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Editorial

Neglected Parasitic Infections in the United States: Needs and Opportunities

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Parasitic infections are a major global health burden. The impact of debilitating diseases caused by parasites is greatest among those who struggle to meet their daily basic needs and access basic health care services in low-income countries. However, persons who have or are at risk for parasitic infections are present in every income and social strata, and residents of the United States and other developed nations are not unaffected. For some persons living in the United States, these parasitic infections are acquired in their own immediate environment; for example, exposure to feces from domestic dogs or cats puts children at risk for toxocariasis and toxoplasmosis. For others, chronic parasitic infections acquired years ago in other areas of the world can manifest with severe illness later in life, such as neurocysticercosis leading to adult–onset epilepsy or Chagas disease leading to severe cardiomyopathy requiring heart transplant. We know much less than we should about the health and economic burden and impact of parasitic diseases in developed countries, including the United States (Table 1).[1]

This issue of the American Journal of Tropical Medicine and Hygiene features brief reviews of five parasitic infections that remain a significant health problem in the United States: Chagas disease, cysticercosis, toxocariasis, toxoplasmosis, and trichomoniasis.[2–6] These five diseases, which are among those that Centers for Disease Control and Prevention (CDC) refers to as neglected parasitic infections (NPIs) in the United States, have different epidemiologic profiles and modes of transmission and require tailored prevention and control strategies. However, in the United States these NPIs share key characteristics, including 1) the surprisingly large number of persons infected or at risk, especially those living in poverty; 2) the potential for underreporting and missed diagnoses, largely because of lack of clinician awareness and poor availability of optimal diagnostic tests; and 3) the dearth of interventions that can prevent or cure illness. As a result of these issues, these diseases have not received needed attention or resources in the United States. These reviews are part of an effort to raise awareness and promote public health actions that can be taken now with available knowledge and tools and highlight areas for further clinical and epidemiologic research and action.

Assessments and reviews of these diseases often highlight the remarkable lack of information about who is at highest risk for infection, how many people in the United States are infected, and how to best intervene to prevent infection from progressing to disease. Estimates of disease burden are often based on serologic markers from cross-sectional population studies that indicate a person has been infected but not whether that person has active disease (e.g., toxoplasmosis and toxocariasis).[7,8] In addition, the estimates may be projected from geographically focused studies that might not be representative of the true population burden (e.g., trichomoniasis, Chagas disease, and neurocysticercosis).[9] The public health community also has few good estimates of the economic burden imposed by these NPIs. Limited estimates, such as one study that examined hospital discharge data on neurocysticercosis for 2009 in California estimated statewide hospital charges and costs at $17 million and $5 million, respectively, suggesting that the nationwide economic burden is considerable.[10] The morbidity caused by NPIs extends across the lifespan, including blindness or severe developmental deficits in children (toxocariasis, toxoplasmosis), infertility and poor birth outcomes (trichomoniasis) or epilepsy (neurocysticercosis) in young adults, and cardiomyopathy sometimes requiring transplant in middle age adults (Chagas disease). Symptoms can develop in persons with Chagas disease, toxoplasmosis, and cysticercosis years after an initial mildly symptomatic or subclinical infection. Furthermore, a few intriguing studies have shown associations between some NPIs and complex chronic diseases with enormous health impact, such as studies linking antibody evidence of *Toxoplasma* infection and mental illness or *Toxocara* infection and asthma.[11–13]

Appropriate and timely medical management of a person with an NPI is critical, but the public health actions needed to identify and prevent infection and disease fall to the under-resourced and overburdened public health sector. For example, a person with neurocysticercosis needs careful medical management to control neurologic symptoms but can also benefit from public health follow up because testing of household members for taeniasis (intestinal *Taenia solium* infection) might identify and treat the typically asymptomatic human source of the person's infection. Women bear most of the burden of symptomatic trichomoniasis, and they can be successfully treated with a short course of metronidazole in clinics for women's health or sexually transmitted infections. However, without finding and treating their male partners, reinfection is likely. Among U.S. residents, Chagas disease risk is much higher among persons who previously lived in rural and impoverished areas in Mexico, Central America, or South America, where the vector of Chagas disease, the triatomine or kissing bug, is commonly found near or in dwellings. Chagas disease patients are increasingly being identified during routine blood donor screening; their health care providers often turn to the public health sector for assistance with diagnosis and treatment decisions. Furthermore, identification of a person with Chagas disease can trigger additional recommendations such as testing others in the family (for example, children of an infected mother). Targeted screening programs in some immigrant communities might identify other infected persons and

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TABLE 1
Estimates of burden and impact of neglected parasitic infections

More than 300,000 persons living in the United States are infected with *Trypanosoma cruzi*, the cause of Chagas disease, and more than 300 infected babies are born every year in the United States
At least 1,000 incident hospitalizations for symptomatic neurocysticercosis per year in the United States
At least 14% of the U.S. population has been exposed to *Toxocara,* and each year at least 70 people, most of them children, are blinded by ocular toxocariasis
More than 60 million persons in the United States are chronically infected with *Toxoplasma gondii*; new infections in pregnant women can lead to birth defects and infections in immunocompromised persons can be fatal
Trichomoniasis is a major cause of infertility and preterm labor and low birthweight, and each year 1.1 million people are newly infected with *Trichomonas* in the United States

thereby reduce their risk of later stage severe complications or perinatal transmission.

