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Editor's Note: Correspondence should be addressed to Dr. Grose, *The Pediatric Infectious Disease Journal*[®], Department of Pediatrics, University of Iowa Hospital, 200 Hawkins Drive, Iowa City, IA 52242. Fax 319-356-4855; E-mail charles-grose@uiowa.edu. Every letter must contain the writer's name and address; these will be omitted in publication on request. Submitted questions will be answered and published at the discretion of the Editor. Receipt of all letters will be acknowledged.

Prophylaxis Against Rabies in Children Exposed to Bats

Abstract: Rabies has become a disease of increasing concern. One reason is that bat variant rabies is a more common cause of human disease, with 1–2 deaths per year in the United States. Bat bites are much more difficult to document than bites from larger animals. Deaths from rabies encephalitis have remained undiagnosed until postmortem examination. Prophylaxis includes a series of 5 vaccinations during 28 days. Vaccine efficacy has been documented, even in young children.

Accepted for publication: August 25 2005.

Q We are receiving an increasingly large number of telephone calls about children who are exposed to bats. The fear of bats in this state has greatly increased after the death of a 20-year-old Iowan in September 2002. Because he was the first person to die of rabies in Iowa since 1951, the event was widely publicized in the media.¹ The patient was first suspected to have acute alcohol poisoning and later encephalitis of undetermined etiology, but the definitive diagnosis of rabies encephalitis was made only postmortem. Genomic analysis of the virus established that it was a bat variant. Extensive questioning of friends and family could not document a bat exposure.

My case involves a 19-month-old boy who was exposed to a bat. The family had been vacationing near a lake. The bat was found in the morning in the child's bedroom. No bite marks were found on the child. The parents did not capture the bat. Because of the parents' subsequent recollection of the 2002 fatal case, they brought the child to my office

several days later and urged me to immunize their child against rabies. I complied with their request. Because I could find little information about the immunogenicity of rabies vaccination in toddlers, I also obtained a convalescent blood sample after completion of the series. The child was not given human rabies immunoglobulin (HRIG).

Many of my colleagues are also receiving similar questions about rabies prophylaxis in children exposed to bats. According to our pharmacy personnel, the use of rabies vaccine in children has increased substantially since 2002. Furthermore the complete cost of the series of 5 vaccines is substantial, around \$1000. Can you provide an update on the best way to handle this situation?

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A In the United States, one-third of rabies cases occur in children and most have no known exposure to a rabid animal. Several recent human rabies cases, including those in Iowa, California and Wisconsin, have focused attention on the bat as a source of infection.^{1–3} Over 40 species of bats live in the United States, but only a few species have transmitted rabies to humans, for example, the silver haired bat and the big brown bat. The common little brown bat is not known to transmit rabies. Likewise the colonial species of bats found in very large numbers under bridges and in caves in central Texas have not transmitted rabies to humans. In fact, bat watching has become a tourist attraction. In central America, rabies is transmitted by the fabled vampire bat.

Bats are most active at night, when they commonly enter cabins found along rivers and lakes in the north-central United States. Because these cabins are occupied mainly in the summers, they frequently are accessible to bats through damaged window screens. When a bat is found in a cabin, the key question is whether there has been a potential direct contact of a human with the bat. Many small cabins are essentially one large room, so all occupants may be at risk. Frequently the bats are first discovered in the morning. Bats found in rooms occupied by children who have been sleeping certainly constitute a significant exposure, because children may not be able to recall contact with the bat in the middle of the night. (This history of exposure is greater than that obtained in half the rabies fatalities in the United States.) The bat should be captured (while avoiding further bites) and submitted for examination to the county or state health authorities. Testing of the bat can circumvent the need for rabies immunization in 60% of cases.⁴ Although 1% of free bats carry rabies virus, 5–15% of submitted bats test positive.⁵ Bats encountered in cabins during the daytime can be chased outside without incident. Bat urine and feces are not infectious.

Children with a documented prolonged exposure to bats should receive rabies prophylaxis as soon as possible.⁴ HRIG is administered by im injection, at a dosage of 20 units/kg. Because the location of a bat bite is rarely known, the total amount can be given in the thigh. Immunization should be initiated at the same time. The vaccine series, now very safe and consisting of 5 im immunizations on days 0, 3, 7, 14 and 28, primarily elicits protective neutralizing antibody. Because of the limited data about

TABLE 1. Antibody Responses to Rabies Vaccine

No.	Age (yr)	Mean*	Range*
6	1–2	15	5–>50
5	3–6	32	5–>50
19	7–10	21	3–33

*Rabies antibody titers expressed in International Units per mL.

the antibody responses of young children, the serum of the 19-month-old child was tested 1 month after completion of the 5 vaccinations.⁶ The rabies antibody titer was >50 IU/mL, considerably above a protective level of 0.5 IU/mL. The latter result is consistent with antibody titers of 30 immunized children in Sweden and therefore reassuring of the efficacy of rabies vaccination in even the youngest children (Table 1).

Bat rabies annually accounts for ~1–2 deaths of humans in the United States. The infrequent recognition of prior exposure to a bat is probably attributable to the fact that bats have small sharp teeth that inflict bites not readily visible by examination (1 mm in diameter). Indeed a bat bite may be relatively painless. Once transmitted by bite, the virus replicates locally in skin before entering peripheral nerves and moving by retrograde axonal

transport to the brain.⁷ This local replication accounts for the highly variable incubation period ranging from weeks to months. Human rabies may have a non-specific febrile prodrome that evolves into encephalitis or, less rarely, polio-like paralysis. Focal neurologic findings, based on virus passage along sensory nerves may include numbness, paresthesias or severe itching involving the bitten body part. Focal findings attributable to retrograde transport through motor nerves may include paresis, tremors or myoclonic jerks. This early symptom complex is often a helpful clue to the diagnosis of rabies. Bat-variant rabies is also able to spread to organs beyond the nervous system; thus organs transplanted from a donor patient dying of undiagnosed bat-variant rabies encephalitis have transmitted rabies to 3 organ recipients.⁷ Because a treatment regimen has now become available for human rabies,⁸ more detailed questions about exposure to bats, as well as rapid rabies diagnosis by polymerase chain reaction amplification and serology, may be indicated in selected cases of encephalitis without an apparent cause.

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Key Words: rabies, bats, transmission

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