HHS Public Access
Author manuscript
Nat Ecol Evol. Author manuscript; available in PMC 2021 February 20.

Published in final edited form as:
Nat Ecol Evol. 2020 April ; 4(4): 517–518. doi:10.1038/s41559-020-1144-3.

Knowledge gaps about rabies transmission from vampire bats to humans

M. Brock Fenton[1,✉], **Daniel G. Streicker**[2,3], **Paul A. Racey**[4], **Merlin D. Tuttle**[5], **Rodrigo A. Medellin**[6], **Mark J. Daley**[7], **Sergio Recuenco**[8], **Kevin M. Bakker**[9]

[1]Department of Biology, University of Western Ontario, London, Ontario, Canada

[2]MRC-University of Glasgow Centre for Virus Research, Glasgow, UK

[3]Institute of Biodiversity, Animal Health and Comparative Medicine & College of Medical Veterinary and Life Sciences, University of Glasgow, Glasgow, UK

[4]Centre for Ecology and Conservation, University of Exeter, Penryn, UK

[5]Merlin Tuttle's Bat Conservation, Austin, TX, USA

[6]Institute of Ecology, UNAM, Mexico City, Mexico

[7]University of Western Ontario & The Vector Institute for Artificial Intelligence, London, Ontario, Canada

[8]Centro de Investigaciones Tecnológicas, Biomédicas y Medioambientales, Universidad Nacional Mayor de San Marcos, Ciudad Universitaria UNMSM, Lima, Peru

[9]Department of Statistics, University of Michigan, Ann Arbor, MI, USA

Bakker et al.[1] cited the incidence of human rabies transmitted by common vampire bats in high-risk environments in South America as being up to 960 human deaths per 100,000 people, an estimate originally published by Schneider and colleagues[2]. This alarming number sparked an exchange of correspondence among bat researchers and advocates that highlighted major knowledge gaps in the burden of human rabies transmitted by vampire bats, and the challenges that poorly communicating these uncertainties pose for bat conservation and human health. Here, with Bakker and his colleagues, we elaborate on emergent issues. Our goal is to facilitate effective communication about the transmission of rabies from vampire bats to humans.

The risk estimate in Schneider et al.[2] originated from a single community in Brazil that was specifically selected because of the high incidence of bats feeding on humans (23% of inhabitants had been bitten within the previous year). Similar and higher frequencies of bat

Reprints and permissions information is available at www.nature.com/reprints.

✉**Correspondence and requests for materials** should be addressed to M.B.F. bfenton@uwo.ca.

Author contributions
M.B.F. initiated the process and saw it through; D.G.S., P.A.R., M.D.T., R.A.M., M.J.D., S.R. and K.M.B. contributed equally to the writing.

Competing interests
The authors declare no competing interests.

bites on humans (23, 27, 41, 70 and 88% of inhabitants) are not unusual[3–6], but the nature of such surveys—always non-random and often following human rabies outbreaks—means that the true frequency of communities that experience frequent bat attacks is mostly unknown.

The second impediment to generalizable estimates of the burden of human rabies is a direct consequence of the epidemiology of vampire bat rabies. The virus occurs sporadically in local bat populations, probably maintained through extinction–recolonization dynamics or other complex spatiotemporal processes that remain largely unknown[7–10]. The frequency of outbreaks within bat populations and the proportion of bats that become infected are therefore key variables needed to estimate human risk. Although data are limited, the frequency of outbreaks seems low (S.R., unpublished observations). Instances of repeated human rabies outbreaks affecting the same community are infrequently documented, suggesting prolonged periods without local viral circulation. The proportion of bats infected during outbreaks is also poorly known, but estimates as high as 10% of a colony have been reported[11,12], creating the potential for substantial human mortality. Between 1 and 39 people in the studied villages have been infected during outbreaks. As outbreaks generally occur in remote communities comprising only several hundred people, substantial proportions (1–7% of total inhabitants) may be directly impacted[5,13–15]. It is clear that when outbreaks occur, local risk and health impacts are substantial and require action.

Averaged over space and time, the likelihood of any one person contracting human rabies is exceedingly low. This creates an obvious communication problem that can generate conflicts between public health and bat conservation. Spatiotemporal averages do not adequately capture local risk, which compromises ongoing public health initiatives to prevent bat bites (for example, the distribution of bed nets) and rabies (that is, mass pre-exposure vaccination campaigns) in high-risk areas[16]. Focusing solely on risk estimates from outbreaks makes people fearful of bats, which has three negative impacts. First, it alarms people unnecessarily. Second, it amplifies the negative public image of bats. Third, it casts a pall over efforts to conserve bats.

