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BAT-BORNE ZOONOTIC VIRUS: A LITERATURE REVIEW

Zoonosis virus yang bersumber dari kelelawar: Literatur review

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Abstract

Bats are flying mammals that are known to be reservoirs of many diseases, especially viruses. Several dangerous and zoonotic viruses are transmitted by bats. This paper aims to provide a systematic summary of zoonotic viruses that can be transmitted by bats. This paper uses the PRISMA method. The review showed that some important viral diseases transmitted to humans by bats are Ebola, Nipah, SARS-CoV, MERS-CoV, Hendra and Rabies. The case fatality rate caused by these diseases is very high to above 50% of the sufferers. It can be concluded that vigilance must continue and be increased against bats that can threaten human and animal health at any time. Understanding and judiciously managing interactions between humans and bats is critical to the prevention of zoonotic diseases.

Keywords: bats, zoonoses, vectors

Abstrak

Kelelawar adalah mamalia terbang yang diketahuo sebagai reservoir banyak penyakit khususnya virus. Beberapa virus berbahaya dan termasuk zoonosis ditularkan oleh kelelawar. Penulisan ini bertujuan untuk memberikan ringkasan sistematis terkait virus zoonosis yang dapat ditularkan oleh kelelawar. Penulisan ini menggunakan metode PRISMA. Hasil review menunjukkan bahwa beberapa penyakit virus penting yang ditularkan ke manusia melalui kelelawar adalah Ebola, Nipah, SARS-CoV, MERS-CoV, Hendra dan Rabies. Case fatality rate yang ditimbulkan oleh penyakit tersebut sangat tinggi hingga diatas 50% dari penderitanya. Dapat disimpulkan bahwa kewaspadaan harus terus dan ditingkatkan terhadap kelelawar yang setiap saat dapat mengancam kesehtan manusia maupun hewan. Upaya untuk memahami dan mengelola interaksi antara manusia dan kelelawar secara bijaksana sangat penting dalam upaya pencegahan penyakit zoonosis.

Kata kunci: kelelawar, zoonosis, vektor

INTRODUCTION

According to Hayman et al., (2013), bats are the only flying mammals that have diversified lives that include long-distance flying, densely clumped social systems, extended life spans, and high metabolic activity. These creatures serve as reservoirs for a variety of newly and re-emerging zoonotic viral diseases, including the SARSCoV-2 pandemic that is currently rife

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(Mackenzie & Smith, 2020). When viruses develop the capacity to infect and disseminate across new host species, it is possible for them to transfer from bats to other mammals (Flanagan et al., 2012). Generally speaking, pathogen-host-environment variables are crucial in the viral species' transition from bats to other mammals, including humans. Bat-associated viruses are becoming more prevalent in human wildlife, most likely as a result of ecological shifts. This is mostly because to human activity and actions like deforestation, which alter the environment and natural equilibrium. Consequently, there are more bat-human encounters and chances for viral transmission to people (McMichael, 2004).

Host jumping events can occur directly from bats to humans or through suitable intermediate hosts, such as livestock, pets, or other wildlife (Allocati et al., 2016). Four bat-borne zoonotic viruses Ebola, Nipah, Middle East respiratory syndrome coronavirus (MERS-CoV), and severe acute respiratory syndrome coronavirus (SARS-CoV) that have caused multiple outbreaks and significant deaths globally have caught scientists' attention in recent decades. In the past ten years, the Nipah virus species has jumped from bats to humans through pigs (Nikolay et al., 2019). After living in bats for an undisclosed amount of time, MERS-CoV (2012) and SARS-CoV (2002) exploited camels and coconut civets as intermediary hosts to transcend species barriers, finally contacted humans, and eventually caused a pandemic outburst (Raoult, Zumla, Locatelli, Ippolito, & Kroemer, 2020). The recent Ebola outbreak in West Africa exemplifies the need to understand human behavior and how they may further interact with animal reservoirs and associated pathogens (Olival et al., 2020). Overall, the case fatality rate for Ebola was around 50%, while for Nipah virus disease it was 40%-75%, MERS was 35%, and SARS was 11% (Khan et al., 2022).

Other important viral diseases are Rabies and Hendra virus. Rabies is transmitted through the bite of an infected bat, which if left untreated can cause death in humans (WHO, 2021). Although human rabies cases caused by bats are relatively rare, bats are a major cause of rabies in animals, which can then be transmitted to humans through bites or contact with the saliva of infected animals (Kunkel et al., 2022). Hendra and Nipah viruses, which are from the Henipa virus family, can be transmitted from bats to humans through contact with the secretions or bodily fluids of infected animals. Both viruses can cause severe illness in humans, including pneumonia and encephalitis, with high mortality rates (Gazal et al., 2022).

