

# Toxoplasmosis in Cats and Humans

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## ABSTRACT

*Toxoplasma Gondii* is an obligate, intracellular coccidian parasite with the ability to infect almost all warm-blooded species. While domestic cats and other felines are the natural hosts, humans and other mammals are intermediate hosts that can develop significant diseases in immunocompromised people or are developing fetuses. In healthy individuals with intact immune systems, the clinical disease is rare. Around 30 million humans are thought to have a *Toxoplasmosis*-related infection, and 20%-60% of cats get diagnosed with *Toxoplasmosis*. The main transmission routes are congenital infections, ingestion of infected tissue, and ingestion of oocyst-contaminated food or water.

## Introduction

*Toxoplasma Gondii* is an obligate, intracellular coccidian parasite with the ability to infect almost all warm-blooded species. While domestic cats and other felines are the natural hosts, humans and other mammals are intermediate hosts that can develop significant diseases in immunocompromised people or are developing fetuses. In healthy individuals with intact immune systems, the clinical disease is rare. Around 30 million humans are thought to have a *Toxoplasmosis*-related infection, and 20%-60% of cats get diagnosed with *Toxoplasmosis*. The main transmission routes are congenital infections, ingestion of infected tissue, and ingestion of oocyst-contaminated food or water.

## Life Cycle of Toxoplasmosis

*Toxoplasma gondii* has two types of life cycles: enteroepithelial and extraintestinal. The enteroepithelial life cycle is only found in felids, who are the definitive hosts that shed oocysts through feces and sexually reproduce more oocysts. Contrarily, the extraintestinal life cycle can be found in all types of warm-blooded hosts, including humans, who are intermediate hosts that undergo asexual reproduction.

In felines undergoing the sexual, enteroepithelial life cycle, *Toxoplasma gondii* has three infective stages: bradyzoites, also referred to as cystozoites, tachyzoites, and sporozoites. Once ingested, the cyst wall that encloses bradyzoites is dissolved and ruptured by proteolytic enzymes in the stomach and small intestine. The bradyzoite then penetrates and settles into the epithelial cells of the small intestine, termed enterocytes, where they initiate asexual reproduction. During this asexual reproduction, merozoites are formed within schizonts during a specialized form of schizogony, or asexual reproduction, through multiple fission. Merozoites are then capable of initiating sexual development. During sexual development, the formation of male and female gametes occurs. A meiotic reduction occurs, and sporulated oocysts are formed within two sporocysts containing four haploid sporozoites. After these gametes are fertilized, oocysts formed within the enterocytes are liberated by disruption of the cell and excreted as unsporulated forms in cat feces. This occurs a few days after being in the external environment. Infected cats can shed more than 100 million cysts in their feces, which can go on to infect several types of intermediate hosts. Oocytes can also be infective for cats but less efficiently.

The extraintestinal life cycle occurs in warm-blooded hosts as well as felids. Within these intermediate hosts, only asexual development occurs. The development process of *T. gondii* is the same irrespective of whether the tissue cysts or oocysts were ingested. When oocysts are ingested through infected food or contact with cat feces, the cysts rupture inside the small intestine and release sporozoites into the gut wall. They are then ingested by macrophages, which are white blood cells that kill invading species and stimulate the recruitment of other immune cells to the site of infection. Once macrophages ingest the sporozoites, they differentiate into tachyzoites. Tachyzoites are the rapidly multiplying form of cysts and can harbor in any type of cell, but mainly cardiac and skeletal muscle. With a healthy immune system, individuals can clear and prevent the spread of tachyzoites into other parts of the body. In immunocompromised, tachyzoites spread to the brain, muscle, and other tissues and develop into bradyzoites. Bradyzoites, the slowly dividing form of the cysts, then infect the intestinal epithelium of the new host and differentiate back into the tachyzoite stage for dissemination through the body.

## Disease and Diagnosis

Cats are the most important animals because they are the only hosts that can excrete environmentally resistant oocysts. (Veterinary parasitology) Most cats get infected by *T. gondii* by ingesting other hosts, such as rodents already infected with *T. gondii*. Humans primarily get *T. gondii* from ingesting meat that contains a cyst, such as undercooked beef or pork. Humans and rodents can also get infected through ingestion of sporulated oocysts, mainly through the environment. Most immunocompetent organisms will stay asymptomatic throughout their life, but both immunocompromised or immunocompetent subjects can get the disease. Infected animals or humans may present with signs and symptoms of myalgia, sore throat, fever, rash, muscle pain, and or fever. To diagnose Toxoplasmosis, a fecal sample is taken to see if the organism can be identified. *T. gondii* can only be diagnosed if the organism is found in tissue or body fluids.

## Epidemiology

Toxoplasmosis is one of the most successful parasitic infections globally and is a significant public health problem. The prevalence varies from region to region, but according to the Centers for Disease Control and Prevention (CDC), it is estimated that 11% of the population in the United States, age six years and older, have been infected with *T. gondii*. More than 60% of some populations have been infected with *T. gondii*, with infections in hot, humid climates and lower altitudes being the most common in other places across the world. This is thought to be the case because the oocysts that reproduce and harbor the disease in hosts can survive in these types of environments.

