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Zero by 2030 and OneHealth: The multidisciplinary challenges of rabies control and elimination

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Rabies, caused by a negative strand RNA-virus belonging to the genus Lyssavirus (family *Rhabdoviridae* of the order Mononegavirales), remains of global concern [1]. This vaccine-preventable viral zoonotic disease is present in more than 150 countries and territories [2]. According to the World Health Organization (WHO), rabies is estimated to cause ~59,000 human deaths annually, with 95% of cases occurring in Africa and Asia [3,4]. However, rabies still occurs in other regions, such as Latin America and the Caribbean [5–8], Central Asia and the Middle East [9,10]. Whilst a number of animals can host the rabies virus, dogs are the main source of human rabies deaths, contributing up to 99% of all rabies transmissions to humans. Dog-mediated rabies has been eliminated from Western Europe, Canada, the United States of America (USA), Japan and some Latin American countries [11]. Nevertheless, the risk of reintroduction and disease among travellers to risk areas is a matter of concern [12–15]. As occurred with many other communicable and non-communicable diseases, the 2020–2022 COVID-19 pandemic negatively impacted the efforts of control and reemergence of rabies in certain countries [7,16,17]. Post-pandemic challenges to enhance control and prevention are multiple and need urgent actions to achieve the goal in eight years by 2030 [16].

In this complex context, the international community has called for the world to be canine rabies-free by 2030 (Zero by 30); specifically, no indigenously acquired dog-mediated rabies cases among humans are to be achieved by the end of this decade [18]. The Global Strategic Plan to End Human Deaths from Dog-mediated Rabies by 2030, launched in June 2018, targets the disease at the dog reservoir and aligns efforts to prevent human rabies and strengthen animal and human health systems. By implementing the Strategic Plan, affected countries will move a step closer to Sustainable Development Goal (SDG) 3.3, "By 2030, end the epidemics of neglected tropical diseases", and make progress towards achieving SDG 3.8 on universal health coverage [18–21]. As with all zoonotic diseases, a One human, animal and environmental health (One Health) approach with cross-continental multi-disciplinary collaborations will be central to achieving the aims of this strategy [22]. The efforts against rabies should comprehensively consider the need for a multidisciplinary OneHealth response [23–27] at multiple levels, which enable a better understanding amongst complex interactions between human and animal health with the shared environment [28], not only the integration of actions between the WHO, the World Organization for Animal Health (WOAH/OIE) and the Food and Agriculture Organization of the United Nations (FAO), that set the target for global dog-mediated human rabies elimination by 2030 [29]; but at community levels by multidisciplinary teams in the control and prevention of disease in humans and animals. This OneHealth approach is essential to strengthen collaboration, communication, capacity building and coordination equally across all sectors responsible for addressing health concerns at the human–animal–environment interface. Therefore, multisectoral engagement and approach are critical under the umbrella of OneHealth collaboration, including community education, awareness program, and vaccination campaigns [1,30]. Unfortunately, in some countries, e.g. Panama and Venezuela, mandatory rabies vaccination is not regularly performed, although in these territories studies about rabies have also demonstrated their circulation also in chiropterans such as *Desmodus rotundus* [31–33].

The strategies to reach "Zero By 30" condense the societal changes into three objectives: i. To effectively use vaccines, medicines, tools, and technologies; ii. To generate, innovate, and measure impact, through authentic sustainable collaborative partnerships between different scientific disciplines and more sophisticated techniques [28]; and iii. To sustain commitment and resources (Fig. 1) [18]. For example, interrupting transmission is feasible through the mass vaccination of dogs [34]. However, since the cornerstone of rabies eradication are mass vaccination campaigns in dogs, these should be reinforced by verifying the seroconversion of animals [34–36]. Any failure of vaccination or seroconversion should be investigated to trace potential errors in the protocol. Additionally, immediate, thorough wound washing with soap and water after contact with a suspect rabid animal is crucial and can save lives [37]. Also, in certain countries, physicians in areas with

