

***Mycobacterium marinum* Infection after Iguana Bite in Costa Rica**

[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. Niaz Banaei, a professor of pathology and medicine at Stanford University in California. We'll be discussing *Mycobacterium marinum* infection after an iguana bite in Costa Rica.

Welcome, Dr. Banaei

[Niaz Banaei] Thank you. Thank you for having me.

[Sarah Gregory] Let's start off with what is *Mycobacterium marinum*?

[Niaz Banaei] So *Mycobacterium marinum* is a type of bacterium that belongs to the genus *Mycobacterium*. Mycobacteria are known for having a mycolic acid-rich cell wall which gives them a special staining property, which it's fast staining, so they're also known as acid-fast bacilli.

[Sarah Gregory] And how is this different from *Mycobacterium tuberculosis*, which clearly is the cause of TB?

[Niaz Banaei] Genetically, *Mycobacterium marinum* is very closely related to *Mycobacterium tuberculosis*, and they share some of the key virulence factors that allow them to infect macrophages or eukaryotic cells, replicate intracellularly and spread to uninfected cells. And for that reason, *Mycobacterium marinum* has become a great model organism for studying *M. tuberculosis* pathogenesis. However, their physiology and transmission modes are different. For example, optimal growth temperature for growing *Mycobacterium tuberculosis* is 37 degrees Celsius, whereas the optimal growth temperature for growing *Mycobacterium marinum* is 30 degrees. And *Mycobacterium marinum* grows faster than *Mycobacterium tuberculosis* by one to two weeks. So they have physiological differences, even though they are closely related genetically.

[Sarah Gregory] Where is it found in the environment?

[Niaz Banaei] *Mycobacterium marinum* is found in fresh and saltwater aquatic environments. So it's natural and artificial. It is thought that they infect and replicate in single-cell protozoa and water, such as amoeba, but they can also colonize or infect cold-blooded animals such as fish and reptiles.

[Sarah Gregory] You said natural and artificial salt water, so would that be true? Could this bacterium be in, say, a saltwater swimming pool?

[Niaz Banaei] Yes. So in fact, you know, one of the sources of exposure to *Mycobacterium marinum* is an individual who cleans fish tanks. And so, these fish tanks (fresh water or salt water), the fish in them can get colonized. And so, it certainly can happen.

[Sarah Gregory] Is there a particular country where it's more prevalent?

[Niaz Banaei] You know, I'm not aware that there is a higher prevalence in certain countries. It seems to have a worldwide distribution.

[Sarah Gregory] And we've talked about fish and people cleaning fish tanks. So how does it affect people?

[Niaz Banaei] *Mycobacterium marinum* infects people when it comes in contact with skin that has lost its natural barrier (sites of wounds or abrasions), and this happens, as I mentioned, if someone is cleaning a fish tank or it can happen if somebody is swimming in a body of water, or it can happen through other types of accidents while they have exposure.

[Sarah Gregory] And how serious is this infection and is it treatable?

[Niaz Banaei] So the pathogenesis of *Mycobacterium marinum* in humans is limited by its inability to grow at human core body temperature of 37 degrees Celsius. So for that reason, it can only produce localized skin or joint infections and spread along the lymphatics in humans. It can be very disfiguring and limiting functionality of the joints. Fortunately, we do have antibiotics to treat it and the cure rate is very high, and typically we have to use a multidrug regimen to treat it.

[Sarah Gregory] Let's talk about your article now. It's about a little girl getting infected with *Mycobacterium marinum* after being bitten by an iguana in Costa Rica. How did this event happen?

[Niaz Banaei] Right. So this was an unfortunate event. This little girl was on vacation with her family in Costa Rica. They were having a relaxing time at a beach when she was eating a cake and an iguana came by and suddenly went for the cake she had in her hand, and in the process of taking the cake, it bit the back of her hand on the third and fourth metacarpal joint area. The parents immediately took her to a clinic where they cleaned the wound, they disinfected it and irrigated it, and gave her a course of amoxicillin antibiotic, and they abandoned their trip and returned home. And in the ensuing months, she developed an infection over the area where she had been bitten.

[Sarah Gregory] So even that immediate intervention didn't help?

[Niaz Banaei] It did not, and it has to do with the fact that this organism is resistant, basically, naturally resistant to the antibiotic that she was administered. So it really didn't do anything for her in terms of getting rid of *Mycobacterium marinum*.

[Sarah Gregory] So is this pathogen common among iguanas?

[Niaz Banaei] So it has never been isolated from an iguana before. However, it is known to colonize and infect reptiles and fish. So its association with an iguana is not novel, but is not that surprising knowing that it can colonize and infect reptiles.

[Sarah Gregory] And how would an iguana get infected with it?

[Niaz Banaei] *Mycobacterium marinum*, as I mentioned previously, is in an aquatic environment. So an iguana can become colonized with *Mycobacterium marinum* or they can get potentially infected. The infection can be superficial, or it can be systemic, and so that's how an iguana can be a vector for transmitting this to an individual.