The main focuses of international efforts to combat emerging infectious diseases include drug and vaccine development, outbreak control, and quarantine (Pike et al., 2014). Understanding human behavior in relation to wildlife contact and the importance of public knowledge of wildlife-derived diseases is often overlooked (Bird & Mazet, 2018). A deeper examination of human factors may help us comprehend the extent to which people participate in high-risk behaviors. Predicting future pandemics also requires an understanding of how the virus is evolving against human physiological systems. Human fatality instances are not the only compelling argument for taking the necessary action to contain the outbreak (Narayanan, 2020).

To reduce the risk of disease transmission from bats to humans, preventive measures need to be implemented. These include public education on the dangers associated with direct contact with bats, strict supervision of the wild animal trade, and efforts to conserve bats' natural habitats. With a better understanding of the role of bats as disease vectors, we can take proactive measures to protect human health and maintain the delicate balance of ecosystems of which bats are an integral part. In exploring the beauty of the night, it is important to also understand and respect the role played by other creatures, including bats, to prevent hidden threats that humans may face.

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RESEARCH METHOD

Research Ethics Statement

This research is a literature study which does not use animals directly in the research process.

Literature Study

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) were used to conduct a systematic review in four steps: database search, evaluation of relevant articles, data extraction, and resume. A literature search on bat-borne zoonotic diseases was conducted through PubMed, Scopus, and Web of Science, and Google Scholar. The search included all articles on bat-borne zoonotic viral diseases.

Data analysis

Data from the study were analyzed descriptively.

RESULTS AND DISCUSSION

Bats

Bats are flying mammals that are widely found around the world. While bats play an important role in ecosystems as insect eaters, pollinators and fruit eaters, they can also be carriers of dangerous diseases to humans. As natural reservoirs of various viruses, bacteria and other pathogens, bats have been known to cause a number of deadly zoonotic diseases. In addition to viruses, bats can also be vectors for a variety of other pathogens. For example, the coronavirus, as seen in the COVID-19 pandemic, is believed to have an animal origin, and bats have been identified as one of the natural reservoirs of the coronavirus that affects humans (Hoffmaster et al., 2016).

It is important to note that while bats can be carriers of potentially deadly diseases, they also play an important role in maintaining ecosystem balance. Efforts to understand and sensibly manage interactions between humans and bats are crucial in zoonotic disease prevention efforts. This includes limiting direct contact with wild bats, protecting livestock from possible bat exposure, and monitoring and furthering research on bat-transported viruses. By understanding the risks associated with bat-borne diseases, we can take the necessary preventive measures to protect human health and maintain the balance of ecosystems that are essential to our lives (Karesh et al., 2012).

Bats as Disease Vectors

Bats, with their inherent grace and mystery, have long been associated with various aspects of human life, both in popular culture and science. However, one aspect that is often overlooked is their role as disease vectors that can pose a risk to human health. As nocturnal animals distributed around the world, bats play an important role in ecosystems. However, some bat species are also known to be carriers and spreaders of various diseases, including deadly viruses such as Ebola, Marburg, and Rabies (Han et al., 2015).

One of the main reasons bats can become disease vectors is because of their unique immune system. Although bats' immune systems allow them to survive deadly viruses, bats can become carriers of these viruses without showing any obvious symptoms. This allows the viruses to circulate within the bat population and, at the same time, be transmitted to humans through direct contact or through intermediate vectors such as mosquitoes or ticks (Serra-Cobo & López-Roig, 2017).

One well-known example is the Ebola virus, which is believed to have originated from fruit bats in Africa. While the fruit bats themselves may not show symptoms of disease, human

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contact with their saliva or feces can spread the virus to humans and other animals, which can then result in a deadly outbreak (Lacroix et al., 2021). In addition, humans' increasing habit of destroying bats' natural habitats can also increase the risk of disease transmission. Shrinking natural habitats can force bats to seek new shelter and food sources, often approaching human settlements and increasing the chances of human-bat contact (Chomel et al., 2014).

Uniqueness of the Bat Immune System

Bats possess a unique immune system that helps them avoid harmful substances and a diverse range of viruses that can affect their physiological system. These unusual flying mammals have developed defense mechanisms against lethal pathogenic microbes and exhibit a surprising capacity to suppress the inflammatory responses elicited by infections like MERS and SARS. In order to decrease inflammation and enhance immunological protection against viruses, bats have evolved a physiological technique that involves the release of interferon-alpha, which triggers a quick immune response and alerts other cells throughout the body (Subudhi et al., 2019). By accelerating the metabolic rate, these animals can generate extreme body heat, which reduces the infectivity of viruses within their bodies. In general, the vigorous physical activity gained through flying and high metabolic pathways help bats cope with tissue damage due to the accumulation of reactive molecules, especially free radicals. In addition, to enable flight, the physiological system of bats has evolved to efficiently and effectively clear damaging and highly reactive molecules. This phenomenon has been attributed to their extremely long lifespan and role as carriers of various deadly viruses. (Khan et al., 2022; O'Shea et al., 2014).