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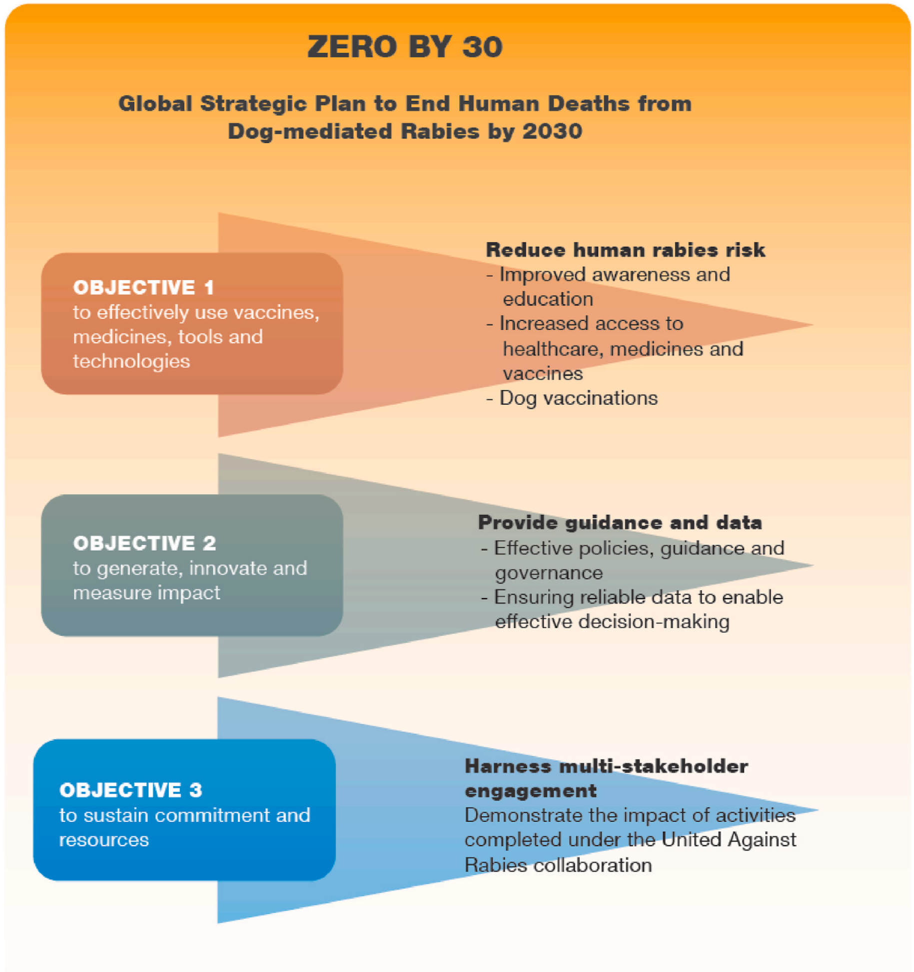

Fig. 1. Global strategic plan to end human deaths from dog-mediated rabies by 2030, WHO [46].

