# Rabies Neglected Modes of Transmission in Pakistan

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## ABSTRACT

Rabies is a contagious but preventable disease. While canine rabies remains the predominant mode of transmission in Pakistan, there are other under-recognized reservoirs and routes of exposure to rabies that pose a significant public health threat. This chapter delves into these neglected routes of rabies transmission, urging a comprehensive approach to rabies control and prevention. Bat-transmitted rabies, mongoose-transmitted rabies, and rabies transmitted through wildlife to human beings are also significant contributors to this disease. Fruit bats have wide-ranging foraging patterns that emerge as potential sources of fruit-borne transmission incidents. Interactions with wildlife are also a cherished aspect of Pakistani culture and warrant scrutiny. Transmission of rabies through professional activities also causes transmission to health care professionals and veterinarians. Ritual activities such as dog fights also spread this disease; fighting dogs also spread this disease ultimately to human beings. Rodents that are present in almost every region and contaminate every household in Pakistan also transmit this disease to human beings. Bites or scratches from seemingly docile or playful animals such as foxes, jackals, mongooses, etc. can spread the rabies virus. Public education initiatives emphasizing responsible wildlife interactions and prompt post-exposure prophylaxis are crucial in the prevention of rabies transmission. Ignoring these non-canine transmission pathways hinders effective rabies control. This chapter advocates for a multifaceted approach encompassing expanded surveillance of diverse animal reservoirs, targeted interventions tailored to specific transmission routes, and heightened public awareness about neglected vectors. Only through such holistic approaches can Pakistan effectively combat the multifaceted threat of rabies.

**Keywords:** Rabies, Modes of Transmission, Bat-Transmitted Rabies, Public Health, Wild Life.

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## 1. INTRODUCTION

Rabies is a highly contagious viral disease affecting mammals' central nervous system. It is caused by the highly contagious rabies virus (Baer 1988; Kaplan 1977). The rabies virus (RV) is a single-stranded RNA virus that belongs to the Rhabdoviridae family of viruses (Wunner and Conzelmann 2013). Dogs are the most frequent source of rabies infection in humans globally (Dutta 2014). The disease is usually transmitted through the bite and scratch of an infected animal to healthy animals and human beings (Hankins and Rosekrans 2004). There are other ways to transmit rabies, but they are neglected and have a significant role in disease epidemiology (Singh et al., 2017). These neglected ways should be considered for effective disease control (Constantine 1962).

For control and prevention strategies to be successful, it is essential to understand modes of rabies transmission (Catherine 2011). Public health authorities and researchers can design focused measures to lower the incidence of rabies and reduce the danger of outbreaks by investigating both the primary and neglected modes of transmission (Afshar 1979).

In this chapter, we'll look at various ways the rabies virus is transmitted, particularly the rare and undervalued methods (Rupprecht et al., 2002). We seek to raise awareness and add to the overall understanding of rabies transmission dynamics by shedding light on these neglected modes of transmission (WHO 2018). This information may be advantageous in formulating thorough strategies to prevent and treat this deadly disease (Crowcroft and Thampi 2015).

## 2. NEGLECTED MODES OF RABIES TRANSMISSION

### 2.1. TRANSMISSION THROUGH MONGOOSES

While animal bites and scratches are the main ways of spreading rabies, other overlooked zoonotic transmission mechanisms must be considered (Davis et al., 2007). Some cases of mongoose-borne rabies are recognized in some areas as a potential source of human infection. In this article, we'll talk about how mongooses spread rabies (Everard and Everard 1988).

Small carnivores such as mongooses are known for their agility and predation (Everard and Everard 1992). Mongooses are found in nearly all countries worldwide but frequently in African and Asian territories and some islands (Nel et al., 2005). Mongooses are not generally considered reservoir hosts for rabies, but in some Asian and African regions where they coexist alongside rabies-carrying animals, reports of rabies transmission from mongooses to humans have been observed (Tierkel et al., 1952).

Uncertainty surrounds the precise transfer mode from mongooses to people (Van Zyl et al., 2010). However, similar to other rabies transmission means, it is speculated to occur through the transfer of saliva (Berentsen et al., 2015). Rabies infection can occur due to bites, scratches, or open wounds exposed to mongoose saliva (Krebs et al., 2003).

Mongoose-to-human rabies transmission is regarded as a neglected zoonotic mode due to its comparatively low frequency when compared to cases from other sources (Nellis and Everard 1983). However, in places like Pakistan, India, and the Caribbean, where mongoose populations are numerous, and rabies is endemic, it is vital to consider these ignored transmission pathways for successful rabies control (Seetahal et al., 2018).

### 3. TRANSMISSION THROUGH RODENTS

Rabies transmission from rodents to humans rarely occurs, but some cases have been reported (Fitzpatrick et al., 2014). Rodents are not considered reservoirs of the rabies virus, but they can become infected and transfer the virus to humans if they are bitten by a rabid animal (Eidson et al., 2005). There have been many incidents where rodents transmitted the rabies virus to humans through bites, scratches, or exposure to their saliva (Jackson 2002). Such instances are relatively infrequent, and rodents are not typically a significant source of human rabies infections (Winkler 2017). Nonetheless, caution should be exercised when handling or encountering wild or stray rodents, especially if they display unusual or aggressive behavior (Mørk and Prestrud 2004).

### 5. TRANSMISSION THROUGH OTHER WILDLIFE

In addition to common carnivores, other wildlife species may also play a role in the transmission of rabies (Macdonald 1980). Animals such as raccoons, skunks, and bats are known reservoirs of the rabies virus. Bites and scratches from infected wildlife are the primary modes of transmission (Winkler and Bögel 1992). Raccoons and skunks can transmit rabies to humans, particularly in areas where these species are endemic (Sterner and Smith, 2006). Bats, in particular, are important vectors of rabies and can transmit the virus through bites or, in rare cases, even through direct contact with mucous membranes or broken skin (Tinline 1988). It is essential to exercise caution and avoid handling wildlife, especially if they appear sick, disoriented, or exhibit aggressive behavior (Rupprecht et al., 1995). Vaccination of domestic animals, particularly against bat-associated strains of rabies, is essential for preventing transmission from wildlife to pets and humans (Acharya et al., 2022).

