

# Heartland Virus from Lone Star Ticks, Georgia, USA, 2019

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Gonzalo Vazquez-Prokopec, an associate professor of environmental sciences at Emory University in Atlanta. We'll be discussing the presence of Heartland virus in lone star ticks in Georgia.

Welcome, Dr. Vazquez-Prokopec.

[Gonzalo Vazquez-Prokopec] Thank you, Sarah.

[Sarah Gregory] Heartland virus and your April EID article have been in the news a lot in the last few weeks. Give us a brief history of the virus.

[Gonzalo Vazquez-Prokopec] Yes. So Heartland...it's a recently discovered virus from the US, actually. So it was discovered in the year 2009. And what makes this virus particular is that it's not transmitted by mosquitoes or from person to person, but by the bite of ticks, particularly a species of tick called *Amblyomma americanum*, or the lone star tick. And our study presents the finding of the discovery of this virus being transmitted in the state of Georgia.

[Sarah Gregory] And besides Georgia, what other states is it found in now?

[Gonzalo Vazquez-Prokopec] Yeah, it's...really, the finding of this virus has occurred in association with the detection of other human cases, many of them fatalities. And we can map the virus through southern USA, from Missouri all the way to Georgia, and from Georgia all the way to Pennsylvania. And really, we do not know the whole range of the virus because there's no testing specifically done for ticks in all the states where the *Amblyomma americanum* (the lone star tick) is found. But we predict that the virus is more widespread than we know, and we have the evidence now. And of course, the evidence of infection might be larger.

[Sarah Gregory] So this virus (and that's why it's called Heartland) started in the Midwest. How did it spread from there to these Southern states and Pennsylvania and the others you mentioned?

[Gonzalo Vazquez-Prokopec] Very good question. We hypothesize that it hasn't spread, per say. The virus has been circulating, and it's very likely circulating throughout the regions—the Midwest and the South and the Southeast. What happens is we usually detect it when somebody gets sick...a human individual gets sick, and at the same time, gets tested for it. The alternative is that what we can do is go to the field, capture ticks, and test those ticks for infection. And that's how we found it in Georgia and many other colleagues found it in different states.

[Sarah Gregory] So you went out specifically looking for these ticks?

[Gonzalo Vazquez-Prokopec] Exactly. And if you look for it, very likely you are going to find it, as long as you have enough ticks of the *Amblyomma americanum* species.

[Sarah Gregory] So there seem to be a lot of emerging tickborne and mosquito-borne diseases. Are there environmental factors playing into this rise?

[Gonzalo Vazquez-Prokopec] Yeah, indeed. So multiple factors (we cannot point to one specific). Climate change is affecting the seasonality of ticks and how far north or south...and especially north they can go, and that's how many have expanded to northern latitudes. But also, land use change. What happens is a forest gets fragmented smaller, animals bump with each

other more, ticks jump from deer to small rodents and from other hosts. And those small patches of forests might be the places where people go hunting, recreational hiking. And that's where the perfect combination of factors occurs, where these tickborne viruses or other pathogens are being transmitted.

[Sarah Gregory] So you mentioned animals. So these viruses, they start in animals and then the infection, there's spillover to people?

[Gonzalo Vazquez-Prokopec] Yes. That's what we call a zoonoses, where we have a pathogen circulating in a reservoir animal, and then there's a spillover event into a human—disease, in many instances, that lead to the detection of the virus from the spillover. And particularly for Heartland, we don't have strong knowledge of what are the reservoirs—so, what are the animals that are maintaining this virus in nature? It could be rodents, it could be opossums, birds. So the *Amblyomma americanum* ticks, which is the primary vector that we hypothesized, bites a wide range of animals. So part of our future research is to really nail down which specific animal species is the one maintaining the virus in nature.

[Sarah Gregory] And how prevalent is this virus so far, that you know of?

[Gonzalo Vazquez-Prokopec] Well, we just know, based on evidence, that there are few human cases that have been reported to the CDC (about over 50 since 2009). There's a study in Missouri that did a screening of a blood bank and found less than 1% of people with antibodies. But really, the true burden is unknown, because there's no testing done, not only on people with symptoms, but also in the general population. And also, there's no screening of ticks done routinely. So what we do know is that those 50 cases are very likely an underestimation of the true burden of the disease.

[Sarah Gregory] How dangerous is Heartland virus compared to the many other tickborne diseases? You mentioned fatality, I think.

