viral surveillance project, he says, will help the WHO and other health agencies fine-tune computer models that can forecast where the next diseases will emerge and then contain them through proactive approaches such as blood-supply testing, education, economic development, and environmental protection.

But some public-health experts believe it ultimately makes more sense to give communities and healthcare providers the tools to bypass international agencies and governments, using information and technology to deal with local threats before they become global crises. To that end, last year Google.org unveiled its Predict and Prevent Initiative. The program aims to expand disease surveillance and build grassroots networks to push detection and response "two steps to the left" of the epidemic curve, according to Dr. Larry Brilliant, the iconoclastic doctor and internet entrepreneur whom Google's founders brought in to run their philanthropy arm.

"We'll always need the international agencies," says Predict and Prevent director Mark Smolinski. "But I hope that within the next 10 years, a farmer in Vietnam will be able to report a sneezing chicken or a sick child without worrying about what system is responding on the other end of the line."

Eric Rasmussen, who heads the disease- and disaster-prevention lab InSTEDD (which is partially funded by Google), says it doesn't matter how many good policies and procedures are in place "if communications hurdles make it impossible to get information to the people with the skills to do something about it."

InSTEDD and its technology partners are working on everything from inflatable satellite dishes that can be transported in backpacks to cell phone–based systems that could broadcast warnings of an imminent calamity, such as a tsunami.

Since most sick people don't go to a doctor as a first step, the Predict and Prevent team is looking at unconventional data sources for disease outbreak detection. These include rumor surveillance by health workers and digital detection (sometimes called "scrubbing") for news articles or blogs suggesting a possible outbreak.

ON OUR FINAL MORNING IN THE FIELD, project leader Joseph Le Doux Diffo convenes a "healthy hunter" meeting in Zoulabot. Bush meat ("We prefer to say 'wild game,'" Wolfe corrects me) is a thorny issue in Central Africa, due to the growing number of commercial hunters. If current hunting levels persist, many species — especially primates such as gorillas and chimpanzees — may go extinct in the wild within a few decades. Wary of occasional crackdowns, villagers are often suspicious of outsiders who talk about hunting.

"We are not telling you not to eat hunted meat, but bad diseases are out there now," Diffo tells the crowd of about 100 people, speaking mostly in French. "So please do it carefully."

"There are ethical subtleties here," says LeBreton, watching the presentation. "On one hand, the levels of hunting are not sustainable, so they are contributing to a major ecological catastrophe that will eventually impact their own food security. On the other hand, every human on Earth will choose to feed their child over saving an endangered piece of meat."

GVFI's approach is a combination of safe-hunting instruction and conservation education. Diffo encourages the hunters to focus on abundant animals, such as rodents; he reminds them that certain species are illegal to hunt; then he demonstrates how to wrap carcasses in either plastic or large palm fronds before carting them home. And, since Ebola has been confirmed across the border in Congo, he advises the hunters to walk away from dead animals in the forest.

"If we want people to change their activities, then we will have to pony up the money and create alternatives," says Wolfe. "And certainly we should. Because if we feel responsible enough to stop pandemics and save endangered species, then we also have the responsibility to deal with the inequalities that reinforce these things." After all, he continues, "they're doing something completely rational. Wild game hunting may be high-risk, but it's not higher-risk than not eating."

Late that afternoon we arrive at the GVFI house in Ngoila just as the caretaker is pouring kerosene over a line of termites heading across the courtyard and up the house's wall, determined to make a meal out of the rafters. Wolfe sits in a plastic chair, his clothing stained earth-red, debating with his team whether viruses could be more important to the evolution of animals than mutation or genetic recombination, as some researchers have theorized.

"We live on a planet that is dominated by microbial life," Wolfe says. "I don't think anyone would debate that. But are viruses the primary driver of evolution? I'm not convinced."

A case of beer arrives just as dark gray clouds begin to gather overhead, their bottom edges highlighted by the orange and pink rays of the recently departed sun. When the storm lets loose we retreat to the porch, watching the rain come down in crazy, curving sheets. "It's mind-boggling," Wolfe says. "A century ago we didn't know viruses existed, and now we're starting to understand that they're the prevailing life form on Earth. We have to rethink just about everything we know about how this planet works."

WHERE TO BUY PAGES 76–81 Hickey Freeman sport coat and shirt at hickeyfreeman.com. **Bobby Jones** pants at hickeyfreeman.com. All **Vans** shoes at vans.com. **Hickey Freeman** suit at hickeyfreeman.com. **Louis Vuitton** shirt at louis vuitton.com. All **Sperry** shoes at sperrytopsider.com. **Zegna Sport** shirt at zegna.com. **Nautica** pants at nautica.com. **Salvatore Ferragamo** sweater at 800-628-8916. **Theory** pants at bloomingdales.com. **Burberry** polo at burberry.com. **John Varvatos Star USA** pants at johnvarvatos.com. **Nautica** shirt at nautica.com. **Ermenegildo Zegna** pants at zegna.com. **Salvatore Ferragamo** jacket at 800-628-8916. **Malo** polo at Malo store, New York, 212-396-4721. **Theory** pants at bloomingdales.com. **Burberry** jacket and pants at burberry.com.