Toxoplasmosis: Truth, Fiction, and Crazy Cat Ladies?
Video Transcript
July 2013

This transcript has been automatically generated and may not be 100% accurate. This text may not be in its final form and may be updated or revised in the future. Please be aware that the authoritative record of Maddie's Institute[SM] programming is the audio.

[Beginning of Audio]

Dr. Berliner: And I said I'd give a little introduction about myself. So I am the Director of Shelter Medicine here at the college. I graduated from Cornell in 2003, went into private practice and emergency practice for five years, wandered into a local shelter and started working for Baltimore Humane. I then came back to the college in 2010. So, I've been fortunate enough to be a part of this conference for the last three years.

I'm really thrilled to see how many people are here. When I first proposed this topic – well, actually, it was earlier this week, nothing like right before you're going to give the talk – that I ran into two colleagues, and on both occasions I was like, "Oh, my goodness; I don't know how I'm going to get this down in this hour." I had two different people look at me and go, "What are you possibly going to talk about regarding toxoplasmosis for an entire hour?" I was like, "You don't even begin to imagine. It's going to be fascinating."

So, here we go. I hope I can get it covered. I do have a lot of quiz questions. This is a very interactive lecture. I've been asked to ask you to hold your questions to the end because of the recording, so we'll try to do that. But, I have a lot of questions for you. Some of this, I think, is going to be challenging, depending on your background, so I'm going to ask you to stick with me. I am throwing a bunch of science at you, because I think it's important that you understand what the concerns are as we then move into discussing the politics and the public health issues that have come up. "Truth, Fiction, and Crazy Cat Ladies" – we'll cover all three of those for sure. Let's start here. Your first quiz question: "Is *Toxoplasma* a bacteria, a virus, a fungus, a protozoa, or a worm?" Go ahead and vote. You vote by, one, turning your clicker on, and then choosing A through E. Let's see how you do. Indeed. *Toxoplasma* is a protozoa, so 45% of you got that right. If you didn't get it right, don't feel bad because House didn't get it right either. The reason [why] that picture is up there is [because] in 2005 they had an episode where somebody contracted toxoplasmosis and they called it a fungus. I remember sitting there watching that episode in real time – it was when it was still on prime time – and they called it a fungus. I'm like, "Are you kidding me? Are you kidding me?" Because, really, I have this secret fantasy of working in Hollywood as a medical advisor for television shows. I've always wanted to do that, and it makes me crazy when they get it wrong.

Then, as I was preparing for this talk, I realized it made other people crazy too. There's this entire website for people to argue with TV shows and call out when people make mistakes. And, so this woman had come on and she says, "What do you think of *Toxoplasma* in this episode being called a fungus? I'm pretty sure it's a protozoa, not a fungus. But they said 'fungus' multiple times. My friends and I were all bug-eyed. This is a pretty big lapse, but it may be because I'm a vet med student." So, leave it to the veterinarians to call it out. They've never really apologized for that, and I don't forgive them, but I'm still waiting for my call to Hollywood. If any of you know anybody, let me know because I'm obsessed with that idea.

So you know – 45 percent of you, indeed, were right – that it is a protozoa. It's a Coccidian protozoa. I'm not going to go into all the details of all these fancy images, but I put them up here because protozoa have multiple stages. We are going to go a little bit through the life cycle. They can exist in all sorts of places. This is all *Toxoplasma*. What I don't have there is a pointer. Let me see here in this one. So I'm not going to have one, I guess.

The first one is what it looks like in tissue, but then it also forms cysts. There is a replicating stage, which is that letter A. There are muscle cysts, which are B and C. Then, there are oocysts, which are actually eggs. They

can look all sorts of ways in different stages of the life cycle. We will talk about that. Let me see if I can get a clicker for the future. Yeah, that will be helpful.

So, next quiz question – I told you there's a lot: "Toxoplasmosis is acquired by people by (a) eating uncooked meat, (b) gardening in contaminated soil, (c) ingesting or inhaling cat feces from litter boxes, (d) contaminated water, or (e) all of the above." All right. So, indeed, 87 percent of you got it right: all of the above. So all of those ways are a way that people can contract toxoplasmosis. All right? And I'm going to talk about that in detail as well. You're going to see this beautiful pregnant lady a few times today.

Human infection. Eating uncooked meat, handling or inadvertently digesting uncooked meat can happen. People preparing meals and then not washing their hands after handling the raw meat can happen. Contaminated drinking water [is] more and more of a concern – contaminated reservoirs and that sort of thing. Ingestion of cat feces. I know we don't plan on doing it, but it does happen sometimes, I guess. Certainly, mother to child is one of the areas that we're most concerned about in terms of active and acute toxoplasmosis, and I'll talk about that. Then, there are transfusions or transplants – through blood or through tissue transplants it has actually been transmitted.

How about cats? [Poll question:] "How do cats get toxoplasmosis?" Poll is started. [Poll options:] Eating uncooked meat, gardening in contaminated soil, ingesting or inhaling cat feces from litter boxes, contaminated water sources or all of the above. Indeed, it's all of the above again. Cats can get it in all of those same ways. Yes, they don't truly garden, but they do go out there and dig around, so they can ingest it in that way. The most common way, we think, is through uncooked meat, because they don't cook their mice and their rats before they eat them. We do think that that's probably the most common way that they contract it, but they certainly can get it from other sources as well.

Here are your lifecycle basics. Here's our cute, little kitty-cat, and the cat is the definitive host for toxoplasmosis. So, what does that mean? It's essentially where the most infective stage and where sexual reproduction occurs. The cat sheds eggs, fecal oocysts. They then sporulate in the environment. What that means is they have to go through a process, a maturation process essentially, to then become infective. When they first come out of the cat, they're not necessarily infective. It takes time. Those oocysts then get eaten by birds and mice, and this is the initial cycle that we think of. And that gets in the tissue, and then cat gets it, and it goes around and around.