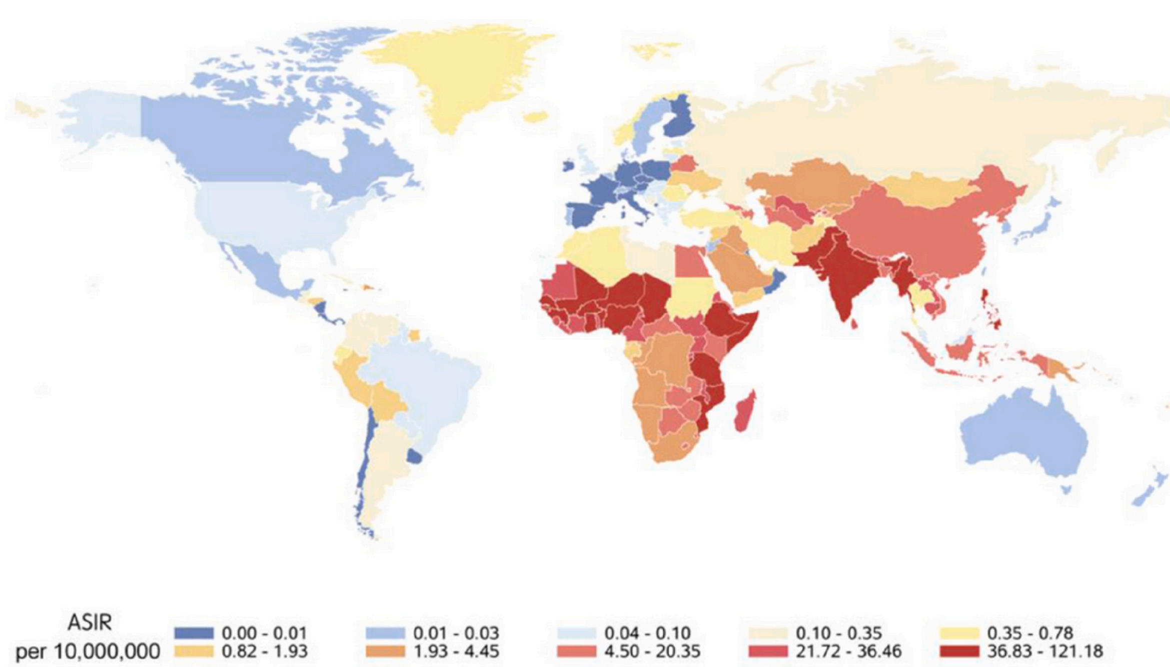

Fig. 2. Age-standardized incidence rate (ASIR) (cases per 10,000,000) in 2019 of rabies in 204 countries and territories [40].

demonstrated rabies circulation in cattle [58], do not consider the importance of cycles where also canids are present, increasing the risk for humans (e.g. Colombia, Guatemala and Panama) [38,39].

Recent estimates from the Global Burden of Disease (GBD) study (Fig. 2) [40] indicated that in 2019, the incident cases of rabies worldwide were 14,075 (95% uncertainty interval, UI: 6,124–21,618), and the number of deaths was 13,743 (95%UI: 6,019–17,938) (for a case fatality rate of 97.6%), both of which were lower than that in 1990. The actual numbers may be higher due to lack of resources for accurate diagnosis, documentation and reporting in rabies endemic developing countries. In addition, data suggested that with the improvement of the socio-demographic Index (SDI), the incident cases, the number of deaths, age-standardized incidence rate (ASIR), age-standardized death rates (ASDR), and disability-adjusted life years (DALYs) of rabies all showed downward trends. Adolescents and adults under 50 represented most rabies cases worldwide [40].

In addition to rabies, in the *Rhabdoviridae* family, at least three genera of animal viruses are included, Lyssavirus, Ephemerovirus, and Vesiculovirus. Lyssavirus has rabies, Lagos bat, Mokola virus, Duvenhage virus, European bat virus 1 & 2 and Australian bat virus (www.cdc.gov) [41,42]. Another animal of emerging importance in transmission of rabies to human is the bat [57]. Rabies can spread to people from bats after minor, seemingly unimportant, or unrecognized bites or scratch. It is worth mentioning that novel related viruses continue to be discovered, predominantly in bat populations, that are of interest purely through their classification within the lyssavirus genus alongside the rabies virus [43]. Although bat rabies accounts for a relatively small proportion of human cases worldwide, it accounts for most human rabies cases in the Americas. In most parts of the continent, haematophagous bats are the primary source of human cases, either by direct transmission or by infection through an intermediate species such as cats, which, given their hunting habits, become a "bridge" between bat rabies and urban areas [44]. Vampire bat rabies is also a significant cause of livestock mortality, affecting subsistence and commercial farmers throughout the geographic range of this bat (from northern Mexico to Argentina and Uruguay) [11,45]. The surveillance and detection of rabies and other pathogens in bats and other sylvatic animals is a complex challenge for public health systems, especially in resource-constrained countries.

