

Human Melioidosis Caused by Novel Transmission of Pathogen from Freshwater Home Aquarium, United States

[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. Patrick Dawson, an epidemiologist at CDC in Atlanta. We'll be discussing a case of melioidosis from a freshwater home aquarium in the United States.

Welcome, Dr. Dawson.

[Patrick Dawson] Thank you so much.

[Sarah Gregory] What is melioidosis? What's it caused by?

[Patrick Dawson] Melioidosis is a disease that can be varied and non-specific, which can make it difficult to characterize. And these symptoms can range from pneumonia and pus formation to blood infections. And due to the non-specific symptoms, melioidosis is often initially mistaken for other diseases like tuberculosis, which actually then delays the proper treatment. And what causes melioidosis is a bacterium that's called *Burkholderia pseudomallei*, and people can become ill with melioidosis when they have contact typically with water or soil that's contaminated with the bacteria.

[Sarah Gregory] And *Burkholderia pseudomallei* is classified as a select agent. Why?

[Patrick Dawson] Yes. So *B. pseudomallei* is classified as a select agent because it's considered to pose a severe threat to human health, and it's actually further classified as a Tier 1 select agent. Other pathogens that are Tier 1 include the pathogens that cause anthrax and Ebola, and that's because they are considered to present the greatest risk of deliberate misuse and they have significant potential for having devastating impacts to public health, the economy, and public confidence.

[Sarah Gregory] Okay. And where is it found?

[Patrick Dawson] *B. pseudomallei* is typically found in soil and water and areas in tropical and sub-tropical climates.

[Sarah Gregory] It's not endemic to the United States, right?

[Patrick Dawson] So *B. pseudomallei* has never been isolated from the environment in the continental United States, but it is suspected to be potentially endemic in the environment in certain parts of the continental US, such as a specific area in Texas based on clinical cases.

[Sarah Gregory] Okay. Well, where is it known to be endemic? How common is it globally?

[Patrick Dawson] *B. pseudomallei* is endemic in Southeast Asia and northern Australia, and also certain areas in the Caribbean and Central and South America. However, our understanding of the geographic range of this bacteria has expanded in recent years, and globally there's an estimated 165,000 human cases per year.

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[Sarah Gregory] And how do people get it?

[Patrick Dawson] So in areas of the world where melioidosis is endemic, people can come into contact with contaminated soil or water through cuts or scrapes in their skin, drinking contaminated water or inhaling contaminated water droplets. And there's also growing recognition that contaminated products can be a source of human exposure, especially in areas where the bacteria is not endemic in the environment.

[Sarah Gregory] If it's found in water, how do people get sick with it, assuming they aren't drinking it?

[Patrick Dawson] So even without drinking it, the water can be contaminated with *B. pseudomallei* and can still cause illness through cuts and scrapes in the skin or through inhalation of water droplets from sprays. So one example might be walking through contaminated flood waters after heavy rain and getting it that way.

[Sarah Gregory] Okay, let's go back a little bit. You said the symptoms are pretty non-specific or similar to other illnesses, so what exactly are the symptoms? Are there any that are common to it? And how would they know if they were sick with it?

[Patrick Dawson] So the symptoms depend on the type of infection. With a localized infection, the signs and symptoms may include fever, localized pain, or abscess formation. With a pulmonary infection, there might be a cough, chest pain, or a high fever. And then there are other signs and symptoms associated with bloodstream infections and disseminated infections. So overall, it's hard to have just a single set of symptoms to kind of characterize melioidosis because it can take so many different forms. And the incubation period can be so long that it's hard to tie back to an obvious exposure.

[Sarah Gregory] So you said the incubation period could be from days, weeks, to decades?

[Patrick Dawson] Yes. It's most often an incubation period of about two to four weeks, but there have been cases where the incubation period has been reported as taking years and even decades in some patients. Although that's quite rare.

[Sarah Gregory] Can it ever be fatal?

[Patrick Dawson] Yes. Melioidosis can be fatal and especially for persons with certain medical conditions that put them at a higher risk for illness, and also in the absence of proper treatment with specific antibiotics.

[Sarah Gregory] And who are at most risk for contracting it?

[Patrick Dawson] Again, most healthy people who come into contact with *B. pseudomallei* do not get ill and do not have symptoms. But people with certain conditions that weaken the immune system are at the highest risk of becoming ill with melioidosis. And the most common factors that make a person more likely to develop infection include things like diabetes, kidney disease, chronic lung disease, and alcoholism.