Infection with Toxoplasmosis can cause devastating disease and mortality and can reduce the quality of life. According to Scallan et al., *Toxoplasma gondii* causes 8% of foodborne illnesses in the United States. Additionally, one of three pathogens, including *Listeria* and *Salmonella*, accounts for more than 75% of deaths due to food-borne illness in the United States. Around 24% of those deaths in the USA due to foodborne illness were from Toxoplasmosis.

Not only does *Toxoplasma* cause a significant health burden, but it also causes increased healthcare costs. Ocular disease resulting from Toxoplasmosis accounts for nearly \$3 billion and an estimated 11,000 quality-adjusted life-years lost annually. For humans, one test for *T. gondii* costs about 4-5 dollars, and the prices of drugs to treat the diseases can go anywhere from 14\$ to 800\$. For animals, the cost of treatment can range from 600-800\$. Both the significant health and financial burden of Toxoplasmosis indicate that there is a need for better strategies that prevent the spread and contamination of *T. gondii*.

## Pathophysiology

As noted earlier, the life cycle and pathophysiology of Toxoplasmosis are pretty complicated. Most infections in immunocompetent adults and children do not cause significant symptoms. When symptoms do occur, they can resemble those of infectious mononucleosis, including fever, rash, and fatigue. Congenital infections passed through the bloodstream from mother to placenta can lead to abortion, stillbirth, or significant disease. The range of disease severity of congenital infection in newborns can vary from fever and jaundice to encephalitis, chorioretinitis, and blindness. Congenital infection with Toxoplasmosis one of the leading causes of blindness in children worldwide. In those who are immunocompromised, such as those with AIDS, a life-threatening disease can occur, the most common of which is encephalitis. This can be seen on MRI brain imaging as a ring-enhancing lesion representative of a brain abscess.

## Treatment

In well-developed countries such as the United States, congenital Toxoplasmosis is treated with sulfadiazine and pyrimethamine. These agents can also be used to treat severe diseases in those who are immunocompromised. For healthy individuals, an acute infection of Toxoplasmosis usually resolves on its own.

## Barriers to preventing the spread of Toxoplasmosis

Toxoplasmosis is not contagious via person-to-person under normal circumstances. The only way that a human can infect another human is from Mother to child, blood transfusions, and organ donations. Toxoplasmosis is most commonly spread to humans in three ways. The first way to get infected is by ingesting raquences of Toxoplasmosis. The second is ingestion of oocysts, an environmentally resistant form of the organism that cats pass in their feces. Exposure to oocysts usually happens through exposure to cat litter or soil. The last way humans can get Toxoplasmosis is a newly pregnant woman passing the infection to her fetus.

Current ways to prevent the spread of Toxoplasmosis in all people are to avoid drinking untreated water as it can carry the parasite, wash fruits and vegetables before eating, and keep outdoor sandboxes covered to prevent it from getting contaminated with feces that carry the parasite. A less common way to get infected is through dairy products. To prevent this, individuals should avoid ingesting unpasteurized dairy products to prevent contact with the parasite. Another common contact to *Toxoplasmosis* is from eating undercooked meat, so any meat should be cooked to 165 degrees Fahrenheit measured with a food thermometer that is put into the thickest part of the meat (4). Allow it to rest for three minutes before consuming the meat. Meat should be cooked to 165 degrees because it kills all the parasites that may be shed in the meat (4). Another way to prevent getting Toxoplasmosis in meat is to freeze your meat at sub-zero temperatures for several days to kill parasites that may still be living in the meat (4). This method only works for Toxoplasmosis gondii and no other parasites; the cold will not harm anything else.

A current prevention strategy for gardening is to make sure to wear gloves when gardening so you do not come in contact with any parasite. Wearing gloves when cleaning a litter box is essential because it is possible to come into contact with sand or soil that was contaminated by cat feces that contain *Toxoplasmosis*. After the litter box is cleaned, the person who cleaned the important litter box must wash their hands with soap and warm water. Cleaning the litter box each day prevents the parasite from developing.

A pregnant woman should not clean a litter box even while wearing gloves because they still have the risk of getting *Toxoplasmosis Gondii*. Data has shown that timely treatment of an acutely infected pregnant woman can prevent or delay transmission of the infection to the fetus (8). In the event of fetal infection, treatment can significantly reduce the frequency or lessen the severity of consea planned serological screening of pregnant women to help identify any women who are at risk of getting the infection or any women who are already infected (8). Another prevention

strategy is to make sure to wash them after using contaminated knives, cutting boards, or utensils. Kitchen utensils that come into contact with raw meat can harbor parasites and then contaminate other things. To prevent cross-contamination after using the utensils on raw meat, they should be washed in hot, soapy water to destroy any parasites that may still be lingering on the utensil.

To prevent *Toxoplasmosis Gondii* in cats, keep cats indoors to prevent them from becoming infected with Toxoplasmosis or from shedding oocysts into the environment. Do not allow cats to hunt or eat wild animals as they can have the infection (10). It is especially important to keep cats away from livestock and to feed cats only commercially prepared foods like dry or canned cat food. Any foods that include meat that are raw or undercooked should not be fed.

## Acknowledgments

I would like to thank Lumiere Education for giving me this opportunity and guiding me through the process of my topic.

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