

How the microscopic Ebola virus kills thousands

The fear of Ebola has spread faster in America than the virus itself. Ebola has infected the American psyche, forcing us to do risk analysis of a pathogen we know little about. This is different from the flu scares of recent years, because this virus is novel here, and we have no cultural memory of what we are supposed to do, or think, or believe, when Ebola is on the loose.

People have to wonder: How contagious is this virus — really? Is there something different and more pernicious about this particular strain of Ebola?

The experts can't answer such questions with certainty. Ebola has been known to science only since 1976. As an exotic disease that until this year affected only Africans in rural villages, Ebola hasn't been studied as closely as, say, influenza or HIV.

The virus has its quirks: Some people infected with Ebola never get sick at all. Some who become sick shed massive amounts of virus — they're "super-shedders" — but others do not. Fever is typically the first symptom of Ebola virus disease, but sometimes it's a lagging indicator or never appears at all.

The virus is mutating, like all viruses, and could conceivably — this is a very remote possibility — change its mode of transmission, a fact that has been much hyped in recent weeks by those with an alarmist frame of mind.



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Patients infected with Ebola are most contagious when their bodies are close to collapse and the "viral load" in their organs is at its peak. Time is a crucial factor in the

Yet for all these uncertainties, the Ebola emergency in the United States has in a key respect played out exactly as epidemiologists would have expected: The people who have gotten infected, both of them at a Dallas hospital, had close contact with an extremely sick person.

Sunday marks 21 days since Thomas Eric Duncan, who contracted Ebola in Liberia and

occurrence of new cases of the disease.

then flew to the United States, was admitted to Texas Health Presbyterian Hospital Dallas. Officials have been monitoring 48 people potentially exposed to Duncan prior to his hospitalization, his fiancée among them. The incubation period of Ebola, from infection to symptoms, is generally considered to be between two and 21 days. So far, none of these people has shown signs of Ebola disease.

This could change with the next news flash, but so far the virus hasn't spread wildly in the United States.

“There's a reason it's not everywhere. It's just not as easy to transmit as people think,” said Michael Kinzer, a medical epidemiologist for the Centers for Disease Control and Prevention who spent five weeks in Guinea this summer fighting the outbreak and will return Monday.

Such encouraging words are unlikely to settle the jangled nerves of Americans who fear the virus will spread like dandelion seeds in the wind. Americans have an unsettled relationship with the expert class, admiring the achievements of scientists without fully trusting that they're immune to fundamental mistakes.

It happened already in this season of Ebola: The CDC assured the public that American hospitals could handle an Ebola patient without permitting secondary infections, and then in Dallas one case became three. Skepticism, for many people, is a form of personal protection.

But Ebola fears have incited overreaction. On Friday, hazmat teams raced to the Pentagon when a woman mistakenly thought to have traveled recently to West Africa [threw up in a parking lot](#); 22 people were quarantined for hours on a shuttle bus because the woman had briefly been on board.

The same day, the Carnival Magic cruise ship was turned away by Mexican authorities at the port at Cozumel because a [passenger had potentially handled](#) sealed blood samples from Duncan at the Dallas hospital. Meanwhile, The Washington Post's Pulitzer Prize-winning photographer Michel du Cille was disinvited to speak at Syracuse University because du Cille had covered the story in Liberia three weeks ago and, as the [journalism](#)



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Ebola's catastrophic effect on the body.

school's dean wrote in explaining the decision, "We did not want to create a panic."

A school district in Northeast Ohio closed a middle school and an elementary school because an employee had flown on the same Frontier Airlines plane on which Ebola-stricken health-care worker Amber Vinson had flown. They weren't even on the same flight.

That's an example of Ebola hysteria, said Mark Rupp, an infectious disease doctor at Nebraska Medical Center, where two Ebola patients have been treated.

"You would have to assume that the nurse is contagious at an early stage, which is very limited, then you have to assume there was a contaminated environment on the plane, and that the contamination results in transmission, which is pretty unlikely. Then you have to assume that a person who was not even on the same flight but who flew on the same plane then came into contact with contaminated material and became infected, and then assume that immediately transfers to a child, which is impossible," Rupp said. "It's unlikely unlikely unlikely unlikely, and then impossible impossible."

The two health-care workers who contracted Ebola, Vinson and nurse Nina Pham, had direct contact with Duncan when he was suffering extreme symptoms, including vomiting and diarrhea. They were among the workers who treated him at a precarious time when he had been admitted to the intensive care unit but had not yet tested positive for Ebola. Duncan died Oct. 8.

The CDC and Texas officials have warned that there may be other health-care workers who test positive in the days ahead. There are also hundreds of people being monitored because they flew on the Frontier Airlines plane. So far, secondary infections at a distance from the hospital haven't materialized, not even among the people who stayed with Duncan in a small apartment after he was feverish.

It's conceivable there are instances here of "asymptomatic infection." Researchers say a

person can become infected with Ebola, [never develop symptoms](#), never become contagious, and fully recover, becoming virus-free — without knowing any of that had happened.

“Asymptomatic cases are likely to have a little bit of virus for a little bit of time, then fight it off,” said Steve Bellan, a post-doctoral researcher at the University of Texas at Austin.

There have emerged in recent weeks two overlapping scientific narratives about this Ebola outbreak. They might be labeled the microbiology narrative vs. the epidemiology narrative. Call it the small picture vs. the big picture.