[Sarah Gregory] Okay. Let's go back to something you said a minute ago. What are the possible long-term complications if it's not treated? You just mentioned that it lay dormant rarely but can for years and then manifest. How is that possible? HIV can do the same as well as prions, but how is that?

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[Patrick Dawson] In addition to the possibility of having an incubation period that lasts months or years, there can also be latent melioidosis in which the disease actually reactivates months or years afterwards. And that's very similar to tuberculosis, which also has latent infections. And even though it's relatively uncommon for melioidosis, this can happen if the bacteria lay dormant inside certain cells like macrophages for years or even decades. And how that's possible is because the bacteria can actually withstand a lot of harsh environments, like how it survives in soil and water, provided there's adequate moisture.

[Sarah Gregory] You mentioned specific antibiotics. So what is the treatment for it and which are those antibiotics?

[Patrick Dawson] There are actually established treatment guidelines for melioidosis that have been published and updated in the recent years. But just kind of a brief overview of the treatment, it can be pretty expensive. So it includes both IV antibiotics for at least two weeks and then oral antibiotics for at least three months, and possibly even longer for more severe cases. But the specific treatment regimen should probably be consulted best with the established guidelines that are published, which do vary based on the type of infection and many other pre-existing risk factors for the patient.

[Sarah Gregory] I see. And when and how was this disease first discovered?

[Patrick Dawson] So melioidosis was actually originally named Whitmore's Disease, and that's because it was first described in 1912 in the literature by someone named Captain Alfred Whitmore. And that was based on clinical cases of a human disease that resembled glanders, which is actually an animal disease that's most often associated with horses. But it was distinct enough from glanders to merit its own diagnosis. And it's worth mentioning too that glanders is caused by *Burkholderia mallei*, which is in the same bacterial genus as *B. pseudomallei*.

[Sarah Gregory] Your article was about a case of melioidosis from a freshwater home aquarium in the United States. Where did this case occur?

[Patrick Dawson] In Fall 2019, a woman in Maryland was diagnosed with melioidosis. And as mentioned, melioidosis is not considered potentially endemic in most of the continental United States, and in fact almost all the cases of melioidosis in the continental US are related to travel to places where the bacteria are commonly found, which is typically Southeast Asia or northern Australia. But when the DNA of a clinical isolate of *B. pseudomallei* from this patient was sequenced, the sequence actually clustered most closely with other isolates that we attribute to Southeast Asia. However, she had no history of any international travel. So the big question was how did she become exposed to the bacteria that we believe originated from Southeast Asia if she had never traveled there?

[Sarah Gregory] And how and when was CDC notified about this case?

[Patrick Dawson] So the CDC was notified in October 2019 by the Maryland Department of Health and also through the CDC Laboratory Response Network. And they had a preliminary positive bacterial isolate of *B. pseudomallei* from a blood culture specimen from this patient in Maryland. And the clinical assessment had also been forwarded to the Virginia Division of Consolidated Laboratory Services, where it was confirmed, and then also shipped to CDC for confirmation and genomic analysis.

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[Sarah Gregory] And how was it figured out that the home aquarium was the source of it?

[Patrick Dawson] After we were notified of this patient, in November the Maryland Department of Health in collaboration with CDC...we conducted an epidemiologic investigation—so we wanted this to determine the source of the patient's exposure to *B. pseudomallei*. So the team conducted multiple interviews with the patient and her family members, and they also conducted environmental sampling in and around her home. And her home was a natural starting place to try to figure this out, again because she had no history of travel outside of the US. So they collected samples and swabs from potted soil, products that might have been imported from Southeast Asia (like beauty products), moist areas like drains and faucets where the bacteria could potentially survive, and also from two freshwater aquariums that she had.

So all these samples were tested at CDC, and they all came back negative for *B. pseudomallei* except for three samples, all were taken from one of the two aquariums she had, and those were positive. And then follow-up testing again confirmed that one of the aquariums was contaminated with *B. pseudomallei* and the other aquarium was not, and so we kind of zeroed in on those aquariums. And we learned from the interviews that she had purchased the aquariums and set them up only two months prior to her symptom onset, and all of the fish in the contaminated tank died one month prior to her symptom onset. And she had reportedly put her bare hands and arms into that aquarium water and gravel while cleaning it in the month prior to her symptom onset.