But there are these other ways that other animals can get it. The oocyst can affect livestock and other animals that way, or infect people directly that way, or people can eat the livestock and get it. Then, there are the oocysts in the soil, or the litter boxes, that can contaminate directly to the people. And then women can give it to their children *in utero* under certain circumstances, which I'll break down specifically, okay? Those are the lifecycle basics. Those things are important because as we talk about trying to prevent toxoplasmosis, we really have to look at the life cycle and figure out what points can we impact in our decision making.

A little bit on epidemiology. The estimates in terms of seroprevalence – and I'm going to explain what that means – in the human population.The CDC reports about 22 percent of people in the US have been exposed to *Toxoplasma*. The way they know you've been exposed is by doing a blood test and looking for antibodies to exposure. So, when you're exposed to a disease, your body, your immune system, will launch antibodies, and we can measure that. If we took a blood sample from all of you and submitted it, they would estimate about 22 percent. Those percentages vary. They're as high as 45 percent in some of the studies, and as low as 11percent. It does tend and it seems to be somewhat regional. But that is their overall estimate of human population in people 12 years and older.

If we did a test right now, a fair number of us would probably have antibodies to *Toxoplasma*. If you have been pregnant, there's a chance you have been tested. Some of you have probably been tested, and so you know whether or not you have antibodies. Much higher in other parts of the world. In Latin America, Asia, and Africa, the seroprevalence – meaning the people who have antibodies to the disease – is much, much higher. There are reasons for that. We'll talk a little bit about that.

In terms of our cats and our dogs in the US, the seroprevalence –that, again, is a blood test in the cat looking for antibodies to *Toxoplasma* – 30 to 40 percent of cats have antibodies, so they have been infected with *Toxoplasma* at some point. They probably have tissue cysts or cysts in the brain, just like the people who have been exposed or infected. So, 30 to 40 percent of cats. Twenty percent in dogs. It's lower. And, again, this is based on antibody testing and so you're looking for infection or exposure historically. That does not mean that those cats are shedding infective stages of the disease now. It does not mean that you have active disease, but it does mean that you have been exposed and you may indeed have cysts somewhere in your body. The parasite may be hiding out.

We call that a cysticercus, if it's in your brain. It is one of my favorite words, because it sounds like it's fun, like you're having a little circus in your head. It's not really fun, I don't think. But, it is one of my favorite

words. I think it would be a great name for a boat or a band. Again, the infective forms are the oocysts, and those are shed by cats – wild cats, big cats, little cats – into the environment. And the shedding period is about – it's only about a week. Somewhere between one week and three weeks will they actually shed oocysts. It's not like they're doing it all the time. There will be a period of time, after they are infected, that they will then shed these oocysts into the environment. It is a limited period.

Now, there is a question that, under stress or if they are re-exposed, can they shed again some point in the future. We do think that's possible, that for some cats it can be reactivated and they may shed again in the future at some point – again, for a short period of time. But, most of the time there's no shedding occurring. Is that clear? Okay. I'm getting some nods. I'll keep harping on this because that's important to understand.

The other thing is that when they shed these eggs into the environment, they are not immediately infective. They have to sporulate. They have to sit. They need to sit somewhere between one and five days in order to actually be a problem in terms of infecting people or other animals. And so there's that window of the first 24 hours when they are not in infective stage. Okay? That's important too, in terms of our management. The other way that you can get infected are these tissue cysts. That's how we

get it from uncooked meat. That's how the cats get it from uncooked mice. And, that is an infective form that can be ingested.

[Poll question:] "In your shelter, how do you know if a cat is shedding *Toxoplasma*?" [Poll options:] "You don't. You do a blood test. You analyze a fecal sample. You see clinical signs." They should be sick if they're shedding *Toxoplasma*. Or "a) and c): you don't or you analyze a fecal sample." Take your best guess. This is when it gets harder. This is when the veterinary students are glad they're not here today for this quiz because this stuff is tricky. Let's see how you did. Good, 63 percent of you – A and C both apply. The truth is, most of the time we probably don't know because we're not looking for it in all the cats. Unless you're doing a fecal sample in every cat and you're essentially doing it every 14 days, you may miss a cat shedding.

Now, the truth is that we estimate that only about one percent of cats are shedding at any moment in time, but they are shedding, and you may not know it. If you do a fecal sample, you may catch toxoplasmosis, if your lab is good at catching it and properly identifying it. It's Coccidia. It can look a lot like *Isospera*. It can look a lot like the other Coccidias that we'll talk about later today. There is some concern that sometimes it can be misdiagnosed, even in a lab. Certainly it may be misdiagnosed if you're doing your fecals in-house. You may not know or you may catch it in a

fecal sample. You cannot identify it by a blood sample. So, going back to choice B, you cannot identify shedding through a blood test. The blood test tells you whether or not a cat or a person was exposed historically. It tells you nothing about active disease or nothing about the cat shedding at the moment. Okay?

Clinical signs in cats. Some of them will get sick from toxoplasmosis and you will see clinical signs. What this is associated with – most of them won't. Most of them simply will ingest the parasite, they will shed oocysts and they'll be absolutely clinically normal. If they do develop signs, it has to do with the replication. It has to do with that letter A picture, of when the cysts start breaking open and what are called tachyzoites start rapidly dividing. And when they rapidly divide, they start destroying cells.

These can be muscle cells. These can be cardiac cells. This can be in the lungs. It can be in fluids. It can be in the brain. Some of our kittens that fade, some of our kittens that get really sick, may have toxoplasmosis. So, in neonates it's particularly hard on them and it can actually kill them through, essentially, a multisystem failure. And so that can sometimes be a reason that you're losing kittens, is that they have actually gotten toxoplasmosis.