Beyond these ecological issues, as a clinical condition, rabies is still challenging, prevention and control remain as key factors, while significant limitations still exist for managing cases. Despite the use of evidence-based approaches, the case fatality rate of rabies is high. Post-exposure prophylaxis (PEP) is critical in its management (Table 1) [46] and should be enhanced in risk areas. Although that, personnel at risk, such as veterinarians and biologists in endemic areas, do not have regular access to prophylaxis in many low and middle-income countries. Even more, in some of these nations, access to vaccine and immunoglobulins is also limited. In the case of travelers there is a high cost for medical evacuation when required, especially if there is no access to vaccines and immunoglobulins. For example, in countries such as Colombia, sometimes rabies affected populations include Afroamerican and Amerindian children, as reported in Choco department, a vulnerable area with rabies outbreaks reported in 2004–2005 [47].

Research on rabies should also be increased, including more assessment of potential antiviral therapies, immunotherapy, and other biological approaches, including more antibodies and vaccines [48–50]. Although pre-exposure and post-exposure treatment options are available, they are efficacious only when initiated before the onset of clinical symptoms. Furthermore, the current rabies vaccine does not cross-protect against the emerging zoonotic phylogroup II lyssaviruses. A requirement for an uninterrupted cold chain and the high cost of the immunoglobulin component of rabies PEP generate an unmet need for developing rabies-specific antivirals [51].

Active and passive surveillance should be enhance in humans and animals [52]. In addition to the intersectoral and multisectoral integration for control of rabies, national evidence-based guidelines should be developed and available periodically for healthcare workers to provide the best available clinical preventive, diagnostic and therapeutic management [53–55].

Table 1
Clinical approach for management of rabies exposure [46].

Exposure	Category	Approach
Intact skin (=no exposure)	I	Washing, but no vaccine
Minor scratches (no bleeding)	II	Washing plus vaccine
Transdermal bite (wounded skin) Multiple wounds	III	Washing plus vaccine plus RIG

Indeed, after the COVID-19 pandemic, multiple challenges remain or even are on recrudescence, including the effective control of rabies in many regions [56]. We are making a call for more research and development to reach globally the "Zero by 30" goal, which will be more feasible if more multi-, inter-, and transdisciplinary work is done, as well as prioritizing the utilization of global health and OneHealth approaches for this zoonotic viral disease. Rabies is preventable. A unified global OneHealth effort is required to make sure that human rabies deaths end by 2030. Investing more into rabies control will build OneHealth solidarity, reduce health inequalities and strengthen core capacities in resource poor regions for tackling fatal zoonotic diseases.

Declaration of competing interest

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References

[1] Acharya KP, Chand R, Huettmann F, Ghimire TR. Rabies elimination: is it feasible without considering wildlife? J Trop Med 2022;2022:5942693.
[2] Rupprecht CE, Mani RS, Mshelbwala PP, Recuenco SE, Ward MP. Rabies in the tropics. Curr Trop Med Rep 2022;9:28–39.
[3] Wilde H, Hemachudha T, Wacharapluesadee S, Lumlertdacha B, Tepsumethanon V. Rabies in Asia: the classical zoonosis. Curr Top Microbiol Immunol 2013;365:185–203.
[4] Nyasulu PS, Weyer J, Tschopp R, Mihret A, Aseffa A, Nuvor SV, et al. Rabies mortality and morbidity associated with animal bites in Africa: a case for integrated rabies disease surveillance, prevention and control: a scoping review. BMJ Open 2021;11:e048551.
[5] Rifakis PM, Benitez JA, Rodriguez-Morales AJ, Dickson SM, De-La-Paz-Pineda J. Ecoepidemiological and social factors related to rabies incidence in Venezuela during 2002-2004. Int J Biomed Sci 2006;2:1–6.
[6] Benitez JA, Rodriguez-Morales AJ, Vivas P, Plaz J. Burden of zoonotic diseases in Venezuela during 2004 and 2005. Ann N Y Acad Sci 2008;1149:315–7.
[7] Raynor B, Díaz EW, Shinnick J, Zegarra E, Monroy Y, Mena C, et al. The impact of the COVID-19 pandemic on rabies reemergence in Latin America: the case of Arequipa, Peru. PLoS Neglected Trop Dis 2021;15:e0009414.
[8] Yoder J, Younce E, Lankester F, Palmer GH. Healthcare demand in response to rabies elimination campaigns in Latin America. PLoS Neglected Trop Dis 2019;13:e0007630.
[9] Taylor E, Del Rio Vilas V, Scott T, Coetzer A, Prada JM, Alireza G, et al. Rabies in the Middle East, Eastern Europe, central Asia and North Africa: building evidence and delivering a regional approach to rabies elimination. J Infect Public Health 2021;14:787–94.
[10] Gautret P, Al-Abri S, Al-Rawahi B, Memish ZA. Human rabies importation to the Middle East: an emerging threat? Int J Infect Dis 2021;102:335–6.
[11] Vigilato MA, Cosivi O, Knobl T, Clavijo A, Silva HM. Rabies update for Latin America and the Caribbean. Emerg Infect Dis 2013;19:678–9.