### 6. TRANSMISSION THROUGH DOMESTICATED ANIMALS

Pets' mainly unvaccinated dogs and cats, can easily get infected by the rabies virus and transmit it to their owners and other animals (Have et al., 2008). It has been documented that domestic cats who wander outside their houses unvaccinated are more likely to acquire the rabies virus than cats who have had vaccinations (Wyatt 2007). In case studies, it has been seen that cats missing from home for several days showed stress signs and later started showing signs of rabies (Beran and Frith 1988). The primary transmission route is scratching or biting by infected animals (Crozet et al., 2020). If one of these unvaccinated pet animals gets bitten by an infected animal, they can get infected with the virus and spread it to humans (Chang et al., 2002). To stop the spread of rabies and protect both animal and human health, it is essential to have well-trained pets and to immunize domesticated animals regularly (Beeler and Ehnert 2020).

### 7. TRANSMISSION THROUGH ENVIRONMENTAL EXPOSURE

Transmission of the rabies virus can occur occasionally after environmental exposure (Dürr and Ward 2015). Transmission may occur when individuals come in contact with objects or surfaces exposed to

infected animals (Setyowati and Machmud 2018). There is a slight chance of a person's mucous membranes or an open wound coming into contact with contaminated surfaces (Rupprecht et al., 2008). Environmental exposure contributes to only a fraction of human rabies cases and is not a significant cause of transmission (Layan et al., 2021). However, it is essential to maintain excellent hygiene and steer clear of potentially infectious objects or surfaces, especially in areas where rabies is prevalent (Dhand and Ward 2012).

## 8. TRANSMISSION THROUGH UNCOMMON OCCUPATIONAL EXPOSURES

Certain occupations that involve close contact with animals or animal tissues may expose workers to rabies (Parize et al., 2021). Veterinarians, animal control workers, researchers, and laboratory workers may be more likely to be exposed if they handle rabies-infected animals or work with the rabies virus in the laboratory (Rupprecht et al., 2006). Incidental needle stick wounds or scratches from infected animals can prompt transmission (World Health Organization 2018). To reduce the occupational risk of rabies transmission, adhere to proper safety protocols, such as wearing personal protective equipment and getting vaccinated (Kessels et al., 2017; Tarrant et al., 2020).

## 9. CROSS-SPECIES TRANSMISSION

Rabies is a disease that primarily affects mammals; however, occurrences of cross-species transmission have been reported (Wallace et al., 2014). In rare cases, rabies infection can be transmitted from one species to another, possibly prompting human diseases (Gordon et al., 2004). Cross-species transmission can occur through bites, scratches, an open wound, or the brain tissue of an infected animal (Borucki et al., 2013). The transmission of rabies to humans from non-reservoir species, such as non-human primates or marine mammals, is an example of cross-species transmission (Bonnaud et al., 2019; Mollentze et al., 2020). Albeit such occurrences are inconsistent, observation and checking of creature populations are fundamental to distinguishing potential cross-species transmission occasions and carrying out suitable preventive measures (Holmes et al., 2002; Singer and Smith 2012).

## 10. CONTROVERSIAL OR DEBATED ROUTES OF TRANSMISSION

In rabies research, several transmission routes are still debatable or controversial (Thomas et al., 1990). These include transmission methods that are either not fully understood or have not been thoroughly investigated (Banyard et al., 2019). A few instances predict that infection might spread through infected animals' tears, sweat, or urine, although the evidence for these theories is scant or ambiguous (Fallon Jr and Schmalzried 2008). Current scientific knowledge does not believe these controversial modes of transmission are significant contributors to human rabies cases (Rupprecht et al., 2017). Continuous research is crucial to analyze and explain these transmission routes to guarantee a thorough understanding of rabies transmission routes (Derbin and Flamand 1985).

## 11. VERTICAL TRANSMISSION

Vertical transmission refers to the transmission of a pathogen from an infected mother to her offspring during pregnancy, childbirth, or breastfeeding (Aguèmon et al., 2016). In rabies, vertical transmission is considered a rare and unusual transmission mode (Iehl et al., 2008). While it is theoretically possible for

a pregnant animal infected with rabies to transmit the virus to her fetus or newborn, documented cases of vertical transmission in mammals, including humans, are extremely rare (Nidia Aréchiga-Ceballos et al., 2019; Swamy and Heine 2015). Vertical transmission of rabies is not a significant concern in the overall epidemiology of the disease, and the primary modes of transmission remain bites and scratches from infected animals (Aréchiga-Ceballos et al., 2019; Warrell and Warrell 1988).

## 12. TRANSMISSION THROUGH NON-BITE EXPOSURE

Rabies commonly spreads through bites and scratches: there are reports of very few cases in which the virus was not spread through saliva from one infected animal to another (Winkler et al., 1972). Non-biting openings incorporate cases where the infection enters the body through mucous films (like the eyes, nose, or mouth) or broken skin that comes into contact with infected animals, discharges, like urine, tears, or respiratory drops (Barnard et al., 1982; Di Quinzio and McCarthy 2008). Despite this, it is unusual that non-biting openings result in the spread of the rabies virus, and these cases are regarded as outstanding and extraordinary modes of transmission (Balachandran and Charlton 1994). The most crucial and pervasive ways of rabies transmission are bites and scratch wounds (Balsamo et al., 2009).

## 13. BLOODBORNE TRANSMISSION

Bloodborne transmission refers to transmitting rabies through contact with infected blood (Dean et al., 1963). Although the rabies virus is found in the blood of infected animals, it is rarely transmitted to other animals via blood contact (Horta et al., 2022). The virus is primarily concentrated in the nervous tissue and saliva of infected animals, making bites and scratches the main modes of transmission (Lodmell et al., 2006). However, in rare cases of organ transplantation from an infected donor or accidental exposure to infected blood in laboratory settings, there is a theoretical risk of bloodborne transmission (Wang and Jin 2009). Strict safety protocols and proper screening of potential organ donors are in place to mitigate this risk (Roine et al., 1988).

## 14. TRANSMISSION THROUGH CONTACT WITH INFECTED ANIMAL WASTE

Contact with infected animals' wastes, like urine, feces, or bedding material sullied with the infection, is not considered the principal mode of rabies transmission (Wright et al., 2021). The virus is fundamentally present in infected animals' sensory tissue and saliva, and the fixation on side effects is ordinarily low (Gilcreas 1966). In this way, the risk of contracting rabies through contact with contaminated animal waste is negligible (Maurer and Guber 2001). When handling or cleaning areas contaminated with animal waste, however, it is still essential to maintain good hygiene, including washing one's hands thoroughly, to lessen the likelihood of contracting additional infections (Goor 1949; Strauch and Ballarini 1994).