[Sarah Gregory] So you mentioned people getting it from natural and artificial salt water and regular water. How does that happen? Do they get a scratch while they are doing it or what's going on here?

[Niaz Banaei] Yes. So there are several ways people can get infected with *Mycobacterium marinum*. It can get introduced through the bite of a reptile, as in this case, or if someone already has a cut or wound, then *Mycobacterium marinum* can get in through the opening when they are exposed to contaminated water, or if they are handling a colonized reptile or infected fish, they can also get exposed. Cases have been reported in individuals working in fish markets getting infected, and also one individual that worked in a vivarium that handled a lot of reptiles also got infected with *Mycobacterium marinum*.

[Sarah Gregory] Perhaps you know this, perhaps you don't, but reptiles are usually known to be shy and reclusive. Was this just a particularly bold iguana or are the iguanas in Costa Rica just getting used to being around people from all the tourism?

[Niaz Banaei] Probably a little bit of both. Iguanas are beautiful and interesting to watch, and some tourists might be feeding them to get close to them. So they might, in fact, be getting used to people and taking food from them. Although, in this case, it resulted in a bite and an infection, so it was an accident as a result of iguanas probably feeling more comfortable around people.

[Sarah Gregory] You mentioned that amoxicillin was not the proper treatment for this, initially. So how was it treated later when it didn't go away? Tell us about the progression of the little girl's symptoms and what finally worked.

[Niaz Banaei] As much as they irrigated the wound and disinfected it—and she even got amoxicillin—that did not prevent this infection from happening. That's because *Mycobacterium marinum* encodes a beta-lactamase enzyme that is able to hydrolyze beta-lactams such as amoxicillin and penicillin. So it really has no effect on *Mycobacterium marinum*. So in her case, initially the wound (the cut) essentially resolved initially. But about five months after the incident, the parents noted that the area over the third and fourth metacarpal joint started to swell, get red, and the child was experiencing pain. And so, they noticed something was going on and they took her to a hand surgeon, and they did an ultrasound and they noticed that the soft tissue in that area over the knuckles was...there was a mass. And so, they excised it and that's how the diagnosis was made. And at that point, once they knew it was caused by *Mycobacterium marinum*, they gave her the recommended two antibiotic therapy—in her case she got clarithromycin and rifampin—and it proved very effective that after a couple months, the infection resolved, and it was sufficient to take her off of antibiotics after she was cured.

[Sarah Gregory] There's a picture of the little girl's hand in the journal article, and it's pretty large. Did it really look that large in real life as it looked in the picture (the lump)?

[Niaz Banaei] I'm a laboratorian, so I didn't actually get to see her hand. But the picture is pretty clear that it infected a large area of her hand, and there was an active inflammatory process going on and the body was trying...her immune system was working very hard to try to contain it, although it wasn't successful.

[Sarah Gregory] So you mentioned four or five months after the initial bite. Is that usual for it to take so long for symptoms to manifest?

[Niaz Banaei] *Mycobacterium marinum* is a slow-growing organism. It doesn't divide that fast. It's not like your *E. coli* that divides every 20 minutes. And so, infections develop over weeks to months. And this was not unusual at all in her case for the parents to note the lesion after five months from the initial exposure.

[Sarah Gregory] And you mentioned that it was tested. So what kind of test was used to delineate this bacterium?

[Niaz Banaei] So after the hand surgeon resected the infected soft tissue mass, initially in the laboratory we could actually see that there was a type of inflammation known as granulomatous inflammation that's associated with mycobacterial infections. Our immune system elicits this type of immune response to try to control the infection. You could actually see the mycobacteria in this specimen by using a special stain known as an 'acid-fast stain'. The mycobacteria take on the stain and they appear as salmon-pink rods.

So in this case, we didn't want to wait for the culture to grow, which could take several weeks. So we performed what's known as non-targeted bacterial sequencing. So we amplified the ribosomal RNA genes sequenced from this bacterium, and from that we could identify *Mycobacterium marinum*. And eventually, her culture did grow after several weeks, and the colonies also had the characteristic pigment production only after exposure to light source, which is an old school way of identifying this *Mycobacterium*.

[Sarah Gregory] But by then, she was already on the antibiotic and recovering, right?

[Niaz Banaei] That's correct. By the time the culture grew, she was already on weeks of antibiotics.

[Sarah Gregory] Was there anything surprising about this case to you?

[Niaz Banaei] For me, the fact that this iguana had a sweet tooth and wanted some cake was very surprising. You assume that lizards would be interested in vegetables and seafood, so I found it odd that this lizard wanted some cake. That was the most surprising to me.

[Sarah Gregory] I've got to agree with you. When I first read the article, that's the first thing that struck to me. It's like, seriously? Cake?

[Niaz Banaei] It's very surprising. Who knew?