It likes to show up in the eyeball, and so you get something called a chorioretinitis. This is true in people too, where you will actually see [that] the organisms are dividing. You get these little granulomas and pockets of infection in the eye, along with cysts. That is one place that they look, in human medicine and in veterinary medicine. We may first see that as evidence.

If you're actually going to diagnose toxoplasmosis, then you are looking for shedding of oocysts. It happens in the fecal sample. The animals that are shedding, those are the ones that are a zoonotic risk. Those are the ones where we worry about them transmitting disease to people. How long is that shedding period, again? A couple of weeks – so usually between 1 and 3 weeks, on average 14 days. They are the ones, within that realm of time of shedding, that are a risk.

If you have ill animals that you're worried about, they may not be shedding at that point. They may have gotten disease earlier, or the toxoplasmosis is now causing disease in them, but they're not actually shedding. You can do blood tests on those guys to decide whether you have systemic illness. And, what you're doing is an antibody titer. You are looking for the body's response to the organism.

Now, what's the problem with that? They may have been exposed a long time ago, and so they're just positive and it's not a problem. Or they may have been exposed recently, and it is a problem. Those can be really hard to distinguish. So, one of the ways we do it – and this is, again, getting a little heady and scientific – but there is a way to break down your antibody test for more immediate antibodies. IgMs (Immunoglobulin M) occur pretty early in disease. IgGs (Immunoglobulin G) are a sign of a more chronic disease. And just so you get a sense of it, if you're going to submit serology, you really want to look at both of these. If it's a more acute disease, your IgM is what's going to help you identify that and be like, "Okay, this disease is new. It probably is responsible for what's actually going on with this animal."

I also use this because if I'm worried that what I'm seeing in a kitten or a cat may be toxoplasmosis, I can essentially rule it out if I get a negative serology in a lot of cases. If I don't have any toxo showing up, I feel a little bit better. If I don't have anything in the fecal sample, I feel a little bit better that that's off my list of differentials, and I need to deal with other things. They can absolutely remain positive for antibodies for life, just like we do. Once you test positive, you're going to be positive for life. Those cats are really a minimal zoonotic risk, if they're not sick and they're not shedding. They may have been exposed a long time ago, and if it's actually a positive serology, that is not a reason to consider that cat a risk.

This is a common error, where people will say, "That cat is *Toxoplasma* positive on serology, and now that cat is a threat." No, it's not. That is the exposure, at least not as we've thought of it traditionally.

How do we treat it in the shelter? I'm going to talk a little bit about an individual animal here. It does respond to antibiotics. What you are treating is the shedding of the oocysts. You do not want to treat titers. You do not want to treat every cat that comes up positive on a blood test. What you want to treat are the cats that come up positive on a fecal test, because you want to treat the shedding and minimize the shedding. That's what is a risk to your shelter population and to the public. Okay?

Clindamycin will shorten the shedding period, and the shedding is the infectious form. It does not clear the organism from the cat. The cat will most likely have *Toxoplasma* for life, encysted somewhere, inactive, just like we do. It does not clear the organism that's gone into hiding in tissues, but it will shorten the shedding period, and that is what we're concerned about in terms of public health.

If the animal has systemic disease, it has toxoplasmosis and it's got neurologic signs from it, or muscle signs from it, or problems with its heart or lungs, clindamycin will help with the symptoms. But, again, it will not eliminate the organism. Neurologists will treat toxoplasmosis.

You will treat it with an antibiotic. It's not going to clear it completely, but it will make the animal better. Some of those signs may remain. Some of those signs may resolve.

But then how are we going to manage that? So let's take it from the individual animal, so pretty easy to be like, "Yes, the cat has signs of disease or the cat is shedding. Let's pop it with some antibiotics." Then, we stick that in our shelter. So now, we've got populations of animals that are surrounding that animal. We've got populations of people that are surrounding that animal. And, we've got potential adopters out there.

We need to manage the poop. This is pretty key every day in our lives. This is what we do in shelter medicine, is we manage poop. One of the things that's really recommended is to be sure that you're cleaning the feces daily or multiple times before sporulation occurs. Remember a key point – those oocysts are not infective until one to five days after they come out of the cat. If we can pick up, eliminate or throw away the poop within that window of time, we're going to have a much better control over that infective form. That may be our most key point in managing this and managing risk.

The other issue is disposable litter boxes. These certainly – a lot of shelters are using them, and the nice thing about them is they eliminate that option that oocysts or parasites of any kind are hanging around in the

crevices of all those plastic boxes, or getting passed from animal to animal. Cardboard disposable boxes are really nice. They can be a little costly, but they certainly eliminate all that cleaning that you're doing with your staff.

How many of you use cardboard litter boxes, disposable ones? Okay. And how many of you are cleaning litter boxes and recycling? I would recommend that you at least have disposables for your ill animals, the ones that are having diarrhea and that sort of thing, because you really don't want to contaminate plastic litter boxes that you then pass around. And so at least for that. Disposable litter boxes can go a long way to trying to help with this.

The other thing is we've gotten very fond of spot cleaning. How many of you doing spot cleaning? Probably you've heard me talk about it, because we're all advocates of it in terms of cleaning to minimize stress in our cats. One of the issues with spot cleaning is that we're just scooping the box and then leaving some stuff behind, right? So we may be leaving oocysts behind that can sporulate. again, disposable litter boxes could help with trying to eliminate some of that.

