Eosinophilia is a common laboratory finding in refugee populations, with etiologies including allergic disorders, medications, autoimmune disease, and malignant diseases. However, parasitic infection is the major cause of eosinophilia in refugees. In 1997, the Centers for Disease Control and Prevention (CDC) and International Organization for Migration (IOM) found that 38% of Somali refugees in Kenyan camps harbored potentially pathogenic intestinal parasites. Subsequently in May 1999, the CDC recommended presumptive treatment of refugees with a single 600-mg dose of albendazole within three days of departure for the United States. This program of presumptive albendazole treatment has been evaluated in different observational studies. In one review of African refugees resettled in Massachusetts, the prevalence of intestinal parasites on stool examination was 48% in the albendazole-treated group and 64% in the nontreatment group ($P < 0.01$).

Although albendazole is active against many intestinal helminths, the drug shows poor efficacy against Strongyloides stercoralis, a potentially pathogenic organism, particularly in immunocompromised hosts. Among U.S. immigrants hospitalized with Strongyloides infection, the overall mortality rate was 16%, and the mortality rate has been higher than 85% in the hyperinfection syndrome, which can manifest with paralytic ileus, pulmonary infiltrates, translocation of gut flora, and sepsis.

The Montagnards, an indigenous Vietnamese population, have faced longstanding persecution at home, and many have found shelter in refugee camps in Cambodia. After an international agreement, the Montagnards were resettled in the United States beginning in 2002. As part of the IOM and CDC Enhanced Refugee Health Program conducted in Cambodia for Montagnard refugees bound for the United States, these refugees were given presumptive treatment with albendazole, 400 mg orally per day for five days.

In a standard refugee screening protocol conducted in North Carolina Public Health departments, 172 of the Montagnard refugees arriving in Wake County from June 2002 through September 2003 had complete blood counts with differential leukocyte counts and three stool specimens collected. Ova and parasite examinations of stool specimens were performed at the North Carolina State Laboratory for Public Health. Repeat complete blood counts were performed if eosinophilia, defined by absolute eosinophil count $\geq 500 \times 10^6/L$, was noted on the initial blood count. If the second blood count demonstrated eosinophilia, a specimen for Strongyloides serologic analysis was ordered. If results of serologic analysis for Strongyloides were positive with an absorbance $\geq 8\%$, refugees were scheduled for treatment with a single dose of ivermectin (0.2 mg/kg). Absolute eosinophil counts were obtained and serologic analysis was repeated three months after treatment. Some refugees had serologic results for Strongyloides obtained or were treated with ivermectin despite the lack of eosinophilia because of logistical issues that occurred during clinical care.

Initial blood counts were obtained a median of 2 days after arrival (range = 50 days prior to 27 days after arrival). The mean age of the refugees was 26.5 years. Thirty-six (21%) were females and 136 (79%) were males. No parasite was identified in stool specimens for 131 (76%) refugees. In the remaining refugees, the parasites found were Giardia (7%), Entamoeba coli (6%), Endolimax nana (5%), Entamoeba histolytica (1%), and Fasciola (1%). Stool specimens showed no S. stercoralis larvae. Of 171 refugees for whom complete and differential blood counts were obtained, 41 refugees (24%) had eosinophilia.

All refugees but one had subsequent complete blood counts with differential counts obtained at a mean of 178 days after the first test (range = 5–983 days) (Figure 1). Thirteen refugees had persistent eosinophilia, and four patients had new eosinophilia with this second specimen. Of these 17 refugees, 13 had S. stercoralis serologic analysis. Positive S. stercoralis serologic titers were significantly associated with eosinophilia (Spearman $r = 0.47, P = 0.019$). There was no correlation between eosinophilia and timing of albendazole therapy (Spearman $r = -0.00637, P = 0.94$). Of the refugees who were subjected to follow-up, 13 were treated with ivermectin, and 9 of these refugees had sub-
sequent blood counts obtained. A significant decrease in eosinophil count was noted after ivermectin treatment ($P = 0.039$).

These data suggest that *Strongyloides* infection was the likely etiology of eosinophilia in this group of refugees. The correlation between asymptomatic persistent eosinophilia and strongyloidiasis is well documented. Furthermore, the sensitivity of absolute eosinophil counts greater than 400 cells/μL for predicting ≥1 positive stool sample for *S. stercoralis* was 84% in a review of 151 *Strongyloides* cases diagnosed by positive stool specimens. In a study of refugees at a Boston Medical Center, 45 (39%) of 115 patients with eosinophilia had positive serologic results for *S. stercoralis*. These investigators also found that the most common pathogens detected in stool specimens of refugees with eosinophilia were *Trichuris*, *Ascaris*, and hookworm, none of which were found in the Montagnard group in our study. The absence of these intestinal helminths in our population at the time of their initial screening suggests either that these pathogens are less endemic in this population or, more likely, that the five-day albendazole treatment regimen was effective in eliminating them.

These data suggest that presumptive therapy with albendazole for five days can significantly decrease parasite burden in the refugee population, with potentially even further impact if ivermectin is used. Our study is notable for the absence of *Trichuris* and hookworm in the treated population, compared with other groups treated with single dose of albendazole.

A trial comparing ivermectin and albendazole in treatment of strongyloidiasis in children found a cure rate of 83% by ivermectin compared with 45% with albendazole. The challenge to wider use of ivermectin lies in cost of the drug, suggesting that a protocol implementing narrow and specific use of the drug in appropriate situations should be further investigated. The limitations of the study are mainly the small sample size and difficulty in follow-up. Although the study began with 172 Montagnard refugees, a small proportion had eosinophilia and an even smaller group underwent both repeat complete blood counts and serologic analysis before and after treatment with ivermectin. Regardless, these limitations are likely common to the screening experience of other U.S. refugees in the public health system. Therefore, the health outcomes may be more widely representative. Also, given the variability in timing of albendazole therapy, there is concern for re-infection with *Strongyloides* prior to departure. However, no correlation was found between eosinophilia and timing of albendazole therapy.

Our eosinophilia estimate of 24% in incoming refugees is comparable to that in a study conducted at Boston Medical Center, which found an eosinophilia prevalence of 12% in newly arrived refugees. The results of our study suggest that strongyloidiasis should be strongly suspected as the etiology...

**Figure 1.** Patient screening and follow-up in the study.
of unexplained eosinophilia in a refugee population arriving from an area endemic for intestinal helminths, even in those persons who have been previously treated with albendazole. Furthermore, the routine addition of ivermectin to albendazole treatment of this population with some exceptions, as now recommended by the CDC, can significantly clear this population of this disease. However, as highlighted in the 2008 CDC guidelines (http://www.cdc.gov/ncidod/dq/refugee/rh_guide/index.htm), ivermectin may be difficult to use routinely in the developing world, given its cost, risk of encephalopathy,12,13 and lack of comparative data.

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Authors’ addresses: Neela D. Goswami and Jason Stout, Division of Infectious Diseases, Duke University Medical Center, Box 102359, Durham, NC 27710, E-mails: dasgu001@mc.duke.edu and stout002@mc.duke.edu. J. Jina Shah, 280 W. MacArthur Street, Oakland, CA 94611, E-mail: jina.shah@gmail.com. G. Ralph Corey, PO Box 17969, Durham, NC 27715, E-mail: corey001@mc.duke.edu.

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