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ID CASE

Toxoplasmosis: The Heart of the Diagnosis

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Toxoplasma gondii is a common parasite that infects warm-blooded animals, including humans, and is a foodborne pathogen. We report a case of acute toxoplasmosis in a 76-year-old man after ingestion of the undercooked heart of a white-tailed deer (*Odocoileus virginianus*) in Tennessee. The patient's adult grandson, who also consumed part of the heart, became ill with nearly identical symptoms, though he did not seek medical care. This case highlights important public health concerns about deer-to-human transmission of *Toxoplasma*.

Keywords. acute toxoplasmosis; Toxoplasma gondii; venison; white-tailed deer.

Toxoplasma gondii, a single-celled parasite able to infect many animals, can be transmitted to humans via ingestion of contaminated water or food containing *Toxoplasma* cysts [1, 2]. Seroprevalence in humans is estimated at ~11% in the United States. In white-tailed deer (*Odocoileus virginianus*), seroprevalence is estimated at 30%–60% specifically in the Southeastern United States [1, 3]. In rare case reports, deer have been implicated in the transmission of *Toxoplasma* to hunters after consumption of raw or undercooked venison [4, 5]. In this report, we present 1 confirmed case and 1 suspected case of acute toxoplasmosis after ingestion of the undercooked heart of a white-tailed deer.

CASE

A 76-year-old man presented to the emergency department with 4 days of fever of up to 102°F, myalgias, poor appetite, and loose stools. His medical history was notable for coronary artery disease, hypertension, hyperlipidemia, urticarial vasculitis, and stage II chronic kidney disease. He was married, lived in suburban Nashville, Tennessee, and worked as a preacher. He denied recent travel.

He was admitted to the inpatient medical service for further evaluation. At initial presentation, he was afebrile with an unremarkable physical examination. Labs noted leukopenia, elevated creatinine, and elevated transaminases (Table 1). Respiratory virus polymerase chain reaction (PCR) panel, blood and urine cultures, and viral hepatitis serologies were all negative. Chest x-ray and abdominal ultrasound were unremarkable. He had no episodes of fever during his admission. He was treated with intravenous normal saline for volume repletion, and his renal function improved to baseline. He was discharged home after 24 hours of observation.

The day after discharge, fevers of up to 102°F recurred and continued daily for 5 days. The patient again presented to the emergency department and was readmitted. On presentation, his temperature was 102.7°F, blood pressure was 117/64 mmHg, heart rate was 76 beats per minute, respiratory rate was 18 breaths per minute, and oxygen saturation was 96% on room air. Physical examination was unremarkable: no cardiac murmurs, normal lungs sounds, abdomen soft and nontender, no lymphadenopathy. The patient reported no visual symptoms, so a dedicated retinal exam was not done. Laboratory studies showed worsening transaminase elevation, baseline renal function, and normal leukocyte count (Table 1). Computed tomography of the chest, abdomen, and pelvis showed mild mesenteric lymphadenopathy and was otherwise unremarkable.

During this second admission, the patient shared additional exposure history; this time course is illustrated in Figure 1. Seven days before onset of symptoms, both he and his adult grandson ate briefly pan-seared portions of the heart of a white-tailed deer. The patient's grandson had killed the deer that same day while hunting locally. No other parts of the deer were consumed, and the patient did not handle the carcass. The patient and his grandson developed nearly identical symptoms, though his grandson did not seek medical care. The deer carcass was unavailable for testing as it had been discarded. The patient reported no other animal exposures aside from his healthy pet dog.

He was initially started on empiric doxycycline for coverage of several possible zoonotic infections while awaiting lab results. Several blood tests returned negative: cytomegalovirus PCR, Epstein-Barr virus PCR, *Francisella tularensis* serology, *Leptospira* serology, *Brucella* serology, *Brucella* blood cultures, *Coxiella* phase I/II IgG, *Echinococcus* serology,

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Table 1. Laboratory Data

Variable	Reference Range	Admission #1 Day 11	Admission #2 Day 17	Clinic Visit Day 28
White blood cell count, $\times 10^3/\mu L$	4.8–10.8	3.4	6.9	8.0
Hemoglobin, g/dL	14.0–18.0	14.8	13.7	13.6
Hematocrit, %	42–52	43.0	39.6	40.9
Platelet count, $\times 10^3/\mu L$	150–500	175	223	400
Sodium, mmol/L	137–145	136	136	139
Potassium, mmol/L	3.4–5.2	3.9	5.4	4.3
Chloride, mmol/L	98–107	97	101	103
Carbon dioxide, mmol/L	22–30	23	23	23
Urea nitrogen, mg/dL	5–25	37	25	35
Creatinine, mg/dL	0.70–1.30	2.10	1.20	1.51
Glucose, mg/dL	70–110	110	102	102
Total Protein, g/dL	6.3–8.2	7.5	—	8.4
Albumin, g/dL	3.5–5.0	4.6	—	4.3
Alanine aminotransferase, U/L	13–69	95	302	82
Aspartate aminotransferase, U/L	15–46	119	444	51
Alkaline phosphatase, U/L	38–126	60	63	99
Total bilirubin, mg/dL	0.2–1.3	1.3	1.8	0.9