## 15. ANIMAL-TO-ANIMAL TRANSMISSION

While rabies primarily affects mammals, the virus can be transmitted between animals (Bano et al., 2017). Animal-to-animal transmission can occur through bites, scratches, or close contact with an infected animal's saliva or neural tissue (Niezgoda et al., 2003). Animal-to-animal transmission is standard in wildlife populations and can contribute to the maintenance and spread of rabies within animal species (Barecha et al., 2017). However, the direct transmission of rabies between animals without subsequent transmission to humans is not considered a neglected mode of zoonotic

transmission (National Association of State Public Health Veterinarians. Compendium of Animal Rabies Prevention and Control 2005). This heading focuses primarily on neglected transmission modes related to human infection (Brown et al., 2011).

## 16. TRANSMISSION THROUGH ENVIRONMENTAL RESERVOIRS

Environmental reservoirs describe environments or places where the rabies virus can survive, even without nearby animal hosts (Scheffer et al., 2014). The virus spreads mainly through direct contact with infected animals, but if specific conditions are met, environmental reservoirs can also infect humans (Escobar et al., 2015). For instance, the virus can survive in bat colonies, where infected bats' saliva, urine, or guano may contact humans (Wandeler et al., 1993). The chance of human infection from environmental reservoirs is often low, and the main focus of rabies control initiatives is on direct animal-to-human transmission (Vercauteren et al., 2012).

## 17. TRANSMISSION THROUGH EXPOSURE TO BAT GUANO

Bat guano feces can contaminate the rabies virus, particularly in areas where bats are identified as reservoirs of infection (Dimkić et al., 2021). Although bat guano has a low risk of transmission, it can be transmitted through handling and coming into contact with feces (Li et al., 2010). It occurs more often in congested areas like caves or attics (Robertson et al., 2011). It is essential to take precautionary measures and maintain hygiene to reduce the risk of contamination (CDC 1998).

## 18. INTRAUTERINE TRANSMISSION

Intrauterine transmission is the spread of the rabies virus from mother to fetus via the placenta (Qu et al., 2016). Even though rabies is rare to transmit through the intrauterine route, a few cases reported and described raise the possibility (Scheidegger 1953). However, the specific mechanisms and transmission perspective are still unknown (Otrzanowska-poplewska 1969). In the general epidemiology of the disease, intrauterine transmission is not regarded as a significant mechanism of rabies transmission but as a neglected one (Roszkowski et al., 1972).

## 19. AEROSOL TRANSMISSION

The possibility of rabies transmission through virus-laden respiratory droplets is called aerosol transmission (Winkler et al., 1973). Although bites and scratches are the primary routes of rabies transmission from one host to another, only a few studies and reports suggest the possibility of aerosol transmission in some cases, such as laboratories or highly controlled environments (Davis et al., 2007; Messenger et al., 2002). In any case, it is essential to note that aerosol transmission of rabies is not a typical or deeply grounded method of transmission, and further research is required to comprehend its importance (Adedeji et al., 2010; Held et al., 1967).

## 20. TRANSMISSION VIA INSECTS

Insects are considered vectors of various contagious diseases, but their role in rabies transmission is negligible compared to other modes of transmission (Shope 1982). Insects are not well known to reproduce or transmit the rabies virus to dogs, cats, or other warm-blooded animals (Pinto et al., 1994).

While bugs might precisely transmit the infection as they come into contact with contaminated spit and consequently bite another person or animal, there is no proof to suggest that this method of transmission is critical to the general transmission elements of rabies (Badrane and Tordo 2001). Rabies spreads most frequently through bites from infected mammals and about negligible through insects (Nel and Markotter 2007).

## 21. TRANSMISSION THROUGH ORGAN TRANSPLANTS

Although organ transplantation is perceived as a likely course of transmission, rabies transmission through this course is phenomenal (Nel and Rupprecht 2007). The transmission of the rabies virus from a rabies-infected donor's organ to a recipient has been observed in a few cases (Dietzschold and Koprowski 2004). To decrease the risk of infections from infected donors, strict screening processes, including point-by-point clinical history evaluations and serological testing, are set up (Bronnert et al., 2007; Srinivasan et al., 2005). Even though there is a low risk of transmission with organ transplants, careful donor selection and rigorous pre-transplant evaluation protocols are essential (Burton et al., 2005; Nigg and Walker 2009).

## 22. TRANSMISSION THROUGH COUNTERATTACK OF JACKALS

If the jackal is infected with the virus, there is a risk of rabies transmission when hunting dogs come into contact with jackals and engage in fights or counterattacks (Swanepoel et al., 1993). During hunting, if a jackal bites a hunting dog, the penetration of the jackal's saliva could transmit a virus to the dog through the bloodstream (Loveridge et al., 2001). The rabies virus attacks the nervous system and spreads to the brain via nerve fibers (Zulu et al., 2009). When the infection arrives at the brain, it starts to reproduce quickly, prompting the trademark side effects of rabies (McKenzie 1993).

The transmission of rabies through bite relies upon different variables, including the viral burden of the mucus of the infected animal, the abrasiveness and severity of the scratch, and the location of the bite (Barnard 1979; Cumming 1982). Higher risks are associated with bites to the head, neck, and limbs, which have an abundant blood supply (Blancou 1988; Hikufe et al., 2019).

It is critical to note that rabies in a jackal cannot be resolved outwardly, as an infected animal may not indicate the illness clearly (Benedictis et al., 2022). Infected animals might seem disturbed, confused, or behave strangely, yet they can transmit the infection during the asymptomatic stage (Atuman et al., 2014; Smith et al., 1993).

Following the previously mentioned preventative measures, such as vaccinating hunting dogs against rabies, is essential to preventing rabies transmission in such circumstances (Briggs 2012). Vaccination helps protect dogs in the event of potential exposure and significantly lowers the risk of infection (Brown et al., 2016; Rupprecht et al., 2016).

## 23. TRANSMISSION THROUGH RITUAL DOGS FIGHT

During a fight between two dogs, if one dog is affected by the rabies virus, it can transmit it to the other (Athingo et al., 2020). This can happen through bites and scratches that one dog gives to another dog (Broban et al., 2018).