The other thing to know about this is that those oocysts are super, super tough. They are resistant to your standard disinfectants, right? Basically,

you need a flamethrower. I don't know how many of you are cleaning with boiling water, but I am not. In order to kill them you basically would need something hot enough to scald your hand, so that doesn't work out very well. Steam will kill them, but your basic cleaners will not. Ten percent ammonia might kill them, but it would probably kill everyone else in the shelter, including you, so I don't recommend that either.

They need moisture, so dryness kills them. We don't exactly live in a dry climate, so when it comes to these oocysts, we are challenged. We'd be better off in a desert. Drying the spaces, completely drying the spaces, will help. Sometimes it's just scrubbing and rinsing, scrubbing and rinsing, more than anything too. Dilution is the solution to pollution, right? Just wash those suckers away as much as you can.

I think the biggest thing is prevention – is being one step ahead of the game, getting rid of the feces in a timely fashion, educating your staff. I'll talk about that too – in terms of trying to prevent the parts of this cycle. If we can prevent this part, then we feel a little bit better. There's not much we can do about people that want to eat bleeding meat. They have to worry about themselves. They can do that at home and not in our shelter.

Certainly, if you have a rodent problem in your shelter – and I know some of you probably do, because I've been in some places that have some

pretty difficult rodent situations – this is certainly one of the risks of increasing this in your shelter. Deal with your rodents, one way or another. It's not always the best thing to be offering your shelter cats live diets.

Managing the zoonotic risk. This gets really tricky because, like everything, we are constantly mitigating risk in interacting with our companion animals. I think it is really important that there's some staff and volunteer education about the risks with toxoplasmosis and lots of the other parasites that our fuzzy little creatures may share with us. The most prone to issue – women of childbearing age. If they have not previously been exposed to toxoplasmosis, they are at the greatest risk.

The immunocompromised. We don't necessarily have the right to ask people if they have diseases that make them immunocompromised, but I'll remind you that some people have a disease that may compromise their immune system all the time, but any one of us with an illness could be immune compromised. Chemotherapy, other sorts of treatments make us immune compromised. And so it's important, I think, that we communicate that to our staff and our volunteers.

Hand washing, hand washing, hand washing, hand washing. If you need another thing to add to the list for why people should wash their hands,

add *Toxoplasma* to your list. And then adopter counseling, really making sure that our adoption staff know how to discuss risk and potential exposure with potential adopters.

So the worst cases that we've talked about with *Toxoplasma* – and most of you know – how many people knew about toxoplasmosis in pregnant women, like that's the thing that sticks out in your head? Yeah. Because those are the worst cases that we see. And so we talk a lot about making sure that pregnant women aren't exposed – and I'm going to break this down for you – pregnant women aren't exposed to cats that might be shedding *Toxoplasma*.

And that's because the congenital infections in humans are pretty awful; they're severe disease. And what needs to happen is that a woman needs to be exposed to the shedding oocysts, and she needs to have not had a previous exposure. So she doesn't have antibodies. She gets exposed to a shedding cat in that window of time when she gets pregnant, and then the fetus is affected. That is how it happens. Right?

It's worse if you are exposed at the third trimester than in the first trimester. So the worst defects occur in the third trimester, and they're pretty bad. We're talking about spontaneous abortion. We're talking about

brain, birth defects, retinal malformations, hydrocephalus, which is fluid in the head. We're talking about very, very serious disease.

And I was surprised because I had no idea that the rate was this high, but in the US it's reported that between 1 and 7 in every 10,000 births is actually – the babies are serologically positive, so they have toxoplasmosis at birth. That's a much higher rate than I had thought, because I feel like we don't hear about it very often.

Especially if you look at that 1 in 10,000 is about the rate of vaccine or injection site sarcomas in cats, and how many of you have heard about that? Like we all talk about injection site sarcomas and making sure that we're being careful with how we inject our cats. I had no idea the rate was that high. About 40 percent of those will actually have disease, but that's still a fairly high number, and if this is your child, this is your baby, that is – I can't even imagine how devastating that is.

So here's your quiz question. When a cat-owning woman gets pregnant, who needs a *Toxoplasma* titer test? Her cat? The woman? Both? Or neither? This is when you get to play Dr. House, and he's not very good. It takes him like four diseases before he gets to what the problem is, and then he calls *Toxoplasma* a fungus. So let's see if you're better. Good.

So, B – we're a split between B and C, so we're split between "the woman" and "both."

The recommendation is really the woman, and I'll tell you why as we go through – I think my scenarios are next. If you are childbearing age, thinking about getting pregnant, exposed to cats on a regular basis – especially in a shelter or because you bring home a bunch of cats – it's about your serology; it's about whether you have antibodies or not. If you have already been previously exposed and you have antibodies, they are thought to be protective, so even if you are exposed while you're pregnant, your body already has antibodies that will protect you. Does that make sense?

And so – oh, let's go through this one. When a pregnant woman gets toxoplasmosis, titer performed, which result puts her fetus at greater risk for acquiring congenital toxoplasmosis? I think I just answered that question for you. If she's positive for antibodies, if she's negative for antibodies, or they are of equal risk. Now see who was listening. Good. So if she is negative for antibodies, that puts her at greatest risk. That means she hasn't been exposed previously; she doesn't have protection. Good. Excellent. You guys are awesome.

So, now, opinion question: Pregnant women should get rid of their cats. True, false, or you're a libertarian – it's a free country; they can do whatever they want. Yay – 88 percent. Eighty-eight percent of you say, indeed, no, they should not get rid of their cats, and that is the most popular opinion for sure. And it is a free country. As her doctor, I'd probably say, "You can do what you want."