Some of the mechanisms that aid bats in their disease resistance include; Virus tolerance: Some studies suggest that bats may have the ability to tolerate certain viruses without showing severe disease symptoms or even without being infected at all. This could be related to the bat's immune system being more efficient at coping with viral infections; High immune system activity: Bats have highly active and efficient immune systems. They can quickly detect and respond to viral infections by producing antibodies and other immune cells; Tolerance to inflammation: An overactive inflammatory response can be a serious problem in fighting infection, as it can lead to tissue damage. Bats are believed to have a higher level of tolerance to inflammation, which helps them not to experience the serious negative impact of the immune response to viral infections; Ability to maintain a balance between virus and host: As natural reservoirs for various viruses, bats may have developed strategies to maintain a balance between the virus and their own immune system. This could include careful regulation of the expression of genes involved in the immune response (Brook & Dobson, 2015; Irving et al., 2021). Specialized biological characteristics: There are several unique biological characteristics of bats that may contribute to their resistance to disease, such as high metabolism, long life span, and ability to fly (Wang et al., 2011).

Ebola

The Ebola virus has captured the world's attention as a frightening and deadly disease since it was first identified in 1976 in the Democratic Republic of Congo and Sudan. Ebola is a disease caused by the Ebola virus, which can cause hemorrhagic fever, muscle pain, headaches, nausea, vomiting, and in more severe cases, can cause severe internal and external bleeding. The virus can cause very serious and often fatal illness in humans and other primates. Transmission of the Ebola virus occurs through direct contact with blood or body fluids from an infected person or an infected animal, such as an infected bat or primate. The disease is not contagious and is not airborne like the common cold (Osterholm et al., 2015; Subissi et al., 2018).

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The Ebola outbreak that occurred in West Africa in 2014-2016 was one of the largest outbreaks in history. Prevention of transmission involves measures such as isolation of patients, use of personal protective equipment, and restriction of direct contact with infected individuals. Although a vaccine has been developed for Ebola, control and management of the outbreak remains a major challenge, especially in areas with limited health infrastructure. Therefore, early detection, rapid isolation and proper treatment are crucial in controlling the spread of the disease (Subissi et al., 2018).

Case fatality rate (CFR) of Ebola virus disease reaches 65.4% (Rugarabamu et al., 2020), and WHO also reports that the CFR is around 50% in infected areas. Different reports identify case fatality rates of 40% to 75% for this viral infection (Arunkumar et al., 2019). While there has been extensive research into the origin and spread of this virus, there is still much to learn, particularly about the role of bats as natural hosts and how this virus can be transmitted to humans.

The role of bats in Ebola virus transmission

Research has shown that bats, especially certain species such as fruit bats, are natural hosts of the Ebola virus. Bats can carry the virus without showing symptoms of disease and act as natural reservoirs of the virus in the wild. In their natural habitat, fruit bats often eat infected fruits or interact with other infected animals, allowing the virus to spread among bat populations (Han et al., 2015).

Ebola virus transmission to humans

Although bats are the natural hosts of the Ebola virus, its transmission to humans is indirect. Human contact with bats or animal products contaminated with Ebola virus is one of the main ways of transmission. For example, consumption of infected bat meat or direct contact with the blood or secretions of an infected animal can lead to humans becoming infected (Rewar & Mirdha, 2014).

In addition, humans can also be infected through direct contact with individuals who are already infected with Ebola. This occurs through contact with blood, bodily fluids, or objects contaminated by the bodily fluids of an Ebola patient. This often occurs in healthcare environments where proper precautions may not always be followed. Understanding the role of bats in Ebola virus transmission has important implications for public health and disease prevention efforts (Vetter et al., 2016).

Ebola Prevention and Control

Ebola prevention and control measures include; Public Education: Providing accurate information to the public about the sources and modes of transmission of Ebola, including the importance of avoiding contact with bats or potentially contaminated animal products. Monitoring and Control: Keeping an eye on bat populations as well as other animals potentially infected with the Ebola virus to reduce the risk of transmission to humans. Safe Health Care: Ensure safe healthcare practices and strict precautions in hospitals and other healthcare facilities to avoid transmission from Ebola-infected individuals. Vaccine and Treatment Development: Continue to conduct research to develop effective vaccines and therapies against the Ebola virus (Kourtis et al., 2015).