[12] Gautret P, Harvey K, Pandey P, Lim PL, Leder K, Piyaphanee W, et al. Animal-associated exposure to rabies virus among travelers, 1997-2012. Emerg Infect Dis 2015;21:569–77.
[13] Bantjes SE, Ruijs WLM, van den Hoogen GAL, Croughs M, Pijtak-Radersma AH, Sonder GJB, et al. Predictors of possible exposure to rabies in travellers: a case-control study. Trav Med Infect Dis 2022;47:102316.
[14] Kaplan S, Khoury S, Zaidenstein R, Cohen E, Tischler-Aurkin D, Sheffer R, et al. Morbidity among Israeli backpack travelers to tropical areas. Trav Med Infect Dis 2022;45:102178.
[15] Croughs M, van den Hoogen GAL, van Jaarsveld CHM, Bantjes SE, Pijtak-Radersma AH, Haverkate MR, et al. Rabies risk behaviour in a cohort of Dutch travel clinic visitors: a retrospective analysis. Trav Med Infect Dis 2021;43:102102.
[16] Nadal D, Beeching S, Cleaveland S, Cronin K, Hampson K, Steenson R, et al. Rabies and the pandemic: lessons for one health. Trans R Soc Trop Med Hyg 2022;116:197–200.
[17] Gongal G, Sampath G, Kishore J, Bastola A, Punrin S, Gunesekera A. The impact of COVID-19 pandemic on rabies post-exposure prophylaxis services in Asia. Hum Vaccines Immunother 2022;18:2064174.
[18] Kanda K, Jayasinghe A, Jayasinghe C, Yoshida T. A regional analysis of the progress of current dog-mediated rabies control and prevention. Pathogens 2022;11.
[19] Fitzpatrick C, Engels D. Leaving no one behind: a neglected tropical disease indicator and tracers for the Sustainable Development Goals. Int Health 2016;8(Suppl 1):i15–8.
[20] Mbilo C, Coetzer A, Bonfoh B, Angot A, Bebay C, Cassamá B, et al. Dog rabies control in west and central Africa: a review. Acta Trop 2021;224:105459.
[21] Fahrion AS, Taylor LH, Torres G, Müller T, Dürr S, Knopf L, et al. The road to dog rabies control and elimination-what keeps us from moving faster? Front Public Health 2017;5:103.
[22] Tidman R, Thumbi SM, Wallace R, de Balogh K, Iwar V, Dieuzy-Labaye I, et al. United against rabies forum: the one health concept at work. Front Public Health 2022;10:854419.
[23] Wei Y, Li D, Yang Z, Chen K, Pan X, Xu J, et al. One Health responses to prevent the occurrence of rabies due to attacks by a rabid stray dog. Veterinary medicine and science. 2022.
[24] OIE. One health. https://www.woah.org/en/what-we-do/global-initiatives/one-health/. 2022.
[25] Bonilla-Aldana DK, Dhama K, Rodriguez-Morales AJ. Revisiting the one health approach in the context of COVID-19: a look into the ecology of this emerging disease. Adv Anim Vet Sci 2020;8:234–7.
[26] Bonilla-Aldana DK, Holguin-Rivera Y, Perez-Vargas S, Trejos-Mendoza AE, Balbin-Ramon GJ, Dhama K, et al. Importance of the one health approach to study the SARS-CoV-2 in Latin America. One Health 2020;10:100147.
[27] Dhama K, Chakraborty S, S K, Tiwari R, Kumar A, R D, et al. One world, one health - veterinary perspectives. Adv Anim Vet Sci 2013;1:5–13.
[28] Cabrera M, Leake J, Naranjo-Torres J, Valero N, Cabrera JC, Rodriguez-Morales AJ. Dengue prediction in Latin America using machine learning and the one health perspective: a literature review. Trop Med Infect Dis 2022;7.