At the point when two canines take part in a battle, their chomps can cause stabbings, gashes, or other wounds that permit the infection to enter the circulatory system (Kanda et al., 2022; Rattanavipapong et al., 2019). If the infected dog's saliva contains the rabies infection, the infection can be transmitted into

the infected dog's body through these injuries (Lembo 2012). The virus can then reach and replicate in the central nervous system of other dogs, including the brain, where it causes the onset of rabies symptoms once it has entered the body through the peripheral nerves (Wunner and Briggs 2010).
It is noteworthy that not all dog fights result in the transmission of rabies (Lapiz et al., 2012). The presence of rabies in one of the canines included is a pivotal element (Fahrion et al., 2016). In regions with effective vaccination programs, rabies is relatively rare in domestic dogs (Coetzer et al., 2018). Nonetheless, in areas where rabies is more common or where immunization rates are low, the risk of transmission increases (Pemberton et al., 2007).

## 24. RABIES AND PUBLIC HEALTH

Rabies is a significant public health concern because it is highly contagious and spreads rapidly (Hampson et al., 2015; Knobel et al., 2005). The primary concern is in African and Asian countries where vaccines are not readily available (Iqbal et al., 2023). We can reduce the risk of rabies transmission through prevention and control ((Baer 2017)). This can be achieved by increasing the vaccination rate (Taylor and Nel 2015). Causalities from rabies post-bite exposure can be reduced through proper wound management and prophylactic treatment (Parviz et al., 2004; Shankaraiah et al., 2015).

## 25. IMPORTANCE OF RABIES PREVENTION AND CONTROL

Rabies can only be controlled through prevention and precautionary measures (Coleman et al., 2004 ). As we know, rabies is a viral disease with a high mortality rate, and there is no known treatment for this deadly disease; therefore, it can only be prevented through vaccination (Taylor and Nel 2015). Pet vaccination is critical to reducing the spread of rabies (Durr et al., 2009). Live rabies vaccines can be used in this regard because they have been observed to be effective in preventing rabies (WHO 2018). We can also reduce prevention by prohibiting pets' exposure to wild animals (Morters et al., 2015).
Dogs are the most prominent source of rabies spreading to humans all across Pakistan ((Seimenis 2008)). In this regard, ensuring vaccination of the maximum canine population can help reduce disease spread in communities (Singh et al., 2017). This is hard to achieve in Pakistan because it is costly, so developing a cheaper and more effective vaccine is needed to fight this disease ((Kumarapeli and Awerbuch-Friedlander 2009)). Therefore, it is essential to vaccinate animals in high-epidemic areas (Barecha et al., 2017; Knobel et al., 2013).
On exposure to rabies, quick and timely vaccination before the onset of neurological signs can prevent the disease (Wandeler et al., 1988). As the first line of treatment, proper wound cleaning and post-exposure prophylaxis treatment can be done as first aid to prevent disease development in infected individuals (Hampson et al., 2008; Tarantola et al., 2019).
In short, implementing preventive measures and vaccinating animals can help reduce the spread and control of rabies (Briggs 2012; Manning et al., 2008).

## 26. EDUCATION AND AWARENESS PROGRAMS FOR PUBLIC HEALTH

Education and awareness programs are some of the most effective tools for public health (Balaram et al., 2016; Hasanov et al., 2018). Rabies can be significantly prevented by spreading awareness among individuals and communities (Acharya et al., 2020; Meslin and Briggs 2013). There is a crucial need to educate people in rural areas because there are many reports of children's deaths due to rabies in Pakistan (Ahmed et al., 2020). We can have seminars or community awareness programs in these areas

to prevent the disease (Khan et al., 2019). Educating people in rural areas can save several precious lives (Prakash et al., 2013; Muthunuwan et al., 2017). Educating people about vaccinating their pets can be very helpful in the control of this disease (Ahmad, Naeem et al., 2021); Dodet et al., 2008)). Arranging workshops about first aid wound management and prophylactic treatment ((Parviz et al., 2004; Farooqi and Hayat 2009). This can help reduce post-bite control for patients and reduce deaths in endemic areas (Garg and Garg 2014; Rupprecht et al., 2022). In short, raising awareness among the community can significantly help prevent and control this disease ((Weyer and Blumberg 2007)).

| Pre-exposure Vaccination | | | | |
|---|---|---|---|---|
| Animals | Age of Vaccination | Second Dose | Booster Dose | Amount of Vaccine |
| Dogs | 3 months | 21 Days | Annually | 1 ml |
| Cats | 3 months | 21 Days | Annually | 1 ml |
| Ferrets | 3 months | 21 Days | Annually | 1 ml |
| Ruminants | 3 months | 21 days | Annually | 2 ml |

| Post Exposure Vaccination | | | |
|---|---|---|---|
| Animals | Quarantine | Vaccinated | Un vaccinated |
| Dogs | 96 hrs | Quarantine 3 months | Euthanize |
| Cats | 96 hrs | Quarantine 3 months | Euthanize |
| Ferrets | 96 hrs | Quarantine 6 months | Euthanize |
| Ruminants | 96 hrs | Quarantine 6 months | Euthanize |

## 27. CONCLUSION

Rabies is a highly contagious disease transmitted mainly through bites and scratches, but there are several other ways of transmission. These ways should be considered for maintaining public health. Taking preventive measures to reduce spreading through these modes of transmission can help eradicate this disease from the world.

## REFERENCES


Adedeji AO et al., 2010. An overview of rabies-History, epidemiology, control and possible eliminatioN African Journal of Microbiology Research 4(22): 2327-2338.

Acharya K et al., 2020. One-health approach: A best possible way to control rabies. One Health 10: 100161.

Acharya K et al., 2022. *Rabies Elimination: Is It Feasible without Considering wildlife?* Journal of Tropical Medicine, 2022.

Afshar A, 1979. *A review of non-bite transmission of rabies virus infectin.* British Veterinary Journal, 135(2): 142-148.

Aguèmon CT et al., 2016. *Rabies transmission risks during peripartum–Two cases and a review of the literaturE* Vaccine, 34(15): 1752-1757.

Ahmad W et al., 2021. Exploring rabies endemicity in Pakistan: Major constraints & possible solutions. Acta tropica 221: 106011.