But I think it's important people have accurate information, and a lot of people get inaccurate information from their physicians – no offense intended for Dr. House and the other MDs out there. But it's about mitigating risk again, and the truth is that if they are positive, they are most likely protected, and then there are some other things you can do other than get rid of your cats, because there's no reason to believe that the cat that you lived with for a long time is necessarily any greater risk to you than it was yesterday. But there are some things we can do to kind of work that out.

So here's your first scenario, and these are not quiz questions with the clicker. Let me turn that off for a minute. *Toxoplasma* scenario. This is hard stuff, so I try to put up cute pictures and little signs, but if the cat is seropositive – meaning the cat has antibodies to *Toxoplasma* – and the woman has antibodies to *Toxoplasma*, as far as we have traditionally thought, is this a problem? Probably not. It is possible this cat may shed

again if there's some sort of stressful event, but the woman should have protection, and so this is a low risk situation for congenital infections as we understand them. Good.

Next one: the cat is seronegative and the woman is seropositive. Is this a problem? Most of you are saying no, and I agree with that too. Now if this is a cat that goes indoor and outdoor it may get exposed to its first round of *Toxoplasma*, or it eats a mouse, and it may shed sometime in that window, but she's positive for antibodies, so she should be protected. So most likely not a problem. Again, I would say this is a lower risk situation. Good.

How about if the cat is positive on a poop sample? Does that concern anybody? It concerns me a little bit. We know this cat is shedding. It's going to shed for a couple of weeks, right? But the woman's seropositive? Yeah, she should be all right. But are we worried now that this cat is shedding oocysts into the environment? Yeah, I'm worried, because now this cat may be a source of contamination for somebody else or someone else, and so this cat should be managed – in your shelter or in a home. We're going to start treatment on this cat. We're going to isolate this cat. We're going to let people know that it's shedding *Toxoplasma*. We're going to take some steps, right? So we need to manage that situation.

So that – yeah, that kitty, he's cute, but we probably need to do something about that. And then if he's seropositive – she; it's a calico; good job – seropositive and poop positive, and this woman – and the owner is seronegative or a shelter volunteer is seronegative, are we worried? Yeah, we're worried. This is the worst case scenario. We don't like this at all, right? So we need to manage this situation appropriately. Good.

So what are the current recommendations for pregnant or immune compromised people in contact with cats? The overall big one is don't clean the litter box, and I hear this time and time again: people are like, "I'm so excited to be pregnant. I don't have to clean the litter box for nine months." And they don't know if their cat's shedding. They don't know if their cat's positive necessarily. It doesn't really matter. You just don't have to clean the litter box. End of story, all right?

If you have to clean a litter box – so you've got an immune compromised disease and you get sick, if you have to clean it, the idea is clean it a lot. Like if you have no choices and there's no one else to scoop, then you need to clean it daily or multiple times a day to get that stuff out of there to avoid sporulation. Does that make sense?

And so we use this sometimes systemic toxo, which I'll try to talk about – I'll get there, towards the end – particularly a problem in AIDS patients,

and that's when it became a big focus in the last couple of decades. And so the recommendation was to find somebody else to scoop litter boxes for AIDS patients that had cats, or to scoop really frequently, wear gloves, and wear a mask, because they can be inhaled. Good. If you must clean boxes, wear a mask.

Wear gardening gloves when you garden outside. Remember, cats are not the only source of contamination. Soils can be contaminated from cats, and so you want to make sure you wear gardening gloves, and we recommend this in general, so all of you gardeners out there, you should have a set of gloves, and then you should wash your hands when you take them off. Wash your hands frequently and don't eat poop. Okay?

So here are all the ways that you can help. And I would argue women of childbearing age should kind of look at this in general anyway. Yeah. You want to eat poop? Okay. Is it okay to lick poop? No. No. No poopsicles.

Audience: Assuming that I have just received a face full of spoors, what is the percentage chance that I will get infected?

Dr. Berliner: It is somewhat dose dependant. I don't know if I can answer that. So if you have a face full of spoors, you may very well get infected. It's going

to depend on your immune system, so is your immune system going to tackle that or not? You will probably form antibodies to that, and so when you're saying "infected," you are probably going to ingest it. You will form antibodies. You may never get sick from it. But your body will most likely respond with antibodies to that, as long as you are immune competent to do that.

Audience: So what would you say is the percentage of people who get exposed who actually develop it?

Dr. Berliner: We don't know because you can't do a challenge study. So the question is how many people who get exposed get infected? To know that for sure we would have to know everybody's exposure, which basically means we'd have to ask you all to eat poop infected with oocysts and then measure how many of you ended up seropositive. And I don't think anybody's signing up for that experiment. We can do that in animals. We do it – and when I say "we" I mean science – but we can't really do that in people. So I don't know that answer.

I do know that in particular areas where the soil is highly contaminated – and we have studies on that where they pull high numbers of oocysts out of the soil – in those places, certain parts of Latin America, Egypt in particular, and Africa, the seroprevalence is extraordinarily high. Sixty,

70, 80 percent in some cases of people in certain urban areas have very, very – are seropositive, have been exposed. So there are regions where it's really, really high. Yeah?

Audience: So, as ridiculous as it might sound, is it almost a better idea for a young woman working in this field to –?

Dr. Berliner: Let me answer. So the question is, as ridiculous as it may sound, should I eat poop before I think about getting pregnant, so that I will be positive? Is that your question?

Audience: Yes.

Dr. Berliner: Let me address that as I hit the end of the talk, because what I'm going to talk about is some of newer concerns about toxo. So, historically speaking, we have said, yes, it may actually be better for you to have antibodies, and people haven't been that concerned. With the AIDS epidemic and with systemic toxo becoming an issue in some immune – when people are immune compromised, that has become more of a concern. And there are some more concerns about whether we have some subclinical toxo issues. So let me come back to that, and if I don't know answer it, let me know, okay? But, yeah, I mean your thinking is not crazy, because a lot of us, especially women in veterinary medicine have

really thought about that and said, "Well, maybe I just need to be positive and be done with it. Yes?

