

A manganese transporter, BB0219 (BmtA), is required for virulence by the Lyme disease spirochete, *Borrelia burgdorferi*

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Communicated by Jonathan W. Uhr, University of Texas Southwestern Medical Center, Dallas, TX, December 19, 2008 (received for review December 4, 2008)

Abstract

Borrelia burgdorferi (*Bb*), the causative agent of Lyme disease, is transmitted to mammalian hosts through an arthropod (tick) vector. To establish infection, *Bb* must acquire essential nutrients, including transition metals, from its mammalian and tick hosts. Thus far, no metal transporter has been identified in *Bb*. Here, we report the identification of the first metal transporter, BmtA (BB0219), in *Bb*. BmtA-deficient mutants of virulent *Bb* were readily generated, and the mutants grew slightly slower than wild-type *Bb* in vitro. However, BmtA mutants were sensitive to the chelating actions of EDTA, suggesting a role for BmtA in metal utilization. Intracellular accumulation of manganese (Mn) was substantially diminished in the *bmtA* mutant, indicating that BmtA was operative in Mn uptake. Given that BmtA lacks homology to any known Mn transporter, we postulate that BmtA is part of a novel mechanism for Mn acquisition by a bacterial pathogen. BmtA also was essential to the infectious life cycle of *Bb* in ticks and mammals, thereby qualifying BmtA as a new borrelial virulence factor. In addition, the *bmtA* mutant was sensitive to treatment with *t*-butyl hydroperoxide, implying that BmtA, and thus Mn, is important to *Bb* for detoxifying reactive oxygen species, including those potentially liberated by immune effector cells during the innate immune response. Our discovery of the first molecule involved in metal transport in *Bb* provides a foundation for further elucidating metal homeostasis in this important human pathogen, which may lead to new strategies for thwarting Lyme disease.

Keywords:

metal transport

pathogenesis

Footnotes

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Author contributions: Z.O. and M.V.N. designed research; Z.O., M.H., T.O., and X.F.Y. performed research; Z.O., M.H., T.O., and X.F.Y. analyzed data; and Z.O. and M.V.N. wrote the paper.

The authors declare no conflict of interest.

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