Ahmed T et al., 2020. Knowledge, attitude and practice (KAP) survey of canine rabies in Khyber Pakhtunkhwa and Punjab Province of PakistaN BMC public health 20(1): 1-12.

Aréchiga-Ceballos N C Almazán-Marín and Á Aguilar-Setién, 2019. *Rabies virus litter-to-mother vertical transmission, a phenomenon that could preserve the virus in wildlife reservoirs.* Gac Med Mex, 155: 228-232.

Aréchiga-Ceballos N C Almazán-Marín and Á Aguilar-Setién 2019. *Vertical transmission of the brood-mother rabies virus, a phenomenon that could keep the virus in wildlife reservoir species.* Gaceta Médica de Mexico, 155(3): 249-253.

Athingo R et al., 2020. Fighting dog-mediated rabies in Namibia—implementation of a rabies elimination program in the Northern communal areas. Tropical Medicine and Infectious Disease 5(1): 12.

Atuman YJ et al., 2014. Detection of rabies antigens in the brain tissues of jackals and mongooses and its implications on public health and conservation goals in Bauchi state Nigeria Scientific Journal Veterinary Advance 3: 42-47.

Badrane H and Tordo N, 2001. Host switching in Lyssavirus history from the Chiroptera to the Carnivora orders. Journal of Virology 75(17): 8096-8104.

Baer GM 2017. The natural history of rabies, RoutledgE

Baer GM, 1988 *Research towards rabies prevention: overview* Reviews of Infectious Diseases S576-S578.

Balachandran A and K Charlton, 1994. *Experimental rabies infection of non-nervous tissues in skunks (Mephitis mephitis) and foxes (Vulpes vulpes).* Veterinary pathology, 31(1): 93-102.

Balaram D et al., 2016. World Rabies Day–a decade of raising awareness. Tropical diseases, travel medicine and vaccines 2: 1-9.

Balsamo GA R Ratard and A Claudet, 2009. *The epidemiology of animal bite, scratch, and other potential rabies exposures, LouisianA* J La State Med Soc, 161(5): 260-265.

Bano I et al., 2017. A review of rabies disease, its transmission and treatment. Journal of Animal Health and Production 4(4): 140-144.

Banyard AC et al., 2019. *Re-evaluating the effect of Favipiravir treatment on rabies virus infection* Vaccine, 37(33): 4686-4693.

Barecha CB et al., 2017. Epidemiology and public health significance of rabies. Perspect Clin Research 5(1): 55-67.

Barnard B. et al., 1982. *Non-bite transmission of rabies in kudu (Tragelaphus strepsiceros).*

Barnard BJH, 1979. The role played by wildlife in the epizootiology of rabies in South Africa and South-West AfricA

Beeler E and K Ehnert, 2020 *Rabies in dogs and cats.* Clinical Small Animal Internal Medicine, 891-897.

Benedictis DE et al., 2022. The importance of accurate host species identification in the framework of rabies surveillance, control and elimination. Viruses 14(3): 492.

Beran G W and M Frith, 1988. *Domestic animal rabies control: an overvieW* Reviews of Infectious Diseases, 10(Supplement_4): S672-S677.

Berentsen AR et al., 2015. *Exposure to rabies in small Indian mongooses (Herpestes auropunctatus) from two regions in Puerto Rico.* Journal of Wildlife Diseases, 51(4): 896-900.

Blancou J, 1988. Epizootiology of rabies: Eurasia and AfricA Rabies 243-265.

Bonnau, E M et al., 2019. *Comparison of intra-and inter-host genetic diversity in rabies virus during experimental cross-species transmissioN* PLoS pathogens, 15(6): e1007799.

Borucki MK et al., 2013. *Ultra-deep sequencing of intra-host rabies virus populations during cross-species transmissioN* PLoS neglected tropical diseases, 7(11): e2555.

Briggs DJ, 2012. The role of vaccination in rabies prevention. Current Opinion in Virology 2(3): 309-314.

Broban A et al., 2018. Bolstering human rabies surveillance in Africa is crucial to eliminating canine-mediated rabies. PLoS Neglected Tropical Diseases 12(9): e0006367.

Bronnert J et al., 2007. Organ transplantations and rabies transmission. Journal of Travel Medicine 14(3): 177-180.

Brown CM et al., 2011. Compendium of animal rabies prevention and control. Journal of the American Veterinary Medical Association 239(5): 609-617.

Brown CM et al., 2016. Compendium of animal rabies prevention and control. Journal of the American Veterinary Medical Association, 248(5): 505-517.

Burton EC et al., 2005. Rabies encephalomyelitis: clinical, neuroradiological, and pathological findings in 4 transplant recipients. Archives of Neurology, 62(6): 873-882.

Catherine MB, *2011. Compendium of animal rabies prevention and control,* MMWR. Recommendations and reports: Morbidity and mortality weekly reporT Recommendations and reports. 60: 1-17.

CDC A, 1998. Human Rabies--Texas and New Jersey. MMWR Morb Mortal Wkly Rep 47(1): 1-5.

Chang GH et al., , 2002. *Public health impact of reemergence of rabies, New York.* Emerging Infectious Diseases 8(9): 909.

Coetzer A et al., 2018. Formation of the Asian Rabies Control Network (ARACON): A common approach towards a global good. Antiviral Research 157: 134-139.