Audience: Don't you think all shelter workers and veterinarians in shelter medicine have been already exposed?

Dr. Berliner: You would think – she asked wouldn't you think all veterinarians and shelter workers have already been exposed. You'd be amazed at how low it actually is. And I don't have the numbers for you, but, no, it's not actually true. The majority of them are not seropositive and, why, I don't know. Because we're probably being good about our bio-security, right? Maybe. That's what I'll believe.

All right. So let me move along and then I'll see if I can hit your questions. So here's a scenario for you. You have a cat with positive fecal, so oocysts in the stool sample, for *Toxoplasma*. What are you going to do: (a) isolate it a 14-day shedding period with no treatment; (b) isolate and treat, then adopt the cat out; (c) adopt out immediately, no treatment; (d) euthanize; (e) we don't do fecal tests, so we don't need to know. B. Good. Excellent. I agree with that one, so isolate, treat, and then adopt. So if you've got a cat that's shedding, that's what I would do, personally, is to isolate that cat, treat them, get through the shedding period, and then they should be okay to go out and be adopted. Good.

What if you have a cat with a positive titer? So now we're back to the blood test. This is kind of quizzing you on what I've talked about. So they have a positive titer for toxo; what are you going to do? Isolate for a 14-day shedding treat with no treatment; isolate and treat, then adopt; adopt out, no treatment; or euthanize. C. Good. I'll leave that up there for a second and then I'll repeat it. So, yes, you are going to adopt out, no treatment.

Remember, titers talk about exposure. They don't talk about infectivity. And so it is fine to move them along for adoption because a lot of cats out there are going to be seropositive; a lot of people out there are going to be seropositive. We're not going to euthanize seropositive cats. We're not going to euthanize seropositive people. We're going to go about our daily life, all right?

So, here we go – toxoplasmosis in the news. And so there's been a lot of attention paid – how many of you have seen news headlines and that's why you're here today? Yeah, there's some stuff going on out there, and if you haven't heard about you will, because there was just something on ABC News a few days ago. A lot of stuff popped out. In fact, as I was doing research for this talk, more things were popping up each day, and I was like, "I can't keep up with all these stories." So there's a lot going on.

So I'm going to give you a little bit of background so that you understand what some of the thoughts are. So when it comes to parasitology – and I find this fascinating – there's something called the manipulation hypothesis. And so there's this idea that parasites – and we know this is true in several of the parasites. Parasites will invade a host, so they will invade an animal – it can be an insect, or a cat, or a rat, or whatever – and change its behavior. And the hypothesis is that it changes the behavior in order to benefit the parasite.

So Dr. Newmark was just talking about rabies; so there's a good example of a virus that invades a host, changes the behavior – it makes it run around, salivate. And how does the virus spread? Through saliva. It makes it run around and bite people, so it spreads the virus. And so it changes the behavior in order to benefit the parasite. And so the question is, do we think toxoplasmosis can change behavior? It certainly – you end up with cysts in your brain. Can they act on the brain to change behavior? And so that was one of the questions that came up.

And, in fact, it's been shown that toxoplasmosis – and this research is pretty good – toxoplasmosis actually does affect rodents and change their behavior, and so infected rodents will demonstrate innate – meaning naturally – reduced fear responses to cat pheromones and cat urine. So if

you take a laboratory rat that has never met a cat, and you expose it to cat urine, it is afraid and it will try to avoid it. It's never seen a cat, doesn't know anything about cats, and yet it will avoid that urine naturally, as part of something that it just has inherited.

And so when a mouse or a rat is infected with *Toxoplasma*, it actually loses that innate fear and it is actually attracted to cat urine, so it will hang out in the cat urine corner. And so they did this sort of thing where they created this big round – it was a big round circle, and they stuck bobcat urine at one end of it, and they stuck rabbit urine at the other end, which they should not be afraid of, and they're not. And the uninfected rodents ran this way and spent a lot of time over here. The infected rodents went over there and hung out in the cat urine because they were no longer afraid of it.

They also demonstrated less learning, less learned fear. And so they took collars and towels and soaked them in cat urine and exposed them to that, and the ones who were not infected were afraid of the collars and towels that were infected. The ones that were infected were not afraid. And then the ones that were infected also didn't learn to be afraid of just a regular old collar or towel, whereas the other ones did. So they failed to learn to be afraid of something that smelled like cat urine as well, and instead they found it really sexy and hung out in the cat urine corner.

The other thing that they did is they demonstrated more risky behavior. They'd jump around more in front of a cat. They became uncoordinated. They were like attracting attention more. And so this idea that the parasite got into the rat brain or the mouse brain and actually makes them attract to the cats. They called it "fatal attraction." And so of course the next question, if you're a crazy scientist, is what? Does this happen in people?

Chronic toxoplasmosis in humans does exist. If you have antibodies, you may have tissue cysts that are in your brain or in muscle tissue, and in most people they're going to do nothing. Again, the prevalence – anywhere from 14 to 22 percent in the US, much higher in other parts of the world. People are usually asymptomatic, causes no disease whatsoever in people, and actually protects you essentially against later infection, or congenital infections if you're a woman getting pregnant.

In immune compromised individuals, particularly AIDS patients, we became aware of the fact that those cysts can come out of dormancy. They can come out of your brain and rupture, essentially, and the parasite can start replicating again and causing disease in people, and so that could breed significant disease in these individuals.