[Gonzalo Vazquez-Prokopec] Yes. So again, we know from the few cases that were detected that were either severely ill or hospitalized. Then again, those are small fractions. But we do not know. What we know is that many people report having fever, tiredness, and some other symptoms about two weeks after the detection of a tick bite or a tick attached to them. But really, the wide range of symptomology is unknown.

[Sarah Gregory] Okay. So why did you do this study? What inspired it?

[Gonzalo Vazquez-Prokopec] Part of it was the detection of or the finding of a human case...the first human case in Georgia (in southern Georgia). The other part is a post-doc in my laboratory, who had experience working with other ticks and tickborne diseases, who expressed, really, her leadership and interest in detecting whether this virus was circulating in Georgia. And those two combined led us to hypothesize that, yes indeed, if we have ticks, we might have the virus. And then, because of that, we initiated the study.

[Sarah Gregory] So what were you looking for in particular when you started this study?

[Gonzalo Vazquez-Prokopec] So we were looking for evidence of not only the ticks found in Georgia....keep in mind that *Amblyomma americanum* (the lone star tick) is the most common tick that bites people in Georgia and many other southern states. So we were interested in just confirming the presence of the virus. So with that confirmation, we can really open up a whole new set of studies to try to understand. That's our ultimate goal, the transmission ecology of

Heartland. What are the reservoirs? If we know the reservoirs, we might know which animal models could be used to understand the ecological components of the virus, and potentially even research a vaccine, if it might be needed in the future. So all of that started with this confirmation, detection in an area that we know, where we hypothesized that had potential and now from then, expanding and trying to go to new areas.

[Sarah Gregory] And why did you choose Georgia to do your investigation? And was there a particular part of the state you collected ticks from?

[Gonzalo Vazquez-Prokopec] Yes. So Georgia...a previous study done in white-tailed deer, they found evidence of antibodies against this virus and from all the southern US states. But from Georgia, there were the most locations where deer collected had evidence of antibody presence. So that's one of the pieces of evidence. The other one was the detection of the single human case in Georgia. And those two combined led us to a specific county...group of counties south of Georgia, east of Macon, where we had not only the county where the human case was reported, but also where we had evidence of infected deer. That's where we nailed that location for our initial study.

[Sarah Gregory] And how did you structure the study?

[Gonzalo Vazquez-Prokopec] So we first had to find habitats that were suitable for the ticks. And for that, we did a first year, where we sampled many locations, particularly in state parks and places that people visit, because we wanted to go to locations that human exposure may happen readily. So in the first year, we sampled over 20 locations. And then in the second year, we visited the locations with the most ticks collected in the first year. And those locations were the ones that yielded two of them—two of the three locations yielded the positive ticks that we reported and we genotyped.

[Sarah Gregory] And how did you go about collecting these ticks?

[Gonzalo Vazquez-Prokopec] Well, it's a tedious process that is trying to mimic a natural process. So we do something called flagging, which basically means having a flag of cloth (felt) that's colored white, and basically walk through the woods and the lower vegetation, putting this piece of cloth on the vegetation. Because ticks that are going to be ready to pierce on a host are going to be waiting for that host on the tips of that vegetation. So what the cloth is doing is mimicking what the ticks would find when deer or other animals are going through the vegetation. It's just that, we try to capture them on that piece of cloth, and then with tweezers and patience, get them into vials for future testing.

[Sarah Gregory] So it's just cloth? It's not, like, scented with deer or anything, human. It's just cloth?

[Gonzalo Vazquez-Prokopec] Just plain cloth. Like the same as your pants when you walk, they might jump on you and pierce on your skin after.

[Sarah Gregory] I see, okay. So once you have all these ticks, how do you process them?

[Gonzalo Vazquez-Prokopec] So we take them to the lab, and we have to grind them really carefully because they're really hard. And the virus is inside their body, their self. So we have to grind them very carefully, mix them with reagents that not only preserve the RNA and genomic material, but also prevent fungal infections and other growth of bacteria. And then, that is the

initial processing that then leads to PCR virus isolation in specific cells that would grow this virus. And those were the main diagnostic tools that we used to detect infection.

[Sarah Gregory] How exactly did you differentiate Heartland from other possible pathogens?

