Assessment of U.S. Pediatrician Knowledge of Toxocariasis

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Abstract. Toxocariasis, one of a group of parasitic diseases known as neglected parasitic infections, is a disease caused by the larvae of two species of *Toxocara* roundworms, *Toxocara canis*, from dogs, and less commonly *Toxocara cati*, from cats. Although most infected individuals are asymptomatic, clinical manifestations may include fever, fatigue, coughing, wheezing, or abdominal pain (visceral toxocariasis) or vision loss, retina damage, or eye inflammation (ocular toxocariasis). To assess U.S. pediatrician knowledge of toxocariasis, we conducted an electronic survey of American Academy of Pediatrics members. Of the 2,684 respondents, 1,120 (47%) pediatricians correctly selected toxocariasis as the diagnosis in an unknown case presentation with findings typical for toxocariasis; overall 1,695 (85%) stated they were not confident that their knowledge of toxocariasis was current. This knowledge gap suggests a need for improved toxocariasis awareness and education for U.S. pediatricians, especially those caring for children at risk for infection.

Toxocariasis is a parasitic disease caused by dog and cat roundworms, *Toxocara canis* and *Toxocara cati*, respectively. The transmission cycle begins when an infected dog or cat sheds *Toxocara* eggs in its feces into the environment; humans become infected when they ingest infectious *Toxocara* eggs, often by touching contaminated hands to their mouths. After ingestion, *Toxocara* eggs hatch and release larvae that can migrate through the body, including the lungs and other internal organs, where inflammation associated with migration can cause signs and symptoms such as wheezing and cough or hepatomegaly.¹ Children are at high risk for infection primarily due to their poor hygiene standards and play habits.² In a nationally representative serologic survey, 14% of the U.S. population were found to have antibody to *Toxocara*, although it remains unknown how many people with a positive test result had clinical manifestations.³ Toxocariasis is one of a group of diseases known as neglected parasitic infections (NPIs), targeted by the Centers for Disease Control and Prevention (CDC) for public health action. These diseases are considered neglected because relatively little attention has been devoted to their surveillance, prevention, and/or treatment.

Toxocara disease severity can range from asymptomatic to permanent organ damage and even death. The two main presentations of toxocariasis are ocular and visceral toxocariasis; visceral toxocariasis is difficult to diagnose as presenting symptoms are often vague (cough, wheezing, abdominal pain) and can mimic other, more common childhood diseases (e.g., asthma).^{4,5} Although *Toxocara* infection can lead to devastating morbidity in humans, little attention has been devoted to educating health-care providers about the disease.⁶ As pediatricians provide care for a population at high risk for toxocariasis, recognition of risk factors is essential to provide preventive guidance. To gain a better understanding of U.S. pediatricians' familiarity with the diagnosis and management of toxocariasis, the CDC and American Academy of Pediatrics (AAP) developed a case

study and survey to assess physician knowledge of the disease.

A web-based, electronic survey was designed using Survey Monkey (<https://www.surveymonkey.com>, Palo Alto, CA). AAP members with valid e-mail addresses were invited to participate. The survey was advertised through a notice published in the monthly electronic AAP member newsletter, *AAP News Oncall* (<http://aapnews.aappublications.org/>) and through AAP-sponsored listservs; participants were instructed to click on a direct link to access the survey webpage. Participants were recruited for 6 weeks, from April to May 2013, with notices about the survey appearing in a daily electronic news brief *AAP SmartBrief* (http://aapnews.aappublications.org/cgi/collection/health_briefs). Participants provided information about their practice type and experience along with their patients' community setting (e.g., rural, urban) and most common form of patient health-care insurance.

Participants then reviewed a case study involving a 2-year-old child presenting with cough, abdominal pain, and an elevated absolute eosinophil count (Table 1). From the information provided, respondents selected choices pertaining to diagnosis, treatment, and prevention strategies. Participants were not allowed to return to previous questions and were not informed that the case study involved a child infected with *Toxocara* until the conclusion of the case study. Following the revelation of the diagnosis in the case study vignette, participants were asked about their familiarity diagnosing *Toxocara* infection, including diagnostic approaches.

Survey responses were analyzed using Statistical Analysis Software (SAS), Version 9.2. Institutional review board approval through the AAP and CDC was obtained prior to initiation.