And so it become a question, one, what do we do about that? How much of a concern is that? What do we do? How do we treat it? Should we be worrying about this? And then the other is, is it causing other disease that we don't know? Especially if you go back to the idea – and I'll back up to look at our mice – maybe not. I won't. If you go back to the idea that in the mouse it affects behavior, can it affect behavior in people? And so the question after that was can it make people attracted to cat pee? Does it make people act like cats – eat off the floor?

And somebody was telling me a story at dinner the other night – I know who it was – about when they were a cat for Halloween as a child and demanded to eat off the floor that night, and their mother let them do that. And I thought of that as I was writing this. Come on – you guys all know you wanted to do that at some point – eat out of the cat bowl. And so the question became, does it affect crazy cat ladies? And so is there something about toxoplasmosis that may make people attracted to the smell of cat pee? Could it be playing a role in hoarding? Could it be playing a role in some mental illnesses where hoarding cats becomes an issue? Does it make people into crazy cat ladies?

So what do they do next? Get some cat pee and have people smell it. Silly. Silly you. Come on, guys. And you're going to see this name come up again and again as I'm talking. Does *Toxoplasma* affect how humans

react to cat pee? And so this guy got some cat pee and did some titers on people. And he took *Toxoplasma* negative people and toxoplasma positive people and exposed them to cat pee to find out if they were more attracted. And, indeed – this is interesting – men that had *Toxoplasma* positive titers actually were attracted to the cat's pee smell. Women were not. So it kind of went against the crazy cat lady, but it supports the crazy cat man theory.

They tried it with other species, so they collected urine from all sorts of animals and did the same thing, and there was absolutely no change. There was no difference between the people that had toxo and the people that didn't. But for cat urine, there was a difference. What does this mean? I don't think we really know, honestly, and so I'm going to talk a little bit more about research and how to think about it, but it was I think an interesting finding, and at least it didn't support the idea that we're making crazy cat ladies out of *Toxoplasma* positive people.

But this guy – and there's his name, and I don't know how to pronounce it – Dr. Flegr *[spelling]*, he's the one who shows up a lot with this research. So he is Czechoslovakian, and he has done a lot of research looking at behavioral conditions in humans, mental illness in humans, and whether or not toxoplasmosis may play a role. And so he's popping up a lot in

popular science. This article came out of *Atlantic Monthly* in March 2012, and he's really interested.

And it all started because, as early as 1896, there was someone who questioned whether schizophrenia might be related to a parasite. And so he's had some issues in his life – he talks about it in the article – and he wondered whether he had a parasite that might, indeed, make him act out in certain ways, because he was a little disruptive in adolescence and early adult. And, indeed, he went looking and, indeed, he's *Toxoplasma* positive, and so he started questioning and then he started doing some studies to try and investigate this.

So human behaviors in question that he's looked at – schizophrenia. And I'm going to come back to that one because that's the one where there may actually be some connection. He's looked at suicide risk. He's looked at car accidents and reaction times, the idea being that reflexes seem to be compromised in people who are *Toxoplasma* seropositive, so they have positive titers. Looking at risk taking and novelty seeking, that idea of changing the behavior of the rat or the mouse. Does it change human behavior? And certainly problem solvings and cognition – there have been questions about whether it compromises humans' ability to kind of reason through problems.

And there's a bunch of different studies. He did this through surveys. So he used students, military people, a couple of other groups, and then asked them long, long questions about their behaviors and their choices and what they do, and then he took their titers to see who was positive and who was negative. The one that has popped up most frequently and that there actually has been something called a meta-analysis of, the one that has had the most broad-based research, is schizophrenia. And there does seem to be an increased risk. There's a higher number of schizophrenics that are *Toxoplasma* [postitive] – no, let me put it the other way. If you are *Toxoplasma* positive, you have a higher risk of having schizophrenia, by 2.3 times higher – at least in the population that he surveyed.

Now, I want to kind of break this down for a minute because just because you have two things that pop up, doesn't mean that there's a cause-and-effect relationship, and we all learn that pretty early on in trying to look at research. So there are several ways to do research, and one of the things we want to talk about is peer reviewed journals. So those are articles where experts review them. So somebody writes an article based on research and experts in the field review them before they ever go to publication. So that's considered better research than non-peer reviewed. Somebody's read it and said – a panel of people have read it and said, "Okay, this is good."

Evidence-based is even better than that, where what they do is they take a bunch of different studies, they do a meta-analysis – which is what was done with that schizophrenia piece – and they tried to analyze a large number of studies verifying that, indeed, what was found across the board was the same and could be supported by multiple pieces of information.

Open source publishing is relatively new with the Internet, and it's a point of concern. Open source publishing usually has no or very limited peer review, and anyone can kind of go online and publish their study without it being critically reviewed. And there's more and more of this out there. The other thing about it is it's available to everyone, so you don't pay a journal because, essentially, anybody can publish. And in some cases these journals actually collect a fee to publish – and a big fee to publish. And so there's a lot of journals out there, especially if you're not in an academic institution, that if you go looking for articles, this may be the only articles you get, are the ones that people were allowed to publish without perhaps the same level of peer review as ones that show up in some of the scientific journals.

And then, of course, there's popular science in the news. How many of you have ever been interviewed by a reporter, and a story went out there, and there were just glaring errors that made you want to crawl back in bed? Yeah, most of you are nodding. That can be really disheartening and it happens all time because, and particularly in the popular media,

they're trying to sell papers, they're trying to get people to watch their TV station, and there may be a lack of peer review. Fair enough? So quick nod to peer-review based research, and a quick nod to epidemiology, that behaviors and conditions are complex.

And so one of the things with schizophrenia is that it also – socioeconomic status, genetics, and experience all play a role. And so, yes, there may be a higher level of *Toxoplasma* positive people and a higher level of schizophrenics. But a lot of times that's also associated with socioeconomic status. Toxo, in particular, is higher in urban areas, where there's higher concentrations of people, and in people with lower educational levels.