The microbiologists study the virus up close, scrutinizing its structure, genetic sequence and behavior as it invades a cell, hijacks cellular machinery, replicates and then spreads through the body. A drop of bodily fluid can potentially contain a million virus particles.

In theory, a single virus particle — a virion — is capable of being infectious and, after replicating billions of times, killing the host. That makes Ebola unusually infectious and virulent.

But that’s not the same thing as contagious. Ebola in humans is spread only through direct contact with virus-laden bodily fluids, and is not as transmissible as such airborne viruses as influenza and measles.

Some scientists have said that perhaps this strain of the virus generates an unusually high “viral load,” with more virus present in any drop of fluid. That would make it more contagious simply as a function of mathematics. So far there is no published data supporting that.

Peter Jahrling, who has studied Ebola for the National Institute of Allergy and Infectious Diseases, said tests on patients in Africa have turned up “a lot of virus,” but he said that could be an artifact of a new type of testing.

Thomas Geisbert, who studies Ebola at the University of Texas Medical Branch at Galveston, said he and other scientists have samples of this Ebola strain in their

laboratories. He said it's difficult to tell if a new strain of the virus is replicating faster than earlier strains, because you'd need very precise data from patients at comparable stages in the course of the disease. The viral load isn't static. It increases as the disease progresses.

That's why a person who is infected but without symptoms will not spread the virus initially: There's very little virus present in the blood, and it is not yet present in other bodily fluids. It can be many days, for example, before it invades the bladder and begins to be detectable in urine, Geisbert said.

"Statistical probabilities come into play," Geisbert said. "In most cases, people are symptomatic before there are any large quantities of virus in things like urine or feces."

The question of precisely when a person begins to shed the virus, and in what quantity, is extremely important given that Vinson, the infected Dallas health-care worker, traveled twice on a plane, Oct. 10 and Oct. 13, the second time when she was already symptomatic with a temperature of 99.5 degrees.

"We don't have it worked out to what exact viral load correlates to the onset of symptoms," said Daniel Bausch, a researcher at Tulane University. "Think of a bell curve starting from the moment of infection [zero virus], then increasing virus replication to the top of the curve, maybe around 20 days later, when there is a high level of virus and the person is severely ill. Maybe around eight to 10 days after the beginning [i.e. the usual incubation period], a person starts to become symptomatic."

The virus itself evolves over time, as all viruses do. Whether that evolution will be significant in this outbreak is unknown. Genetic changes could potentially affect the accuracy of diagnostic tests or the effectiveness of vaccines.

What would be even more alarming, scientists say, is if Ebola somehow mutated to become an airborne virus.

"What the hell are we going to do if we suddenly see the potential for transmission that might be respiratory in nature. Do we have a plan?" Michael Osterholm, an outspoken University of Minnesota epidemiologist, said last week at a conference on Ebola at Johns

Hopkins University.

Most scientists have said it is extraordinarily unlikely that Ebola will change its mode of transmission. Scientists are wary of absolutes as a rule, but in the annals of medical science, such a major change in transmission has never been observed in a pathogen that already affects human beings.

“If a virus were to acquire the ability to go airborne, it would change the landscape dramatically,” Jahrling said. But he said the likelihood of that is “remote squared.”

Moreover, the Ebola virus does not have an affinity for the cells deep in the lungs.

The scale of this outbreak is like nothing seen before, and that could have implications at the microbiological level, said Peter Piot, director of the London School of Hygiene & Tropical Medicine, and one of the main researchers who discovered the Ebola virus in 1976. He said that all the previous outbreaks combined killed about 1,500 people. This one has killed more than 4,500 people in West Africa, and the virus has many more opportunities to evolve as it passes through the human population, Piot said.

“As it adapts to the human species, it could kill in a slower way, which is paradoxically a bad thing,” Piot said. “If it kills only 30 percent of patients, there is more time for people to be sick and to infect others.”

He suspects the depth and breadth of the current epidemic are attributable not to changes in the virus but rather the lack of a timely international response and the way societies have become more urban and interconnected in recent decades. “A perfect storm,” he said.

This summer Kinzer, the CDC epidemiologist, told members of the Guinea media, “Ebola’s not transmitted by the air. Fear and ignorance are transmitted by the air.”

The big picture is that Ebola is rampant in West Africa because these are very poor countries in which people often lack access to public health care. Ebola victims suffer in unhygienic conditions, and their caregivers struggle to keep themselves clean, Kinzer said. Burial traditions include close contact with the bodies. Under such conditions, a

pathogen is not under pressure to evolve in a way that enables a new mode of transmission.

Someday there could be a widely distributed vaccine for Ebola, but for now the best hope for Ebola patients is staying hydrated and nourished.

“Ebola is a disease that is basically leaky pipes,” Kinzer said. “Your vessels are leaking, you’re losing water, electrolytes, protein, nutrients. You’re losing the things you need to fight off the viral infection. You feel terrible. You don’t feel like taking care of yourself. If you can counteract that, you can vastly increase your chances of survival.”

The World Health Organization on Friday sent out its [latest update on the West Africa outbreak](#), officially listing the United States as having three cases (Duncan, Pham and Vinson) and one death (Duncan). Liberia, Sierra Leone and Guinea have had 9,191 cases and 4,546 deaths.

Lenny Bernstein, Abby Phillip and Lena H. Sun contributed to this report.