[29] Gibson AD, Yale G, Corfmat J, Appupillai M, Gigante CM, Lopes M, et al. Elimination of human rabies in Goa, India through an integrated One Health approach. Nat Commun 2022;13:2788.
[30] Lapiz SM, Miranda ME, Garcia RG, Daguro LI, Paman MD, Madrinan FP, et al. Implementation of an intersectoral program to eliminate human and canine rabies: the Bohol Rabies Prevention and Elimination Project. PLoS Neglected Trop Dis 2012;6:e1891.
[31] Cárdenas-Canales EM, Stockmaier S, Cronin E, Rocke TE, Osorio JE, Carter GG. Social effects of rabies infection in male vampire bats (Desmodus rotundus). Biol Lett 2022;18:20220298.
[32] Briggs CL. Uncovering a tragic flaw in revolutionary health policies: from health and communicative inequities to communicative justice in health. Salud colectiva 2017;13:411–27.
[33] Lee DN, Papeş M, Van den Bussche RA. Present and potential future distribution of common vampire bats in the Americas and the associated risk to cattle. PLoS One 2012;7:e42466.
[34] Morters MK, McKinley TJ, Horton DL, Cleaveland S, Schoeman JP, Restif O, et al. Achieving population-level immunity to rabies in free-roaming dogs in Africa and Asia. PLoS Neglected Trop Dis 2014;8:e3160.
[35] Wu X, Hu R, Zhang Y, Dong G, Rupprecht CE. Reemerging rabies and lack of systemic surveillance in People's Republic of China. Emerg Infect Dis 2009;15:1159–64.
[36] Trujillo-Rojas L, Martínez-Gutierrez M..., ..., . Low level of the immune response against rabies virus in dogs and cats, a cross-sectional study in sheltered animals, Santander, Colombia. Pesquisa Veterinária; 2018.
[37] Rysava K, Miranda ME, Zapatos R, Lapiz S, Rances P, Miranda LM, et al. On the path to rabies elimination: the need for risk assessments to improve administration of post-exposure prophylaxis. Vaccine 2019;37(Suppl 1):A64–a72.
[38] Arellano-Sota C. Vampire bat-transmitted rabies in cattle. Rev Infect Dis 1988;10 (Suppl 4):S707–9.
[39] Gilbert A, Greenberg L, Moran D, Alvarez D, Alvarado M, Garcia DL, et al. Antibody response of cattle to vaccination with commercial modified live rabies vaccines in Guatemala. Prev Vet Med 2015;118:36–44.
[40] Gan H, Hou X, Wang Y, Xu G, Huang Z, Zhang T, et al. Global burden of rabies in 204 countries and territories, from 1990 to 2019: results from the global burden of disease study 2019. Int J Infect Dis 2022. https://doi.org/10.1016/j.ijid.2022.10.046. In press.
[41] Malerczyk C, Freuling C, Gniel D, Giesen A, Selhorst T, Müller T. Cross-neutralization of antibodies induced by vaccination with purified chick embryo cell vaccine (PCECV) against different lyssavirus species. Hum Vaccines Immunother 2014;10:2799–804.
[42] Tyem DA, Dogonyaro BB, Woma TA, Ngoepe EC, Sabeta CT. Sero-surveillance of lyssavirus specific antibodies in Nigerian fruit bats (Eidolon helvum). Trop Med Infect Dis 2017;2.
[43] Shipley R, Wright E, Selden D, Wu G, Aegerter J, Fooks AR, et al. Bats and viruses: emergence of novel lyssaviruses and association of bats with viral zoonoses in the EU. Trop Med Infect Dis 2019;4.
