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Angiostrongylus cantonensis Eosinophilic Meningitis in an Infant, Tennessee, USA

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Angiostrongylus cantonensis, the rat lungworm, is the most common infectious cause of eosinophilic meningoencephalitis worldwide. This parasite is endemic to Southeast Asia and the Pacific Islands, and its global distribution is increasing. We report *A. cantonensis* meningoencephalitis in a 12-month-old boy in Tennessee, USA, who had not traveled outside of southwestern Tennessee or northwestern Mississippi.

In 2016, a 12-month-old, fully vaccinated boy was admitted to a hospital in Memphis, Tennessee, USA, for evaluation of 18 days of daily fever, irritability, decreased oral intake, and emesis. His medical history was unremarkable, and he had no known contact with sick persons. He had not traveled outside the area comprising southwestern Tennessee and northwestern Mississippi. He lived in a nonagricultural rural area and was exposed to a vaccinated family dog. Wild rats had been observed in and around the home, and rat droppings had been found in the child's bed. Raccoons were seen on the property; however, contact, either direct or through fomites such as latrines, was not reported. During a 17-day period, 2 evaluations by his primary care physician and 4 emergency department visits resulted in the diagnosis of fever of unknown origin and inpatient admission.

A cerebrospinal fluid (CSF) sample taken by lumbar puncture on day 20 of illness showed eosinophil-predominant pleocytosis, mild hypoglycorrhacia, and a mildly elevated protein level (Table). Magnetic resonance imaging of the brain and spine showed scattered areas of restricted diffusion throughout the brain parenchyma, leptomeningeal enhancement, and multifocal nodular enhancement along the ventral portion of multiple spinal levels. Serologic testing was negative for *Toxocara canis/cati*, *Strongyloides stercoralis*, *Ehrlichia chaffeensis*, *Rickettsia rickettsiae*, Epstein-Barr virus, HIV, and *Toxoplasma gondii*; a rapid plasma reagin was also negative. Tuberculin skin testing was negative. Results of CSF PCR for *Streptococcus pneumoniae*, herpes simplex virus, and enteroviruses were negative; CSF cryptococcal antigen testing was also negative. Due to concern for infection with *Baylisascaris procyonis*, the raccoon roundworm, physicians prescribed albendazole and dexamethasone. The patient's temperature returned to normal, and his symptoms resolved. Upon discharge, he was to complete 3 weeks of albendazole and tapering doses of corticosteroids. Attending physicians repeated lumbar punctures on days 28, 41, and 56 (Table).

Physicians sent samples (CSF and serum) taken on day 20 to the Centers for Disease Control and Prevention (Atlanta, GA, USA) to test for *B. procyonis* roundworms and samples taken on day 56 to test for *Angiostrongylus cantonensis*, the rat lungworm. Results were negative for *B. procyonis* but positive for *A. cantonensis*. In addition, serum samples obtained at the time of the initial lumbar puncture were positive for *A. cantonensis* antibodies by investigational whole-worm Western blot.

The first documented human infection with *A. cantonensis* worms occurred in 1944 in Taiwan. Since then, >2,800 cases among humans have been reported; most have been in Southeast Asia and the Pacific islands (*J*; online Technical Appendix, <https://www.cdc.gov/EID/article/23/10/17-0978-Techapp1.pdf>). In the late 1950s, the first report of human *A. cantonensis* infection in the

Table. Results of cerebrospinal fluid testing for 12-month-old boy with meningoencephalitis, Memphis, Tennessee, USA, 2016*

Test	Reference range	Day of illness			
		20	28	41	56
Leukocytes, cells/mm ³	0–8	547	55	2,979	115
Polymorphonuclear cells, %	0–1	0	4	20	4
Lymphocytes, %	0–5	44	80	65	64
Monocytes, %	0–5	20	6	10	21
Eosinophils, %	NA	36	10	5	11
Erythrocytes	≤0	0	14	0	45
Glucose, mg/dL	40–70	37	25	22	27
Protein, mg/dL	15–45	67	74	164	104
Gram stain	NA	Few leukocytes; 0 organisms	Rare leukocytes; rare erythrocytes; 0 organisms	Moderate leukocytes; rare erythrocytes; 0 organisms	Rare leukocytes; 0 organisms
Bacterial culture	NA	Sterile	Sterile	Sterile	Sterile

*NA, not applicable.

United States occurred in Hawaii. *A. cantonensis* worms have since become endemic to wide-ranging tropical and subtropical locales in the Western Hemisphere, including the Hawaiian Islands (2), the Caribbean Islands (3), and South America (4).

The first report of the rat lungworm in the continental United States was in 1987, when Kim et al. found that 18% of rats sampled on necropsy in New Orleans, Louisiana, were infected with the nematode (5). First-stage *A. cantonensis* larvae from these rats produced infections in native gastropods, providing the potential for these parasites to become endemic to the region. A report ≈15 years later documented infection in vertebrates not only in New Orleans but also in other areas of Louisiana and Mississippi. *A. cantonensis* worms are now considered to be endemic to Louisiana (5). Infection has since been documented in rats (6), gastropods (7), and vertebrates (8) across a large area of the southern United States, from Oklahoma (6) to Florida (7,8).