Coleman G et al., 2004. Estimating the public health impact of rabies. Emerging infectious diseases 10(1): 140.
Constantine DG, 1962. *Rabies transmission by nonbite routE* Public health reports, 77(4): 287.
Crowcroft NS and N Thampi, 2015. *The prevention and management of rabies.* Bmj, 350.
Crozet G et al., 2020. *Evaluation of the worldwide occurrence of rabies in dogs and cats using a simple and homogenous framework for quantitative risk assessments of rabies reintroduction in disease-free areas through pet movements.* Veterinary Sciences, 7(4): 207.
Cumming DHM, 1982. A case history of the spread of rabies in an African country. South African Journal of Science 78(11): 443-447.
Davis AD et al., 2007. Effects of aerosolized rabies virus exposure on bats and mice. The Journal of Infectious Diseases 195(8): 1144-1150.
Davis et al., 2007. *The evolutionary dynamics of canid and mongoose rabies virus in Southern Africa* Archives of virology. 152.
Dean DJ WM. Evans and R.C McClure, 1963. *Pathogenesis of rabies.* Bulletin of the World Health Organization, 29(6): 803.
Derbin C and A Flamand, 1985. *Penetration and maturation of the rabies virus at the neuromuscular junction* Virus Research, 3: 16.
Dhand NK and M Ward 2012. *Anthropogenic and environmental risk factors for rabies occurrence in Bhutan* Preventive veterinary medicine, 107(1-2): 21-26.
Di Quinzio M and A McCarthy 2008. *Rabies risk among travellers.* CMAJ, 178(5): 567-567.
Dietzschold B and Koprowski H, 2004. Rabies transmission from organ transplants in the USA The Lancet 364(9435): 648-649.
Dimkić I et al., 2021. The microbiome of bat guano: for what is this knowledge important? Applied Microbiology and Biotechnology 105: 1407-1419.
Dodet B et al., 2008. Rabies awareness in eight Asian countries. Vaccine 26(50): 6344-6348.
Dürr S and M Ward, 2015. *Development of a novel rabies simulation model for application in a non-endemic environment* PLoS neglected tropical diseases, 9(6): e0003876.
Dürr S et al., 2023. The Role of Dog Ecology in Canine Rabies Prevention and Control in Asia: Lessons from Indonesia and the Oceanic RegioN One Health for Dog-mediated Rabies Elimination in Asia: A Collection of Local Experiences, CABI GB: 142-159.
Dutta TK, 2014. *Rabies: an overvieW* International Journal of Advanced Medical and Health Research,. 39.
Eidson M et al., 2005. *Rabies virus infection in a pet guinea pig and seven pet rabbits.* Journal of the American Veterinary Medical Association, 227(6): 932-5, 918.
Emerging infectious diseases, 1(4): 107.
Escobar LE et al., 2015. Ecological approaches in veterinary epidemiology: mapping the risk of bat-borne rabies using vegetation indices and night-time light satellite imagery. Veterinary Research 46: 1-10.
Everard C and J Everard, 1992. *Mongoose rabies in the Caribbean* Annals of the New York Academy of Sciences, 653: 356-366.
Everard C and J Everard, 1988. *Mongoose rabies.* Reviews of Infectious Diseases, 10: S610-S614.
Fahrion AS et al., 2016. Human rabies transmitted by dogs: current status of global data, 2015. Wkly Epidemiol Rec, 91(2), 13-20.
Fallon Jr LF and H D Schmalzried, 2008. *Rabies: an unusual route of exposure and carelessness.* Journal of Controversial Medical Claims, 15(4): 1-5.
Farooqi J and W Hayat 2009. Rabies in the Developing World: The Problem Remains. Infectious Diseases Journal of Pakistan Official Organ of Infectious Diseases Society of Pakistan 77.
Fitzpatrick JL et al., 2014. *Rabies in rodents and lagomorphs in the United States, 1995–2010.* Journal of the American Veterinary Medical Association, 245(3): 333-337.
Garg S R and S. R. Garg 2014. Rabies Prevention and Control. Rabies in Man and Animals: 89-123.
Gilcreas FW, 1966. Standard methods for the examination of water and wastewater. American Journal of Public Health and the Nations Health 56(3): 387-388.
Goor S, 1949. Rabies in Animals in this Country and its Control. Harefuah 37(6): 76-77.

Gordon E et al., 2004. *Temporal dynamics of rabies in a wildlife host and the risk of cross-species transmissioN* Epidemiology & Infection, 132(3): 515-524.

Hampson K et al., 2015. Estimating the global burden of endemic canine rabies. PLoS neglected tropical diseases 9(4): e0003709.

Hankins DG and J.A Rosekrans, 2004. *Overview, prevention, and treatment of rabies*. in *Mayo Clinic Proceedings*. Elsevier.

Hasanov E et al., 2018. Assessing the impact of public education on a preventable zoonotic disease: rabies. Epidemiology & Infection 146(2): 227-235.

Have et al., 2008. *Risk of rabies introduction by non-commercial movement of pets.* Developments in biologicals, 131: 177-186.

Held JR et al., 1967. Rabies in man and animals in the United States, 1946-65. Public Health Reports 82(11): 1009.

Hikufe EH et al., 2019. Ecology and epidemiology of rabies in humans, domestic animals and wildlife in Namibia, 2011-2017. PLoS Neglected Tropical Diseases 13(4): e0007355.

Holme, E C et al., 2002. *Genetic constraints and the adaptive evolution of rabies virus in naturE* Virology, 292(2): 247-257.

Horta MA et al., 2022. *From dogs to bats: Concerns regarding vampire bat-borne rabies in Brazil.* PLOS Neglected Tropical Diseases, 16(3): e0010160.

Iehl C et al., 2008. *Delivery and follow-up of a healthy newborn from a mother with clinical rabies.* Journal of Clinical Virology, 42(1): 82-85.

Jackson AC, 2002. *Rabies pathogenesis.* Journal of neurovirology, 8(4): 267-269.

Kanda K et al., 2022. A Regional Analysis of the Progress of Current Dog-Mediated Rabies Control and PreventioN Pathogens 11(10): 1130.

Kaplan C, 1977. *Rabies: the facts*. Oxford University Press, Walton Street, Oxford OX2 6D

Kessels JA et al., 2017. *Pre-exposure rabies prophylaxis: a systematic revieW* Bulletin of the world Health Organization, 95(3): 210.

Khan A et al., 2019. Knowledge, attitude & practices (KAPs) regarding rabies endemicity among the community members, PakistaN Acta tropica 200: 105156.

Knobel D L et al., 2005. Re-evaluating the burden of rabies in Africa and AsiA Bulletin of the World health Organization 83: 360-368.

Krebs JW et al., 2003. *Rabies among infrequently reported mammalian carnivores in the United States, 1960–2000.* Journal of Wildlife Diseases, 39(2): 253-261.

Kumarapeli V and T Awerbuch-Friedlander 2009. Human rabies focusing on dog ecology—A challenge to public health in Sri LankA Acta tropica 112(1): 33-37.

Lapiz SMD et al., 2012. Implementation of an intersectoral program to eliminate human and canine rabies: the Bohol Rabies Prevention and Elimination ProjecT PLoS Neglected Tropical Diseases 6(12): e1891.

Layan M et al., 2021. *Mathematical modelling and phylodynamics for the study of dog rabies dynamics and control: A scoping revieW* PLOS Neglected Tropical Diseases, 15(5): e0009449.