By discussing the limitations of all available estimates, we hope to encourage a more nuanced discussion of human rabies that includes public health practitioners and bat conservationists. Looking forwards, an alternative approach to estimating the burden of vampire bat-transmitted human rabies would be to use case data reported to international health agencies (such as the Pan American Health Organization or the World Health Organization)[17]. Doing so reliably requires statistical models that use auxiliary data to accommodate under-reporting of disease incidence. While this has been achieved for dog-transmitted rabies and rabies transmitted from vampire bats to livestock[18–20], we are unaware of efforts to incorporate this approach to inferring the burden of human rabies transmitted by vampire bats, where reporting can be hindered by cultural, socioeconomic, educational and geographic factors[14]. Understanding the proportion of human communities that live in high-risk conditions (for example, through geographically randomized questionnaires) and the frequency and magnitude of rabies outbreaks in bat populations (through longitudinal monitoring of wild bats) are critical knowledge gaps that must be filled to make such estimates meaningful.

References

1. Bakker KM et al. Fluorescent biomarkers demonstrate prospects for spreadable vaccines to control disease transmission in wild bats. Nat. Ecol. Evol 3, 1697–1704 (2019). [PubMed: 31740844]
2. Schneider MC et al. Potential force of infection of human rabies transmitted by vampire bats in the Amazonian region of Brazil. Am. J. Trop. Med. Hyg 55, 680–684 (1996). [PubMed: 9025698]
3. Gilbert AT et al. Evidence of rabies virus exposure among humans in the Peruvian Amazon. Am. J. Trop. Med. Hyg 87, 206–215 (2012). [PubMed: 22855749]
4. Schneider MC, Aron J, Santos-Burgoa C, Uieda W & Ruiz-Velazco S Common vampire bat attacks on humans in a village of the Amazon region of Brazil. Cad. Saúde Pública 17, 1531–1536 (2001). [PubMed: 11784915]
5. Lopez A, Miranda P, Tehada V & Fishbein DB Outbreak of human rabies in the Peruvian jungle. Lancet 339, 408–411 (1992). [PubMed: 1346669]
6. Ormaeche M & Gomez-Benavides J Factores de riesgo para mordeduras por murcielagos hematofagos en el valle del rio Apurimac. Rev. Peru. Med. Exp. Salud Publica 110, 89–92 (2007).
7. Blackwood JC, Streicker DG, Altizer S & Rohani P Resolving the roles of immunity, pathogenesis, and immigration for rabies persistence in vampire bats. Proc. Natl Acad. Sci. USA 110, 20837–20842 (2013). [PubMed: 24297874]
8. Benavides JA, Valderrama W & Streicker DG Spatial expansions and travelling waves of rabies in vampire bats. Proc. R. Soc. B 283, 1–9 (2016).
9. Streicker DG et al. Host–pathogen evolutionary signatures reveal dynamics and future invasions of vampire bat rabies. Proc. Natl Acad. Sci. USA 113, 10926–10931 (2016). [PubMed: 27621441]
10. Streicker DG, González SLF, Luconi G, Barrientos RG & Leon B Phylodynamics reveals extinction-recolonization dynamics underpin apparently endemic vampire bat rabies in Costa Rica. Proc. R. Soc. B 286, 20191527 (2019).
11. Baer GM The Natural History of Rabies (CRC, 1991).
12. Bergner LM et al. Demographic and environmental drivers of metagenomic viral diversity in vampire bats. Mol. Ecol 29, 26–39 (2019). [PubMed: 31561274]
13. Dirección General de Epidemiología. Brote de rabia silvestre en la comunidad nativa San Ramón-Yupicusa, Distrito Imaza, Provincia Bagua, Amazonas: situación actual. Bol. Epidemiol 20, 138–139 (2011).
14. Stoner-Duncan B, Streicker DG & Tedeschi CM Vampire bats and rabies: toward an ecological solution to a public health problem. PLoS Negl. Trop. Dis 8, e2867 (2014). [PubMed: 24945360]
15. Verlinde JD, Li-Fo-Sjoe E, Veersteeg J & Decker SM A local outbreak of paralytic rabies in Surinam children. Trop. Geogr. Med 27, 137–142 (1975). [PubMed: 1179478]
16. Kessels JA et al. Pre-exposure rabies prophylaxis: a systematic review. Bull. World Health Organ 95, 210–219C (2017). [PubMed: 28250534]
17. *WHO Expert Consultation on Rabies: Second Report* Tech. Rep. No. 982 (WHO, 2013).
18. Benavides JAJA, Rojas Paniagua E, Hampson K, Valderrama W & Streicker DGDG Quantifying the burden of vampire bat rabies in Peruvian livestock. PLoS Negl. Trop. Dis 11, e0006105 (2017). [PubMed: 29267276]
19. Hampson K et al. Estimating the global burden of endemic canine rabies. PLoS Negl. Trop. Dis 9, e0003709 (2015). [PubMed: 25881058]
20. Escobar LE, Peterson T, Favi M, Yung V & Medina-Vogel G Bat-borne rabies in Latin America. Rev. Inst. Med. Trop. Sao Paulo 57, 63–72 (2015). [PubMed: 25651328]