[Gonzalo Vazquez-Prokopec] Yes. So we do molecular tests, particularly RT-PCR, which is a very sensitive method because we have specific primers, specific parts of the sequence of the genome of the virus that would only bind to the virus. And with that method, we were able to unequivocally detect that we had the virus. But at the same time, because it is really hard to find it, we also took those...the mixture of the tick tissue and plated it in cells (monkey cells). That allowed the virus to grow into them and then extract the virus from there and then do also PCR. So molecular testing was done, and then what further confirmed the virus was we took those viruses and did what we call whole genome sequencing. We just tried to get, as complete as possible, sequence of the whole virus. And that matched perfectly with Heartland, which is already found in repositories in banks of genome sequences. So the matching was done through these two processes.

[Sarah Gregory] I see. So your study also mentions Bourbon virus from the Midwest. How is that related to Heartland virus?

[Gonzalo Vazquez-Prokopec] Yes. So what we know of Bourbon is it is the least known (one of the least known) viruses here that we know infected a few individuals. But we do know is that when the virus was found, it was also found in areas where Heartland was detected. So what we tried to do is try to detect whether both viruses were in the same ticks in Georgia. And we didn't detect Bourbon, although we did the same methods for Heartland. So we hypothesized that either it's not here or the frequency of transmission is really low or the location where it is found is not where we went. So there are multiple explanations for that.

[Sarah Gregory] Why is it important to know that Heartland virus is a danger in Georgia now, or anywhere?

[Gonzalo Vazquez-Prokopec] Yes. So the threat of emerging infectious diseases is apparently known, and we are experiencing it. For us, as scientists, what we're trying to do is gain evidence of these rare pathogens that could have implications for human health, particularly in springtime, when people go out hiking or hunting or exposing themselves in the forest. But we want to know what type of viruses could be out there transmitted by ticks. Not to cause panic or alarm (this is not a virus that is going to spread like many others), but just to bring awareness that when we go outside, there is potential for exposure and that we have to exercise our personal protections against tick bites, so we minimize any potential risk.

[Sarah Gregory] Is there a test for it in people? Could I go into my doctor and say, "I think I have Heartland virus, look for it"?

[Gonzalo Vazquez-Prokopec] Unfortunately, that's really hard because it's not a notifiable disease, so there's not a formal routine diagnostic. But we do know is that if you have symptoms and you're at the right time, you could be detected as infected by this molecular method (PCR). There's also...post infection, you could do some antibody detection. But again, it's not something done routinely, and it would be really hard for physicians, just based on the general symptoms, to prescribe that diagnostic. So to me, it's really asking big questions about are you going outside? Did you have a tick about two weeks ago on your body? Those might be signals that could lead

physicians to prompt some further testing if the symptoms do not match any other symptomology of a disease, right?

[Sarah Gregory] And what would those symptoms be?

[Gonzalo Vazquez-Prokopec] Well, it has very generic symptoms at the beginning. You might have a mark where the tick bite happened. But fever, tiredness, nausea...so they are very generic. So at the beginning, there's nothing that would prompt you from saying, "Oh, I have Heartland". Because most of the hospitalizations and fatalities occur in people who have other conditions, particularly who are elderly and had other pre-existing conditions that basically exacerbated with the infection of Heartland.

[Sarah Gregory] So assuming somebody might actually get it diagnosed, is there a treatment if it's caught soon enough?

[Gonzalo Vazquez-Prokopec] Unfortunately not. There's no treatment for Heartland.

[Sarah Gregory] Well, that's bad news. What are the particular ways that this is important to public health?

[Gonzalo Vazquez-Prokopec] Well, again, emerging infections are really important because they could change as the ecology of a system changes. And right now, what we've seen with Lyme disease and other tickborne diseases in the US is that they are expanding and becoming a bigger problem in areas that 10, 20 years ago, they were not. So studies like ours are bringing light to some of those pathogens that hopefully would never become problematic. But if we have knowledge and evidence before they become problematic, then we have better to protect.

[Sarah Gregory] And just on a very practical level, here. What do you think are the best ways for people to protect themselves from tick bites?