Lembo T, 2012. The blueprint for rabies prevention and control: a novel operational toolkit for rabies eliminatioN PLoS Neglected Tropical Diseases 6(2): e1388.

Li L et al., 2010. Bat guano virome: predominance of dietary viruses from insects and plants plus novel mammalian viruses. Journal of Virology 84(14): 6955-6965.

Lodmell D.L. D.E Dimcheff, and L.C Ewalt, 2006. *Viral RNA in the bloodstream suggests viremia occurs in clinically ill rabies-infected mice* Virus research, 116(1-2): 114-118.

Loveridge AJ et al., 2001. Seasonality in spatial organization and dispersal of sympatric jackals (Canis mesomelas and C adustus): implications for rabies managemenT Journal of Zoology 253(1): 101-111.

Macdonald DW, 1980. *Rabies and wildlifE A biologist's perspectivE* : Published for Earth Resources Research Limited by Oxford University Press ….

Manning S E et al., 2008. Human rabies prevention—United States, 2008: recommendations of the advisory committee on immunization practices. MMWR Recomm Rep 57(RR-3): 1-28.

Maurer W and Guber SE, 2001. Rabies vaccination of foxes: vaccine residues as potential biohazardous wastE The Pediatric Infectious Disease Journal 20(12): 1184-1185.

McKenzie AA, 1993. Biology of the black-backed jackal Canis mesomelas with reference to rabies. The Onderstepoort Journal of Veterinary Research 60(4):367-71.

Meslin F X and D Briggs 2013. Eliminating canine rabies, the principal source of human infection: what will it take? Antiviral research 98(2): 291-296.

Messenger SL et al., 2002. Emerging epidemiology of bat-associated cryptic cases of rabies in humans in the United States. Clinical Infectious Diseases 35(6): 738-747.

Mollentze N et al., 2020. *Virulence mismatches in index hosts shape the outcomes of cross-species transmissioN* Proceedings of the National Academy of Sciences, 117(46): 28859-28866.

Mørk T and Prestrud, 2004. *Arctic rabies–a revieW* Acta Veterinaria Scandinavica, 45: 1-9.

Morter, M. K. et al., 2015. Effective vaccination against rabies in puppies in rabies endemic regions. Veterinary Record 177(6): 150-150.

Muthunuwan . et al., 2017. Preliminary survey on knowledge, attitudes and practices regarding rabies.

National Association of State Public Health Veterinarians. Compendium of Animal Rabies Prevention and Control, 2005. MMWR. Recommendations and reports: Morbidity and mortality weekly reporT Recommendations and reports 18;54(RR-3):1-8.

Nel L et al., 2005. *Mongoose rabies in southern Africa: a re-evaluation based on molecular epidemiology.* Virus research, 109(2): 165-173.

Nel LH and Markotter W, 2007. Lyssaviruses. Critical Reviews in Microbiology 33(4): 301-324.

Nel LH and Rupprecht CE, 2007. Emergence of lyssaviruses in the Old World: the case of AfricA Wildlife and emerging zoonotic diseases: the biology, circumstances, and consequences of cross-species transmission 161-193.

Nellis DW and C Everard, 1983. *The biology of the mongoose in the CaribbeaN* Studies on the fauna of Curacao and other Caribbean Islands, 64(1): 1-162.

Niezgoda et al., 2003. Animal rabies. Rabies 163-218.

Nigg AJ and Walker PL, 2009. Overview, prevention, and treatment of rabies. Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy 29(10): 1182-1195.

Otrzanowska-poplewska N et al., 1969. Immunology of experimental rabies in rats; influence of the age factor. Acta Microbiologica Polonica, Ser. A 1(1): 55-59.

Parize et al., 2021. *Systematic booster after rabies pre-exposure prophylaxis to alleviate rabies antibody monitoring in individuals at risk of occupational exposurE* Vaccines, 9(4): 309.

Parviz S et al., 2004. Rabies deaths in Pakistan: results of ineffective post-exposure treatmenT International journal of infectious diseases 8(6): 346-352.

Pemberton N et al., 2007. Rabies at Bay:'The Dog Days', 1831–1863. Mad Dogs and Englishmen: Rabies in Britain 1830–2000: 40-68.

Pinto RM et al., 1994. Structures associated with the expression of rabies virus structural genes in insect cells. Virus Research 31(1): 139-145.

Prakash M et al., 2013. Rabies menace and control–An insight into knowledge, attitude and practices. Medical journal armed forces India 69(1): 57-60.

Qu ZY et al., 2016. Survival of a newborn from a pregnant woman with rabies infectioN Journal of Venomous Animals and Toxins including Tropical Diseases 22: 1-3.

Rattanavipapong W et al., 2019. The impact of transmission dynamics of rabies control: Systematic revieW Vaccine 37: A154-A165.

Rehman S u et al., 2023. Real-Time Surveillance of Dog Bite Incidence in Islamabad: A Cross-Sectional Study from December 2019 to July 2020. Zoonotic Diseases 3(3): 179-187.

Robertson K et al., 2011. Rabies-Related Knowledge and Practices among Persons at Risk of BaT PLoS Neglected Tropical Diseases 5(6): e1054.

Roine RO et al., 1988. *Fatal encephalitis caused by a bat-borne rabies-related virus: clinical findings.* Brain, 111(6): 1505-1516.

Roszkowski J et al., 1972. The possibility of transplacental penetration of rabies from infected ewe to its foetus. Bulletin of the Veterinary Institute in Puławy 16(3-4).

Rupprecht C E et al., 2022. Rabies in the Tropics. Current Tropical Medicine Reports 9(1): 28-39.

Rupprecht C et al., 2017. *Lyssaviruses and rabies: current conundrums, concerns, contradictions and controversies.* F1000Research, 6.

Rupprecht CE et al., 1995. *The ascension of wildlife rabies: a cause for public health concern or intervention?* Rupprecht C et al., 2008. *Can rabies be eradicated?* Developments in biologicals, 131: 95-121.

Rupprecht CE et al., 2006. *Current and future trends in the prevention, treatment and control of rabies.* Expert review of anti-infective therapy, 4(6): 1021-1038.

Rupprecht CE et al., 2016. Current status and development of vaccines and other biologics for human rabies preventioN Expert Review of Vaccines 15(6): 731-749.

Rupprecht et al., 2002. *Rabies re-examined.* The Lancet infectious diseases, 2(6): 327-343.