And so this was actually the first known case of transmission of melioidosis from the fish or fish tank to a person in the US. And in the past, contaminated water used to transport freshwater tropical fish originating from Singapore had been detected and reported in France. And it's also worth noting too that most tropical ornamental fish in the US originate in and are imported from Southeast Asia. So it's possible the transport water was contaminated and the bacterium made their way into the patient's local pet store, and eventually her home aquarium.

[Sarah Gregory] And what methods were used to test the water in the fish tank?

[Patrick Dawson] So these samples that were collected from the fish tank were tested at CDC by culture and real-time PCR. And then we also performed whole-genome sequencing and multilocus sequence typing on the isolates.

[Sarah Gregory] And clarify here how did the patient get sick from the fish tank water? Did you say she had sores on her arm or something?

[Patrick Dawson] So we believe she got sick just through the regular contact with the home aquarium that was contaminated. Possibly that was from when she reached into it with her bare hands and arms while cleaning it or other maintenance or other types of contact. But we're not exactly sure the exact moment of the exposure or if there were multiple opportunities for the exposure. But again, you know not everyone who comes into contact with bacteria become ill, but she did have some medical conditions that likely increased the chances that she would become ill. So it's probably from either skin contact if there were any very, very small cuts or abrasions in her skin in the hands or arms while she reached into the water and gravel, or it also

could have been from inhaling water droplets that, you know, from the spray of the aquarium filter.

[Sarah Gregory] Could she have, like, had the water on her hand or arm and touched her nose or mouth? Would that have done it?

[Patrick Dawson] It's really hard to say, you know, because she probably likely had a lot of contact with the aquarium over this, you know, month, two-month period. So it's really hard to say what was the exact moment where she had the exposure with that bacteria. But it could have been through a number of different routes based on the fact that the aquarium water was definitely contaminated with the bacteria, and most likely for almost the entire time she had it up until that point.

[Sarah Gregory] Okay. And what were her symptoms that she finally went to the doctor for? And how long did she have them for before it was diagnosed?

[Patrick Dawson] She had a fever, cough, and chest pain for two days and then went to the hospital. And at the hospital she was diagnosed with pneumonia and they also collected blood cultures which grew gram-negative rods, and then she was hospitalized. And actually, it only took a few days for the bacteria to be identified as *B. pseudomallei* through the Laboratory Response Network. And once they were identified as *B. pseudomallei*, that confirmed the melioidosis diagnosis. And this was kind of fortunate because sometimes the amount of time it takes to diagnose melioidosis can be delayed because *B. pseudomallei* can be misidentified in the laboratory and even misidentified by automated identification systems in clinical labs. So this is why the Laboratory Response Network is so important here, because they can perform that confirmation quickly and reliably so we get that information and can therefore use that to diagnose and then make sure that the proper treatment is being given.

[Sarah Gregory] Okay. So there's some kind of special test that was used. And did a doctor have to think to check for this disease? Or does it somehow just pop up automatically in the system?

[Patrick Dawson] Most likely after the blood cultures were growing the gram-negative rods when they sent it for kind of further testing and confirmation to the Laboratory Response Network. And then there they were able to test for a number of things, and clearly *B. pseudomallei* was on that list that they tested for and then were subsequently able to confirm it.

[Sarah Gregory] I see. And how severe was her illness? And did she survive?

[Patrick Dawson] Yes. Fortunately, she survived the illness, but melioidosis can be very severe. So she was actually hospitalized twice for this illness and then had to endure a long treatment regimen even after being discharged from the hospital. So she was treated with IV antibiotics and then oral antibiotics for more than three months.

[Sarah Gregory] Fish are commonly kept as pets. How likely is a case like this to happen again in the United States?

[Patrick Dawson] So currently we think this route of exposure is exceedingly rare, given the amount of pet fish ownership in the US and only one case of melioidosis so far linked to having a home aquarium. But I think this investigation though demonstrated that this can happen, and so we should be on the lookout for potential future cases that may occur in people who have pet tropical fish that are imported from areas where *B. pseudomallei* is endemic. Because in this

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case, what's most likely happened is that the fish that she purchased from her local pet store had been imported from a farm in Southeast Asia where the bacteria are endemic, and that contaminated transport water made its way through the supply chain to her home aquarium. And that happened when she purchased the fish in bagged water. Again, I think this was an incredibly rare event, but there are industry safeguards in place to prevent disease transmission. So this could have just been a series of extremely bad luck events.

[Sarah Gregory] Unfortunate.

So how can people protect themselves? Assuming it could happen again—in aquariums or anywhere—but specifically in aquariums.