[Sarah Gregory] What are steps people should take in the event that they are bitten by a wild reptile?

[Niaz Banaei] As with all animal bites, they should immediately disinfect and irrigate the bite, and they should seek medical professional help as quickly as possible. Each animal...most animals have a known microbiota associated with their oral flora, so they may be able to target those organisms with different antibiotics. So it's best to get professional help as soon as possible.

[Sarah Gregory] Okay. So not just going to a clinic and getting some standard antibiotic, but actually going to somebody that's going to know what they are looking for, yes?

[Niaz Banaei] Ideally. But that might be challenging. You know, as in this case, they went to a local clinic. And the reality of it is that, in most cases, it's a wait and watch plan to see if anything develops and then sample it and see what is actually the causative agent. It is challenging to be able to cover everything upfront.

[Sarah Gregory] Especially on vacation.

So we've already said that this bacterium is found in fish and things. So is it in other lizards and snakes? Just generally cold-blooded species?

[Niaz Banaei] Yeah, definitely. It is well-known that other cold-blooded animals can carry it, and in fact there are case reports about people getting infected after handling reptiles in a vivarium and individuals that clean fish tanks. And workers that work in fish markets and clean fish for a living, they come down with infections as well.

[Sarah Gregory] What about pet iguanas or pet snakes or fish? How can pets have this and how should people be careful not to get infected?

[Niaz Banaei] It is certainly possible that pet iguanas are colonized with *Mycobacterium marinum*. So people might want to wear gloves when handling pet reptiles, lizards, is a good precaution. I would recommend it and it would make it safer, in my opinion.

[Sarah Gregory] So what kind of gloves? Like vinyl gloves? Latex gloves? Cloth gloves? Leather gloves?

[Niaz Banaei] Yeah, any glove that gives you a barrier between you and the animal. So any kind of latex glove or any kind of plastic glove. Typical gloves that healthcare providers use would work.

[Sarah Gregory] Okay. So what are the public health implications of your article?

[Niaz Banaei] It would have to be that one can get infected with *Mycobacterium marinum* after close contact with an iguana. So people should not feed wild reptiles or tempt them with their food. Also, people should wear gloves when handling reptiles and lizards to prevent potential exposure and infection.

[Sarah Gregory] I guess one of the lessons of this article is if you are in a place where there are these kinds of reptiles, to maybe not be eating cake or anything?

[Niaz Banaei] Yes. You want to keep your distance and not get close to them and not feed them. And in this case, this iguana saw that this was a child and felt okay to go for the cake as opposed to if an adult had been doing the same thing, the iguana probably would not have been able to attack them in the same way. So care for little ones and not let them be at risk.

[Sarah Gregory] So what further research do you think is needed?

[Niaz Banaei] The recommended antibiotic treatment for *Mycobacterium marinum* infection is two antibiotics for two months...for long enough until two months after resolution of symptoms. So treatment duration typically is three to four months and longer if deeper structures are involved. So this is a really long time for treatment. It's very similar to the situation for *Mycobacterium tuberculosis* and other mycobacterial infections. So we really need better antibiotics that can be used in a shorter amount of time so that treatment duration is not so long.

[Sarah Gregory] Do you know if such antibiotics are in research?

[Niaz Banaei] There's a lot of trials going on in the field of tuberculosis. And there is, in animal models, in some cases you can get treatment down to a month. So there's a lot of research going on, but so far we don't have a regimen that can be recommended for patient care (I'm talking about active disease). In the case of latent tuberculosis infection, the treatment can be brought down to eight weeks with the combination. Eight weeks is still a long time, but that's better than six months, right?

[Sarah Gregory] Yes. Tell us about your job, where you work and what you do, and what you enjoy most about it.

[Niaz Banaei] I'm the medical director of the clinical microbiology laboratory at Stanford Healthcare, which is affiliated with Stanford University. I work with my team in the clinical microbiology laboratory, and we are responsible for diagnostics. We offer to diagnose patients with infectious diseases. I enjoy applying different diagnostic tools to make a diagnosis when patients present to us with serious infections. Some of these diagnostics we have developed, so it is particularly rewarding to see them in action and make a difference.

[Sarah Gregory] Given your particular field, is there an environmental threat you worry about most?

[Niaz Banaei] So environmental mycobacteria (like *Mycobacterium marinum*) and another group of pathogens known as endemic mycoses can cause pretty severe infections, so I do worry about them as we encroach on natural habitats and increase our chances for an exposure.

[Sarah Gregory] Well, I think we all do anymore, don't we? After COVID, everything seems more in our faces.

Thank you for taking the time to talk with me today, Dr. Banaei.

[Niaz Banaei] Thank you so much. It was my pleasure.

[Sarah Gregory] And thanks for joining me out there. You can read the June 2023 article, *Mycobacterium marinum* Infection after Iguana Bite in Costa Rica, online at [cdc.gov/eid](https://www.cdc.gov/eid).

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

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