Clearly, additional work is needed in three major areas to advance prevention and control of these diseases: 1) better estimates of disease burden and a better understanding of how to reduce the risk of acquiring NPIs; 2) improved diagnostic and treatment methods; and 3) programmatic expansion of currently available, proven interventions (Table 2). Estimating disease burden and identifying practical and effective risk reduction programs is challenging for diseases that frequently go unnoticed, especially because most NPIs in the United States disproportionately affect persons with reduced access to adequate health care, such as those living in poverty or in immigrant communities. Targeted surveillance or screening programs in populations most likely to be at risk could be a first step in improving burden estimates, at relatively low cost. For example, community-based screening surveys in areas with high concentrations of Latino immigrants might efficiently identify the proportion of area residents who have asymptomatic Chagas disease or taeniasis and should be evaluated for treatment.

We must develop more accurate diagnostic testing methods that can be made widely available, especially tests able to distinguish past exposure from current infection. For example, persons who test positive for Chagas disease as part of routine blood donor screening typically require additional antibody tests that are performed at CDC before diagnosis is confirmed and treatment is provided. Sometimes these test results are not able to definitively confirm or exclude the diagnosis, leaving the clinician uncertain about the merits of advising treatment. We remain uncertain about whether an antibody test that is positive for toxocariasis might indicate continued infection. A positive IgM test result for acute *Toxoplasma* infection in a pregnant woman leaves the patient and healthcare provider in the agonizing position of being uncertain whether the test result is a false positive or an indicator that the fetus is at high risk for congenital toxoplasmosis. Additional testing is not always able to provide definitive answers.

For some persons, NPIs treatment options are limited or suboptimal. Drug therapies recommended for treatment of Chagas disease are not approved by the U.S. Food and Drug Administration and are available only from CDC. It is not clear how to best treat women in early pregnancy with evidence of acute toxoplasmosis. There is evidence that some *Trichomonas* strains are developing resistance to metronidazole, and new drugs are unlikely to be available in the near future. Therefore, in the coming years we will need a robust program of research and development to design, develop, and implement new interventions.

However, there are some interventions we can and should make right now to attack these diseases, including deworming dogs and cats, rapid and safe pickup of pet feces, covering sandboxes to reduce animal fecal contamination, and appropriate cooking of meat to help prevent toxoplasmosis, to name but a few. Increasing knowledge of NPIs among health care providers and the at-risk population can lead to more of those affected being diagnosed and receiving appropriate treatment.

The articles in this issue highlight the urgent need to characterize and reduce the impact of NPIs in the United States. The perception that parasitic diseases are no longer relevant or important is a major impediment to implementing currently available control and prevention strategies. To support efforts

TABLE 2
Key knowledge and intervention gaps for neglected parasitic infections*

Assess disease burden and risk factors
Burden of congenital Chagas disease; role of autochthonous transmission
Burden of cardiac disease caused by *Trypanosoma cruzi* and risk factors for severe sequelae among persons infected
Burden of visceral toxocariasis and natural history of disease
Burden of neurocysticercosis
Trichomoniasis and increased risk of HIV and adverse outcomes of pregnancy
Role of *Toxoplasma gondii* infection in psychiatric diseases
Role of toxocariasis in allergic diseases
Improved diagnostic tests and treatments
Chagas disease tests and drugs
Drug-resistant trichomoniasis: alternative drugs, better test to determine resistance
Antibody tests using recombinant antigens to better identify active neurocysticercosis and monitor response to treatment
Evaluation of drug regimens for treatment of pregnant women with acute toxoplasmosis
Appropriate treatment of various manifestations of neurocysticercosis
Optimal treatment for visceral and ocular toxocariasis
Programmatic expansion of proven interventions
Screening and treating contacts of neurocysticercosis cases for taeniasis
Deworming of dogs and cats
Covering sand boxes to reduce exposure to animal feces
Health education to prevent toxoplasmosis: cooking meat adequately, pregnant women avoiding contact with cat litter
Appropriate clinical management to prevent Chagas disease progression
Treatment of male partners of women who have trichomoniasis

*HIV = human immunodeficiency virus.

to reduce NPIs, CDC serves as a national and global resource for diagnosis through DPDx (the CDC web-based diagnostic resource for parasitic diseases); provides investigational drugs available through its drug service to treat parasitic infections when U.S. Food and Drug Administration–approved drugs are not available; supplies comprehensive information about NPIs to public health departments, healthcare providers and the public; and continues to work on developing better diagnostic tools. The NPIs in the United States are part of the global burden of parasitic diseases, and strategies that reduce or eliminate them in the United States can someday be applied globally.

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