[Patrick Dawson] There are a few simple things that anyone can do to protect themselves against possible exposure to *B. pseudomallei* if they have a home aquarium. So the CDC recommends thorough handwashing with soap and water before and after handling or cleaning aquariums and feeding fish, wearing gloves to cover any cuts or wounds while handling fish or aquariums, avoiding cleaning fish aquariums if you are immunocompromised, and not allowing children under five years of age to clean fish aquariums.

[Sarah Gregory] And can this danger be extrapolated out to saltwater fish and aquariums?

[Patrick Dawson] So these bacteria are associated with freshwater environments, so it's unlikely to affect saltwater aquariums and systems.

[Sarah Gregory] Okay. And what are the most important public health implications of your case study?

[Patrick Dawson] So one of the most important implications of the study is that we identified a novel route of transmission for melioidosis—through aquariums—and that has expanded our understanding of how people become exposed to *B. pseudomallei*, and particularly in areas where the bacteria are not considered endemic, such as Maryland.

So similar to the 2021 cluster of domestic melioidosis cases, which was eventually traced to a contaminated aromatherapy spray, the role of products as vehicles for transmission is certainly kind of an emerging area that warrants more study and understanding. And I think also, you know, we really are urging clinicians to consider melioidosis in patients who have symptoms and exposure to tropical ornamental fish and freshwater aquariums, especially if the patients are immunocompromised, because prompt diagnosis and proper treatment can dramatically improve health outcomes for them.

[Sarah Gregory] Okay. So it would behoove patients themselves to mention this to their doctors in case the doctors or clinicians don't think to ask themselves, right?

[Patrick Dawson] Yes. I think definitely it's something that should be mentioned if there's, you know, someone has a home freshwater aquarium and they have very concerning symptoms. You know, it's definitely worth mentioning to your physician.

[Sarah Gregory] Dr. Dawson, tell us about your job, what you like most about it, and how you became involved in this case study?

[Patrick Dawson] I participated in this investigation while in the CDC Epidemic Intelligence Service, which was from mid-2019 to mid-2021, and that was when I was placed with the

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Bacterial Special Pathogens Branch. And *Burkholderia pseudomallei* is one of our pathogens in the Bacterial Special Pathogens Branch that we focus on. So I became involved in this investigation and the follow-up investigation after we were notified of the case by the Maryland Department of Health. And, you know, being in the Epidemic Intelligence Service were truly two of the greatest but also the most challenging years of my life. We conducted multiple melioidosis investigations, anthrax and leptospirosis investigations, and then of course had the onset of the COVID-19 global pandemic.

[Sarah Gregory] So what's your specialty as an EIS officer? What were you brought on as?

[Patrick Dawson] EIS officers are actually very interdisciplinary. So there are physicians, there are epidemiologists with PhDs, there are nursing PhDs, veterinarians. It really just spans a lot of different disciplines and specialties. So I came from a background with a PhD in epidemiology with a focus on emerging infectious diseases and zoonotic diseases. So that's kind of how I fit in best with Bacterial Special Pathogens Branch, kind of with the focus on emerging diseases and also zoonotic diseases.

[Sarah Gregory] And you're no longer an EIS officer because it's only a two-year program. So you're now a permanent employee in which group?

[Patrick Dawson] I stayed on with CDC and I'm now in the Office of Science. I've been working on things ranging from using our knowledge management system to look at how our agency portfolio is shaping up, trying to get a better sense of how we are incorporating health equity science into everything that CDC does, and then I've also continued to serve on the COVID-19 response, most recently for the last six months on the Strategic Science Unit, focusing on the CDC COVID-19 Public Health Science Agenda.

[Sarah Gregory] And unfortunately it looks like we're going in for another round of it.

One last question, do you have any pet fish of your own?

[Patrick Dawson] No, I don't have any pet fish. I don't think I could take on any fish right now because I have enough pets. I have an Alaskan Malamute dog and cats that we adopted from shelters. So I think I'm all set on pets for the time being.

[Sarah Gregory] Oh, nice, nice, nice.

Well, thank you for taking the time to talk with me today, Dr. Dawson.

[Patrick Dawson] Oh, thank you so much for having me.

[Sarah Gregory] And thanks for joining me out there. You can read the December 2021 article, Human Melioidosis Caused by Novel Transmission of *Burkholderia pseudomallei* from Freshwater Home Aquarium, United States, online at [cdc.gov/eid](https://www.cdc.gov/eid).

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

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