Scheffer KC et al., 2014. Hematophagous bats as reservoirs of rabies. Revista peruana de medicina experimental y salud pública 31(2): 302-309.

Scheidegger S, 1953. Experimental Viral Infections in the Embryo and Fetus: Preliminary Notes on Pathologic Findings With Viruses of Psittacosis, Ectromelia, and Rabies. The American Journal of Pathology 29(2): 185.

Seetahal JF et al., 2018. *Rabies in the Caribbean: A situational analysis and historic revieW* Tropical medicine and infectious disease, 3(3): 89.

Seimenis A 2008. The rabies situation in the Middle EasT Developments in biologicals 131: 43-53.

Setyowati TIB and B Machmud, 2018. *A Study of Correlation Between Agent, Host, Environment and Vaccine Factors With Prevalence of Rabies in Indonesia 2015.* Indonesian Journal of Tropical and Infectious Disease, 7(1): 1-5.

Shankaraiah R H, et al., (2015). Compliance to anti-rabies vaccination in post-exposure prophylaxis. Indian Journal of Public Health 59(1): 58-60.

Shope, RE, 1982. Rabies-related viruses. The Yale journal of Biology and Medicine 55(3-4):271.

Singer A and G.C Smith, , 2012. *Emergency rabies control in a community of two high-density hosts.* BMC Veterinary Research8(1): 1-15.

Singh R et al., 2017. *Rabies–epidemiology, pathogenesis, public health concerns and advances in diagnosis and control: a comprehensive review.* Veterinary Quarterly. 37(1): 212-251.

Singh R et al., 2017. Rabies–epidemiology, pathogenesis, public health concerns and advances in diagnosis and control: a comprehensive revieW Veterinary Quarterly 37(1): 212-251.

Smith JS et al., 1993. Rabies in wild and domestic carnivores of Africa: epidemiological and historical associations determined by limited sequence analysis. The Onderstepoort Journal of Veterinary Research 60(4): 307-14.

Srinivasan A et al., 2005. Transmission of rabies virus from an organ donor to four transplant recipients. New England Journal of Medicine 352(11): 1103-1111.

Sterner RT and GC Smith 2006. *Modelling wildlife rabies: transmission, economics, and conservatioN* Biological conservation, 131(2): 163-179.

Strauch D and Ballarini G, 1994. Hygienic Aspects of the Production and Agricultural Use of Animal Wastes. Journal of Veterinary Medicine, Series B 41(1-10): 176-228.

Swamy GK and R Heine, 2015. *Vaccinations for pregnant women* Obstetrics and gynecology, 125(1): 212.

Swanepoel R et al., 1993. Rabies in southern AfricA Onderstepoort Journal of Veterinary Research 60: 325-325.

Tarantola A et al., 2019. Evaluating new rabies post-exposure prophylaxis (PEP) regimens or vaccines. Vaccine 37: A88-A93.

Tarrant S et al., 2020. *Zoonotic disease exposure risk and rabies vaccination among wildlife professionals.* EcoHealth, 17: 74-83.

Taylor L H and L H Nel 2015. Global epidemiology of canine rabies: past, present, and future prospects. Veterinary Medicine: Research and Reports: 361-371.

Thomas I. et al., 1990. *Primary multiplication site of the vaccinia-rabies glycoprotein recombinant virus administered to foxes by the oral route* Journal of general virology, 71(1): 37-42.

Tierkel E S et al., 1952. *Mongoose rabies in Puerto Rico.* Public Health Reports, 67(3): 274.

Tinline R 1988 *Persistence of rabies in wildlifE* Rabies, 301-322.

Van Zyl N et al., 2010. *Evolutionary history of African mongoose rabies.* Virus research, 150(1-2): 93-102.

Vercauteren KC et al., 2012. Rabies in North America: A model of the One Health approacH USDA Wildlife Services - Staff Publications. 1202

Wallace RM et al., 2014. *Right place, wrong species: a 20-year review of rabies virus cross species transmission among terrestrial mammals in the United States.* PloS one, 9(10): e107539.

Wandeler A et al., 1988. Dog ecology and dog rabies control. Reviews of infectious diseases 10(Supplement4): S684-S688.

Wandeler AL et al., 1993. The ecology of dogs and canine rabies: a selective revieW Revue scientifique et technique (International Office of Epizootics) 12(1): 51-71.

Wang X and Y Jin, 2009. *Progress in research on therapeutic monoclonal antibody against rabies virus.* Chinese Journal of Biologicals, 22(10): 1032-1035.

Warrell D and M Warrell, 1988. *Human rabies and its prevention: an overview* Reviews of infectious diseases, 10(Supplement_4): S726-S731.

Weyer J and L Blumberg 2007. Rabies: Challenge of diagnosis in resource poor countries. Infectious Diseases Journal of Pakistan 16(3): 86-88

WHO, 2018. *Rabies vaccines: WHO position paper, April 2018–Recommendations.* Vaccine, 36(37): 5500-5503.

WHO, 2018. World Health Organization expert consultation on rabies: third reporT World Health Organization 1012.

WHO, 2018. World Health Organization *expert consultation on rabies: third reporT*. WHO, 1012.

Winkler W 2017. *Rodent rabies*, in *The natural history of rabies*. RoutledgE 405-410.

Winkler WG and K Bogel 1992. *Control of rabies in wildlifE* Scientific American, 266(6): 86-93.

WINKLER WG et al., 1972. *An outbreak of non-bite transmitted rabies in a laboratory animal colony.* American journal of epidemiology, 95(3): 267-277.

Winkler WG et al., 1973. Airborne rabies transmission in a laboratory worker. Jama 226(10): 1219-1221.

Wright N et al., 2021. The role of waste management in control of rabies: A neglected issuE Viruses 13(2): 225.

Wunner W H and KK Conzelmann, 2013 *Rabies virus*, in *Rabies* Elsevier. 17-60.

Wunner WH and Briggs DJ, 2010. Rabies in the 21st century. PLoS Neglected Tropical Diseases 4(3): e591.

Wyatt J 2007. *Rabies—update on a global diseasE* The Pediatric infectious disease journal, 26(4): 351-352.

Zulu GC et al., 2009. Molecular epidemiology of rabies: focus on domestic dogs (Canis familiaris) and black-backed jackals (Canis mesomelas) from northern South AfricA Virus Research 140 (1-2): 71-78.