

# Embers, Monica

**Monica E. Embers, PhD**

Tenure-Track Assistant Professor  
Division of Bacteriology and Parasitology  
Tulane National Primate Research Center  
Covington, LA

[http://www.tnprc.tulane.edu/division\\_bacteriology.html](http://www.tnprc.tulane.edu/division_bacteriology.html)



## ***The Challenges of Diagnosing and Curing Late Stage Lyme Disease***

Monica E. Embers obtained her Ph.D. in the Department of Microbiology and Immunology at the Pennsylvania State University College of Medicine in Hershey, P.A., where she studied immune responses to Papillomaviruses. She made the transition to the study of bacterial pathogenesis when performing her postdoctoral research on the Lyme disease spirochete at the Tulane National Primate Research Center (TNPRC). She subsequently joined the faculty at the TNPRC. Her research program regarding *Borrelia burgdorferi* and Lyme disease is designed around three major foci: (1) evaluating antibiotic efficacy against Lyme disease; (2) identifying treatments that can eradicate *B. burgdorferi* infection; and (3) *immunodiagnosis* for *B. burgdorferi* infection and cure. The first research goal is to examine, using xenodiagnosis, the efficacy of antibiotic treatment during disseminated *B. burgdorferi* infection in the nonhuman primate model of Lyme disease. The second goal is to use animal models of persistent infection to evaluate new therapeutic strategies. The third goal is to develop a quantitative multi-antigen test that expands detection limits and helps to distinguish persistent infection from clinical cure. By transmitting Lyme disease to nonhuman primates by tick, and studying the natural course of infection, her group hopes to facilitate a better understanding of the clinical quandaries of human Lyme

disease, including effective diagnosis and treatment.

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### **Conference Lecture Summary**

According to recent estimates, the number of new Lyme disease cases in the United States may exceed 300,000 per year. Given the breadth of clinical manifestations that can result from infection with the spirochete *Borrelia burgdorferi*, reliable laboratory diagnostic testing is essential. Currently, the two-tier test which involves an initial enzyme immunoassay followed by a confirmatory western blot is the standard. However, this serological testing falls short in sensitivity, especially in the early/acute phase. Another significant issue is the proportion of patients who continue to experience signs and/or symptoms of disease following antibiotic therapy. This phenomenon, known as post-treatment Lyme disease syndrome (PTLDS) may be defined by fatigue, musculoskeletal pain, and cognitive problems that persist for 6 months or more after completion of antibiotic therapy. It is clear that two-tier serologic testing is neither sensitive nor specific enough for diagnosis of PTLDS because of variability in serologic responses after treatment of early Lyme disease. A multiplex assay that utilizes Luminex® technology has been developed and includes five antigens (OspA, OspC, DbpA, OppA-2 and the C6 peptide). We are using this test to identify differences in serum responses during early disease and in PTLDS. Initial studies indicate a significant improvement over two-tier for detecting exposure in PTLDS patients.

The efficacy and accepted regimen of antibiotic treatment for Lyme disease has been a point of significant contention among physicians and patients. While experimental studies in animals have offered evidence of post-treatment persistence of *B. burgdorferi*, variations in methodology, detection methods and limitations of the models have led to some uncertainty with respect to translation to human infection. We sought to mimic

human infection and treatment in the closest animal model, namely, the nonhuman primates. Rhesus macaques were inoculated with *B. burgdorferi* by tick bite and a portion were treated with recommended doses of doxycycline for 28 days at four months post-infection. Signs of infection, clinical pathology, and antibody responses were monitored throughout the ~1.2 year study. Our results demonstrate host-dependent signs of infection and variation in antibody responses. In addition, we observed evidence of persistent, intact, metabolically-active *B. burgdorferi* and associated foci of inflammation in central and peripheral nervous tissue, joints and heart after antibiotic treatment of the disseminated infection.