[44] Tierradentro-Garcia LO, Cortes-Albornoz MC, Talero-Gutierrez C. Of love and other demons: depicting human rabies in Colombia. Heliyon 2022;8:e09703.
[45] Adhikari SP, Meng S, Wu YJ, Mao YP, Ye RX, Wang QZ, et al. Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review. Infect Dis Poverty 2020;9:29.
[46] WHO.; United Against rabies collaboration first annual progress report: global strategic plan to end human deaths from dog-mediated rabies by 20302019.
[47] Valderrama J, García I, Figueroa G, Rico E, Sanabria J, Rocha N, et al. [Outbreaks of human rabies transmitted by vampire bats in Alto Baudó and Bajo Baudó municipalities, department of chocó, Colombia, 2004-2005]. Biomedica 2006;26:387–96.
[48] Rohde RE, Rupprecht CE. Update on lyssaviruses and rabies: will past progress play as prologue in the near term towards future elimination? Faculty reviews 2020;9:9.
[49] Tantawichien T, Rupprecht CE. Modern biologics for rabies prophylaxis and the elimination of human cases mediated by dogs. Expet Opin Biol Ther 2020;20:1347–59.
[50] Smith SP, Wu G, Fooks AR, Ma J, Banyard AC. Trying to treat the untreatable: experimental approaches to clear rabies virus infection from the CNS. J Gen Virol 2019;100:1171–86.
[51] Du Pont V, Plemper RK, Schnell MJ. Status of antiviral therapeutics against rabies virus and related emerging lyssaviruses. Curr Opin Virol 2019;35:1–13.
[52] Henry RE, Blanton JD, Angelo KM, Pieracci EG, Stauffer K, Jentes ES, et al. A country classification system to inform rabies prevention guidelines and regulations. J Trav Med 2022;29.
[53] Schreuder I, De Pijper C, van Kessel R, Visser L, van den Kerkhof H. Abandon of intramuscular administration of rabies immunoglobulin for post-exposure prophylaxis in the revised guidelines in The Netherlands in 2018: cost and volume savings. Euro Surveill 2020;25.
[54] Liu C, Cahill JD. Epidemiology of rabies and current US vaccine guidelines. R I Med J 2013;103:51–3. 2020.
[55] Townsend SE, Lembo T, Cleaveland S, Meslin FX, Miranda ME, Putra AA, et al. Surveillance guidelines for disease elimination: a case study of canine rabies. Comp Immunol Microbiol Infect Dis 2013;36:249–61.
[56] Goel K, Sen A, Satapathy P, Kumar P, Aggarwal AK, Sah R, et al. Emergence of rabies among vaccinated humans in India: A public health concern. Lancet Reg Health Southeast Asia 2022:100109. https://doi.org/10.1016/j.lansea.2022.100109. In press.
[57] Bonilla-Aldana DK, Jimenez-Diaz SD, Arango-Duque JS, et al. Bats in ecosystems and their Wide spectrum of viral infectious potential threats: SARS-CoV-2 and other emerging viruses. Int J Infect Dis 2021;102:87–96. https://doi.org/10.1016/j.ijid.2020.08.050.
[58] Bonilla-Aldana DK, Jimenez-Diaz SD, Barboza JJ, Rodriguez-Morales AJ. Mapping the spatial distribution of bovine rabies in Colombia, 2005-2019. Trop Med Infect Dis 2022. In press.

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