Of the 60,000 registered AAP members who received the electronic survey invitation, 2,684 (4.5%) responded. The majority of survey respondents were general pediatric practitioners (68%), neonatologists (5%), hospitalists (4%), and infectious disease specialists (4%). Participants resided in all 50 states, the District of Columbia, and three U.S. territories; California (268, 10%), New York (217, 8%), and Texas (163, 6%) had the highest number of participants. Most pediatricians reported practicing in suburban (34%) or urban (24%)

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TABLE 1
Case study and knowledge assessment of toxocariasis for pediatricians

Chief complaint: 2-year-old child with cough and abdominal pain

A 2-year-old Caucasian male is brought to the pediatrician with a nonproductive cough for 1 month and intermittent abdominal pain for 2 weeks. His mother reports he has been otherwise healthy but has complained daily about the abdominal pain. The patient has had no fever, vomiting, or diarrhea. The patient has no past medical or surgical history. He has no known allergies and is not taking any medications. The patient lives with his mom and dad and does not attend group child care. He has never traveled outside the United States. On physical examination, he is afebrile (T 98.3°F) and his pulse is regular with a rate of 100 bpm. His blood pressure is 100/60 mmHg. He is mildly tender to palpitation in the right upper quadrant of the abdomen with no rebound tenderness or guarding noted. Normal bowel sounds are present. The remainder of his physical exam is normal. His complete blood count is significant for an elevated absolute eosinophil count of 680/uL (normal absolute eosinophil count < 350/uL). What is the most likely diagnosis?

Question	No./total no. reported (%)*
What is the most likely diagnosis? (N = 2,370)†	
Appendicitis	8 (< 1)
Asthma	446 (19)
Giardiasis	183 (8)
Infectious mononucleosis	51 (2)
Don't know	374 (16)
Lymphatic filariasis	61 (3)
Malaria	3 (< 1)
Toxoplasmosis	124 (5)
Visceral toxocariasis (visceral larva migrans)	1,120 (47)
The mother of the patient reports a history of pica (specifically a history of eating dirt) and frequent play outside in a sandbox. The family owns a cat and a dog. Does this new information change your diagnosis? (N = 2,346)	
Yes	1,115 (48)
No	1,231 (53)
If yes: What is your revised diagnosis? (N = 1,102)	
Appendicitis	0 (0)
Asthma	9 (< 1)
Giardiasis	45 (< 1)
Infectious mononucleosis	0 (0)
Don't know	54 (1)
Lymphatic filariasis	18 (0 < 1)
Malaria	0 (0)
Toxoplasmosis	461 (42)
Visceral toxocariasis (visceral larva migrans)	515 (47)
What is the recommended treatment of the parasite? (N = 1,535)	
Quinine	5 (< 1)
Benznidazole or nifurtimox	46 (3)
Albendazole or mebendazole	1,123 (73)
Don't know	348 (23)
Other (please specify)	13 (1)
Which of the following are appropriate strategies that can help to prevent <i>Toxocara</i> infection? (check all that apply) (N = 2,269)	
Deworming cats and dogs	1,717 (76)
Frequent hand washing	1,617 (71)
Cooking meat thoroughly	660 (29)
Always wearing shoes when walking outside	884 (39)
Avoiding drinking unfiltered water from streams	625 (28)
Don't know	112 (5)
Number of survey participants who were able to select all of the appropriate preventative strategies. (Deworming cats and dogs, frequent hand washing and cooking meat thoroughly)	135 (6)
Prior to taking this survey, had you ever heard of toxocariasis? (N = 2,255)	
Yes	2,018 (90)
No	237 (11)
Yes (have heard of toxocariasis and selected the correct diagnosis)	1,447 (94)
No (have heard of toxocariasis but selected the wrong diagnosis)	86 (6)
Are you confident that your knowledge of toxocariasis is up to date? (N = 1,991)	
Yes	296 (15)
No	1,695 (85)
Selected the correct diagnosis and were confident in their knowledge (N = 1,430)	
Yes (selected the correct diagnosis and confident in their knowledge)	254 (18)
No (selected the correct diagnosis but were not confident in their knowledge)	1,176 (82)
How often do you consider the risk of toxocariasis in your patient population? (N = 1,991)	
Never	584 (29)