Ehrlichia PCR, *Ehrlichia* serology, and *Rickettsia rickettsii* IgM. Serum *Toxoplasma* serology testing was done by LabCorp (Birmingham, AL) by chemiluminescent immunoassay. *Toxoplasma* IgM was positive at 57.4 IU/mL (upper limit of normal, 8.0 IU/mL), and IgG was negative at 5.3 IU/mL (upper limit of normal, 7.2 IU/mL).

The patient improved symptomatically with resolution of fevers and he was discharged home 3 days after admission. At follow-up in the infectious diseases clinic 7 days later, his symptoms had completely resolved despite not receiving specific treatment for toxoplasmosis. Repeat serum *Toxoplasma* serology from that visit, also done by LabCorp, showed IgM >160 IU/mL and IgG of 64.6 IU/mL (both positive).

DISCUSSION

This case of acute toxoplasmosis, with a related suspected case, was acquired after ingestion of the undercooked heart of a white-tailed deer (WTD). The heart likely contained *Toxoplasma* cysts, as has previously been demonstrated in WTD [1]. This led to infection with *Toxoplasma* upon ingestion of the heart without it being adequately cooked. Unfortunately, the deer carcass was unavailable for definitive testing.

On initial testing, the patient's serum *Toxoplasma* IgM was positive and IgG was negative. Although this result alone does not confirm diagnosis of acute toxoplasmosis, the patient showed *Toxoplasma* IgG seroconversion on repeat testing 10 days later. Given that the patient did not receive blood products, which can affect testing results, this documentation of IgG seroconversion confirmed the diagnosis of acute toxoplasmosis. His illness resolved without specific treatment for toxoplasmosis, though doxycycline may have some activity against *Toxoplasma* [6].

Although most cases of toxoplasmosis are subclinical or present with mild flu-like symptoms, *Toxoplasma gondii* was the second deadliest foodborne pathogen in the United States between 2000 and 2008, with 327 deaths estimated annually [7, 8]. More

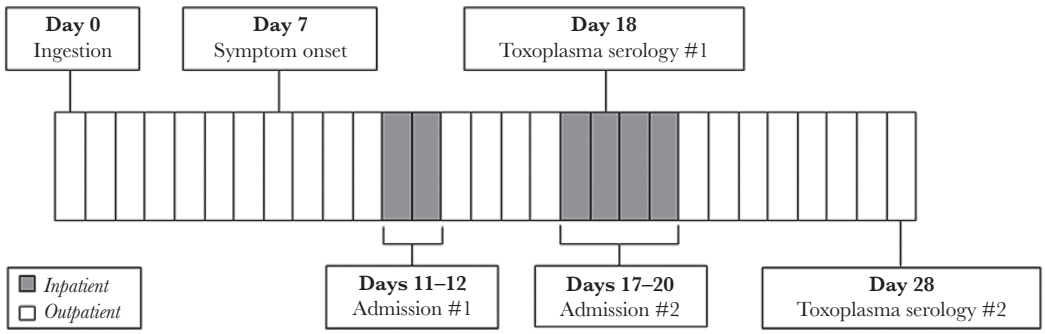

Figure 1. Clinical time course.

severe cases of toxoplasmosis may be associated with atypical genotypes, some of which have been identified in wildlife in the United States, including WTD [1].

As common game animals with high *Toxoplasma* seroprevalence, WTD have significant potential for transmission of *Toxoplasma* to humans, representing an important public health issue [1, 2]. Few cases of direct deer-to-human transmission have been previously reported, and, to our knowledge, there have been no prior reports of toxoplasmosis contracted specifically from the ingestion of the heart of a WTD [4, 5]. However, nearly 90% of individuals in the United States remain susceptible to acute infection [3].

There are also many instances in the online hunting network that incorrectly assert that the ingestion of raw deer meat is a safe practice, despite US Department of Agriculture recommendations that venison be cooked to >160°F to kill potential pathogens, including *Toxoplasma* [9–12]. Additionally, as tradition in some circles, first-time hunters ingest the heart of their first freshly killed animal, often raw [13]. Outside the domain of deer hunting, "venison heart tartare" has been featured on restaurant menus in New York and Chicago [14, 15]. Given the high prevalence of *Toxoplasma* in WTD and many misconceptions about the safety of consuming undercooked deer meat, this case highlights important public health concerns.

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