[Gonzalo Vazquez-Prokopec] Yes. So first of all, they should follow the CDC recommendations. There's plenty of information on the CDC website. And the main recommendation is that ideally, for those who are or potentially spending time (a lot of time) in the forest, wearing long pants, protecting themselves with boots. And also in those conditions or areas where they know there's a lot of ticks, they could use insecticide-treated clothing. There's an insecticide called permethrin that either you can buy clothing that comes with it, or you can buy the product and impregnate it yourself. And what that insecticide will do is, any tick jumping on their legs, or their arms would just basically feel the insecticide and come off or die. If you cannot wear those, especially long pants, the minimum would be wearing repellent, like DEET as one of the active ingredients. It has high efficacy, particularly the higher concentration (like 30%). Putting on repellent often is another one that would work. And in the case or the event of seeing or detecting a tick, immediately taking it off your body (not waiting). Because what we know with viruses (other viruses) is that it takes about 20 minutes of the tick being pierced to inject or transmit the virus. So the earlier you can take it off, the better. And those methods could be enough for preventing or minimizing the exposure of ticks and tick bites.

[Sarah Gregory] Okay. So you mentioned forests and woods and hiking and that kind of thing several times now. Are they the areas that are most infested with tick—say, as opposed to my backyard?

[Gonzalo Vazquez-Prokopec] Yes. So this tick depends on basically having enough wooded areas. So it's not going to be found in a swamp, it's not going to be found in a plains field or a

grassland. They're really in wooded areas where we have under storage vegetation, like bushes and grasses and other vegetation (under trees). Those are the same areas where people go. Around the city...it's not necessarily in the city, per say, it's going to be in locations that are forested far away because the tick and the virus require a wide array of mammals, deer, and others. And those are not very likely to be found in your backyard or in the middle of the city. But, yes, if we go into different locations, we will find those.

[Sarah Gregory] I see. So is there something environmentally that can or should be done by counties or the state to protect people?

[Gonzalo Vazquez-Prokopec] Environmentally, it's really difficult because it's leading to this increase in tickborne diseases, it's a combination of forests, high abundance of deer (which actually are key for ticks), and also people going to these areas. So it's not something that I can recommend and say we should environmentally change the whole ecology. What we know is that areas with high biodiversity and abundance of predators and a healthy community should not have ticks and Heartland or any other tickborne diseases in the abundance that we see now, in that forest patches are smaller, and then the whole ecology is constrained in a small space. So the main recommendation at this point is really to bring awareness to people about the challenges and also the potential impact of getting to those areas and getting exposed to ticks. And it's not saying, no, don't go there. It's just saying, exercise your caution and your personal protection.

[Sarah Gregory] So tell us about your job at Emory University and how you are involved in this study?

[Gonzalo Vazquez-Prokopec] Yes. So I am a professor in the department of environmental sciences. By training, I am an ecologist, particularly a disease ecologist. So I primarily look at diseases, but not from the perspective of medicine or the medical field, but from the perspective of what factors in the interaction between vectors (which is what I study, vectorborne diseases), the environment, and humans. What are those interactions that lead to spread, spillover, or transmission? And I do that through fieldwork studies, as well as quantitative methods, statistics, mathematical modeling. And what we try to do is piece the pieces of the puzzle together to understand the transmission ecology of these emerging infectious diseases.

[Sarah Gregory] So Emory University is in Atlanta, which is a very large city with a lot of urban sprawl. But despite that, there is nature everywhere with plenty of access to hiking and outdoor recreation. Do you take advantage of these? What do you do for relaxation?

[Gonzalo Vazquez-Prokopec] Absolutely. You know, for us, we can actually do this kind of research in our backyard. And Atlanta is a very important location in the southeast. We have an extended warm period. There are mosquitoes (plenty of them), some of them could potentially be vectors of viruses, we have ticks. So in my work, in particular my students, we are a large operation of undergraduates, masters, PhD and post-doc students, all of them learning by doing. And what we can do is just work on Emory campus all the way to northern or southern Georgia. And I think it provides this unique opportunity, not only to make predictions about risk, but also link them (particularly in Atlanta) to specific locations where that risk might lead to an increased transmission of viruses.

[Sarah Gregory] Well, thank you for taking the time to talk with me today, Dr. Vazquez-Prokopec.

[Gonzalo Vazquez-Prokopec] Thank you, Sarah. It was a pleasure.

[Sarah Gregory] And thanks for joining me out there. You can read the April 2022 article, Isolation of Heartland Virus from Lone Star Ticks, Georgia, USA, 2019, online at [cdc.gov/eid](https://www.cdc.gov/eid).

I'm Sarah Gregory for *Emerging Infectious Diseases*.

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