And so there may be multiple factors, and my best explanation for this is let's say – okay, I'm a red head naturally. I get a little help these days. But let's say I'm in gym class and I'm really bad at volleyball, and so the – and there's two other red heads in my class and they're really bad at volleyball. And so you decide to write a study that red heads are bad at volleyball – because 3 out of 23 people are red headed and bad at volleyball.

Well, what if I say that – what about if we're identical twins? So maybe our genetics now played a role in all of us being bad at volleyball. Does that make sense? Or maybe all three of us came from – we just got to this

school and we never played volleyball before seventh grade, and everybody else has been playing volleyball since kindergarten because they all were at this school and they had better training?

And so it's very easy to jump to a conclusion if you've got two things and say, well, these two things are connected, when really they're not because there's other factors that are involved. And for both toxoplasmosis and schizophrenia there are complicated factors that play a role, and it may be that some of those overlap. And even Flegr says that. If you actually read what he wrote versus what the newspaper writes, that is absolutely in his work as well.

So very small numbers of toxo positive people actually manifest mental or behavioral disorders. So we have a lot of people that are seropositive. Very few of them actually have mental illness. The other thing is that the majority of schizophrenics are *Toxoplasma* negative, so if you look at it the other way, the vast majority of them are not positive for *Toxoplasma* titers. And the other question that I got from somebody yesterday – and I went back and looked – is, indeed, countries that have the highest rate of *Toxoplasma* positive serologies do not have higher rates of schizophrenia than the US; the rates are the same even though their numbers of people that are positive for *Toxoplasma* are much higher.

So it begs the question if there is another factor, some kind of genetic predisposition or known association. It's certainly something to pay attention to and to be concerned about, but it's not an earth shattering – we don't all have to be afraid at this point, I don't think, based on what's out there. But I certainly think it's something to watch.

The other thing that they've looked at – and this is really, really recent information – is that toxoplasmosis in people, the quiet subclinical form, the question is whether it can play a role in dopamine and whether this might be the connection. So if you stick *Toxoplasma* in a Petri dish, which is a little science dish, it does affect the amount of dopamine made in mammalian cells, and dopamine has a lot to do with your fear responses, your sense of pleasure, your sense of paying attention to things. And so dopamine does have a really active role and there is a question of whether toxoplasmosis may affect dopamine.

Now, again, in a Petri dish there is one study which was an open source publication online that says, indeed, they think it does, but that's really new. And we do know that in schizophrenia, dopamine is increased. That we do know for sure. And so there may be a connection that's connected through dopamine. Again, but not all schizophrenics are *Toxoplasma* positive, and actually very few of them are.

But we're seeing these sorts of headlines: "Harmful Parasites in Cat Poop are Widespread," "*Toxoplasma* Oocsyt is a Public Health Problem." This is the kind of stuff that's coming out, and I've already heard from some communities where people are – it's becoming the thing to go after feral cats again, community cats, and so the concern whether they're going to be a source of *Toxoplasma* and whether that means everybody's going to develop schizophrenia in that neighborhood, or other diseases from *Toxoplasma*.

So this actually came out of a parasitology peer-refereed journal, and I'm just going to read it out loud because this is kind of the vision that I'm most afraid of, because I think it's a narrow vision. "Public health policy should prohibit the practice of allowing pet cats to roam. Organizations and individuals that feed feral cats are unwittingly contributing to the dissemination of *Toxoplasma* by sustaining artificially dense populations of the definitive host of these protozoa parasite." So, basically, the parasitologists came out saying that we shouldn't feed feral cats, or outdoor cats, or roaming cats.

This sounds familiar. To me it sounds familiar in talking about TNR and all of those questions. And I say we need to be a little bit more creative than that, because we know that trapping and euthanizing is not humane or effective. And we know that ignoring the problem and not feeding the

cats is not going to fix the problem. They're still going to be out there; they're just not going to be fed. I mean this, to me, implies let's stop feeding the cats and just let them die off, which is not going to happen. So we need to be smart about it, and through spray-neuter we've been smart about it. Let's target those communities. Let's reduce population.

So my take on points – and I'll get to questions in just one second – but things I want you to go home thinking about. The number of cats shedding oocysts is low. It's less than one percent at any time. The shedding period is the risk period, so it is that one to three weeks, on average 14 days, of shedding. That is the risk period for actually spreading the oocyst, and we can control some of that in how we manage our cats. Serologic testing of healthy cats is of little clinical value. You do not want to use *Toxoplasma* titers as a screening test to elect what you do with your cats.

Immune compromised individuals and pregnant women need to take precautions. Maybe we all need to take precautions and manage how we handle poop. That's what we're good at. Cats are only one source and indoor cats very low risk, unless you have a rodent population. So, again, cats are one source. Raw meat is a problem. Soils are now a problem. Water is a problem in some areas; water sources can be contaminated. Indoor cats extremely low risk.

Disposing of feces within 24 hours is your best approach, hands down; get rid of it before it sporulates. And decreasing populations of free-roaming cats through humane and effective methods – meaning TNR, not PTS, put to sleep – could contribute to lower environmental contamination. We all want to control the numbers of free-roaming cats we have out there, and we're trying to do it through targeted spay-neuter efforts and other humane efforts. I don't think trapping and euthanizing the cats is the answer to that. We need to bring the numbers down, but let's do it through a way that's not harmful to the cats.

These are my references. I put them all in there. There are lots of things you probably never want to read in your life. I put some other ones that are available online out there or that you should easily have on your shelf. And thank you to Maddie's Fund®, the ASPCA, and Cornell for hosting this conference. And now questions. Yes, sir.

[End of Audio]