Soon after the initial recognition in local animal reservoirs, the first reported *A. cantonensis* infection in a human acquired in the continental United States occurred in an 11-year-old boy residing in New Orleans. Since then, 3 additional cases have been reported in an 11-month-old, a 12-month-old, and a 19-month-old, all of whom resided in Houston, Texas, and had not traveled (9).

A. cantonensis infection causes a self-limited illness in which headaches, nonfocal neurologic findings, and cranial nerve involvement are the most common signs and symptoms. Optimal therapy has not been clearly defined, and symptomatic management is an option for this self-limited illness. When therapy is prescribed, corticosteroids alone or in combination with antihelminth medications are most commonly used. In a prospective study that followed up on 3 previous studies, Chotmongkol et al. confirmed that a 2-week course of corticosteroids shortened the duration of headache and reduced the need for repeated lumbar puncture (10). The study concluded that corticosteroids plus albendazole was no better than corticosteroids alone.

International shipping and the ability of *A. cantonensis* worms to use diverse species of gastropods as intermediate hosts have all contributed to this parasite becoming a pathogen of increasing public health concern (5). Angiostrongyliasis should be considered in the differential diagnosis of prolonged fever of unknown origin with compatible clinical and laboratory findings.

Dr. Flerlage is a second-year fellow in a combined fellowship program for training in pediatric infectious diseases and critical care medicine at University of Tennessee/St. Jude Children's Research Hospital. His primary research interest is acute lung injury caused by respiratory viruses in immunocompromised patients.

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Dengue Virus Exported from Côte d'Ivoire to Japan, June 2017

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Since April 2017, a dengue fever outbreak has been ongoing in Côte d'Ivoire. We diagnosed dengue fever (type 2 virus) in a traveler returning to Japan from Côte d'Ivoire. Phylogenetic analysis revealed strain homology with the Burkina Faso 2016 strain. This case may serve as an alert to possible disease spread outside Africa.

In recent decades, dengue virus (DENV) infection has been spreading worldwide. Although in Africa the leading cause of acute febrile illness is still malaria, dengue has recently gained momentum (1). Dengue has been reported in 34 African countries, although it has probably been underreported because of the lack of diagnostic testing and systematic surveillance in Africa (2). Four types of virus have been isolated; the most endemic to Africa is DENV

type 2 (DENV-2), followed by DENV-1 (2). The first reported case of DENV-1 infection occurred in a young soldier from Abidjan, Côte d'Ivoire, in 1999 (3). At that time, no other similar cases or epidemics in Abidjan had been reported. In 2008, a closely related strain, DENV-3, was isolated from visitors to Côte d'Ivoire (4,5). In 2010, dengue fever was biologically confirmed for 7 patients who had never been in a dengue-endemic area, and DENV-3 was confirmed by reverse transcription PCR for 4 of these patients (6). A prospective study in Abidjan also revealed that DENV-3 had been the cause of febrile illness during 2011–2012 (7). Thus, DENV-3 may have circulated widely in Côte d'Ivoire, especially in Abidjan. During the 2016 outbreak in Burkina Faso, DENV-2 infection was detected in 2 travelers returning from Burkina Faso to France (8). During August–November 2016, the World Health Organization reported 1,061 probable dengue cases and 15 deaths from dengue (9). We report a case of dengue fever exported to Japan from Abidjan in 2017.

On June 19, 2017, a man in his early 50s sought care at the Center Hospital of the National Center for Global Health and Medicine, Tokyo, Japan, for fever, chills, headache, and mild joint pain. In June 2013, he had traveled to Abidjan for business, and on June 13, 2017, he returned to Japan. He had been vaccinated for yellow fever. He had noticed a high fever in the morning and sought care the same evening.

Physical examination revealed body temperature of 39.3°C, mildly hyperemic conjunctiva, and a slight rash on his trunk. His blood biochemistry profile showed $3,640 \times 10^9$ leukocytes/L, hemoglobin level 13.5 g/dL, and 151×10^9 thrombocytes/L. Results of a rapid diagnostic test for malaria (BinaxNOW Malaria; Alere, Waltham, MA, USA) were negative. A thin-coated peripheral blood smear with May-Grünwald Giemsa stain showed no *Plasmodium* parasites. Results of a dengue rapid diagnostic test (Dengue Duo NS1 Ag + Ab Combo; Alere) were negative for IgM and IgG but positive for nonstructural protein 1 antigen. Serum samples obtained on June 19 and 26 were sent for real-time reverse transcription PCR to the National Institute of Infectious Diseases, Tokyo, where DENV-2 RNA was detected.

The patient's signs and symptoms resolved spontaneously in a week; his lowest thrombocyte count was 99×10^9 thrombocytes/L. On June 19, a diagnostic test for DENV IgM (Dengue Virus IgM Capture ELISA; Focus Diagnostics, Cypress, CA, USA) yielded negative results; however, on June 26, positive results indicated seroconversion.

Phylogenetic analysis of the DENV envelope gene indicated that the sequence of DENV-2 obtained from the patient belonged to the cosmopolitan genotype and was 99% identical with the envelope gene of DENV-2 strains from the 2016 dengue epidemic in Burkina Faso (GenBank accession nos. LC206003, KY627763, and KY627762) (Figure). The sequence of DENV-2 from the patient also showed 97% identity

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Technical Appendix

Additional reports of human infection with *Angiostrongylus cantonensis*, the rat lungworm.

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