(continued)

TABLE 1
Continued

Chief complaint: 2-year-old child with cough and abdominal pain	
Rarely	1,146 (58)
Sometimes	243 (12)
Frequently	13 (1)
Always	5 (< 1)
Before completing this survey, were you aware of the availability of serologic testing used for diagnosis of toxocariasis? (N = 1,987)	
Yes	895 (45)
No	1,092 (55)
Have you ever taken care of a patient with visceral or ocular toxocariasis? (N = 1,987)	
Yes	345 (17)
No	1,642 (83)

* Totals do not sum exactly because of rounding.

† Denominators differ because of missing data.

areas. When asked to choose the most likely diagnosis, 1,120 (47%) survey respondents gave the correct answer of visceral toxocariasis. The second and third most common responses were "asthma" (19%) and "don't know" (16%). After further clinical history was given, including that the patient had a history of pica and owned a dog and a cat, 1,115 (48%) of respondents stated that this additional information would change their diagnosis. Of those who selected a new diagnosis, 515 (47%) selected visceral toxocariasis. An almost equal number of participants changed their diagnosis to toxoplasmosis 461 (42%), which was an increase from the 124 (5%) participants who selected toxoplasmosis initially. Thus, after respondents were given further clinical history along with the option of changing their answers, the total number of correct responses was 1,174 (50%). A total of 1,123 (73%) respondents correctly selected albendazole or mebendazole as the recommended treatment of visceral toxocariasis. Among participants who responded to the question about *Toxocara* prevention strategies, only 6% (135/2,265) chose all three correct answers (deworming cats and dogs, frequent hand washing, and cooking meat thoroughly).

A majority, 2,018 (90%) of respondents were familiar with the term "toxocariasis" but 1,695 (85%) were not confident that their knowledge was up to date. Only 254 (18%) participants who initially selected the correct diagnosis were confident in their knowledge, and 584 (29%) participants replied that they never consider a diagnosis of toxocariasis when evaluating their patients. Less than half (895, 45%) of respondents were aware that a serologic test is available for *Toxocara* infection, and the majority of respondents (1,642, 83%) had not cared for a patient diagnosed with either visceral or ocular toxocariasis. Among respondents who correctly chose the diagnosis in the case presentation and answered the question about previous experience with a case of ocular or visceral toxocariasis, 65% (226/350) reported they had cared for a patient with visceral or ocular toxocariasis.

Our survey results indicate that pediatricians are uncertain about toxocariasis presentations, diagnosis, and treatment. For example, after participants were given additional case information including cat ownership, many chose toxoplasmosis as the correct answer. This may reflect the participant's greater familiarity with toxoplasmosis and its association with cats or confusion between toxoplasmosis and toxocariasis. Additionally, many survey participants were unaware that serologic testing is available for toxocariasis, which may limit understanding the role of *Toxocara* infection in people with

clinically compatible illness. The majority of respondents were not able to correctly identify prevention strategies to decrease risks for acquiring *Toxocara* infection.

There are a number of limitations associated with these results. First, the response rate was extremely low (4.5%). To be aware of the survey, AAP members had to open the newsletter e-mail; it is possible many members delete the electronic newsletters without looking at the contents. A second limitation is the possibility that participants took the survey more than once or used outside resources to assist them with answering the questions, leading to an overrepresentation of pediatrician knowledge about toxocariasis. Pediatricians who were more knowledgeable about toxocariasis may have also been more likely to complete the survey, leading to responder bias. Lastly, as we only surveyed pediatricians who are AAP members, our results may not accurately reflect knowledge of toxocariasis for all pediatricians practicing in the United States.

The knowledge gap elucidated by these results supports a need for improved toxocariasis awareness and education for U.S. pediatricians, especially those caring for children with risk of infection. In an effort to combat this gap, CDC has developed downloadable resources for the public and for physicians, available at <https://www.cdc.gov/parasites/toxocariasis/printresources.html>. As long as toxocariasis continues to be endemic in the United States, all health-care providers need to recognize, diagnose, manage, and prevent toxocariasis. Education of health-care providers about toxocariasis may improve recognition and optimize management, thus reducing the burden of disease.

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