Nipah

Nipah disease is a zoonotic disease caused by Nipah virus (NiV). The virus is a pathogenic agent belonging to the family Paramyxoviridae, genus Henipavirus (Banerjee et al., 2019). One important aspect of the epidemiology of Nipah disease is the role of bats as natural reservoirs of the virus. Nipah disease is a complex global health challenge, and understanding the role of

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bats in its transmission is key to developing effective prevention strategies and reducing the risk of its spread to humans (Han et al., 2015).

Many studies have shown that fruit bats, especially species of the genus Pteropus, also known as ‘big fruit bats’, are natural reservoirs of Nipah virus. These bats are fruit-eaters that are widespread in tropical regions of Asia Pacific, including in countries such as Malaysia, Bangladesh, India and neighboring countries (Clayton et al., 2012). These fruit bats can carry the Nipah virus without showing significant symptoms of disease. They consume fruits contaminated with Nipah virus, and then transmit the virus through saliva, feces or other bodily fluids to humans or other animals (Singh et al., 2019).

Transmission of Nipah to Humans

Transmission of the Nipah virus from bats to humans usually occurs through direct contact with the bodily fluids of infected bats, or through consumption of fruits contaminated by the saliva or urine of infected bats (Luby et al., 2009). In addition, there is also evidence that contact with infected intermediate animals, such as pigs in the 1999 outbreak in Malaysia, can also lead to human transmission of Nipah virus (Clayton et al., 2012).

The case fatality rate of Nipah disease ranges from 50%-75% (Arunkumar et al., 2019). The effectiveness of the clinical management and epidemiological surveillance systems may determine the amount of death in humans (Lam & Chua, 2002). One million pigs were culled in order to restrict the outbreak because 105 of the 265 human cases were deadly (Ang et al., 2018). Subsequently, outbreaks were documented in Bangladesh, where they occurred annually. Periodically, outbreaks were also noted in India (Epstein et al., 2020; McKee et al., 2022). Given that the virus has been discovered in its natural reservoir host (the Pteropus bat species) in a number of nations, including Ghana, Madagascar, the Philippines, Indonesia, and Cambodia, other areas may be susceptible to infection (Olival et al., 2020)

Nipah Prevention and Control

Prevention of Nipah disease involves several steps; Reducing Contact with Bats: Efforts should be made to reduce direct contact with bats, including avoiding places where they congregate or reducing their access to human settlements. Animal Health Surveillance: It is important to monitor animal health, especially animals that may be intermediaries or intermediate hosts, such as pigs. Prevention of animal-to-human transmission should also be a priority. Community Education: Education about the risk of Nipah disease transmission and ways to reduce that risk should be delivered to the community at large. Further Research: Further research on Nipah virus, including the role of bats in the transmission cycle, is important to develop more effective prevention and control strategies. (Banerjee et al., 2019).

SARS-CoV

Since the early 2000s, viruses from the Coronaviridae family have been at the center of global attention due to their ability to cause serious disease in humans. One of the most well-known viruses is the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), which was first detected in Guangdong Province, China, in November 2002. The virus then spread rapidly to countries in Asia, North America and Europe, causing global panic. The disease caused by this virus, known as SARS, has a high mortality rate, especially in vulnerable groups such as the elderly and individuals with weakened immune systems (Xu et al., 2004).

The Role of Bats in the SARS-CoV Outbreak: Research and Implications

In the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) outbreak of 2002-2003, bats were identified as a natural reservoir of the virus. Scientific research shows that viruses

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similar to SARS-CoV have been found in bats in various parts of the world, including in China, where the SARS outbreak first appeared. Bats are natural reservoirs for many viruses, including some coronaviruses. Due to their unique living habits and immune systems, bats can act as hosts for these viruses without showing severe symptoms of illness. This allows these viruses to circulate among bat populations without being recognized (Wang et al., 2006).

Transmission to Humans

Although bats are natural reservoirs for SARS-CoV, transmission of the virus to humans usually occurs through animal intermediaries. In the case of the 2002-2003 SARS outbreak, research suggested that civets were the most likely intermediary in spreading the virus to humans, especially in China's live animal markets (Wang & Eaton, 2007).

Symptoms and Spread

The main symptoms of SARS include high fever, coughing, shortness of breath and pneumonia. Transmission is mainly through direct contact between individuals, especially through respiratory droplets produced when someone coughs or sneezes. The SARS outbreak in 2002-2003 ended in July 2003 after strict control measures were put in place by various countries (Hui et al., 2003). Although the SARS outbreak in 2002-2003 has been contained, the virus remains a potential threat. Several isolated cases of SARS-CoV infection have been reported after the main outbreak, mostly related to laboratory research where the virus was isolated or stored. This suggests that the potential for SARS-CoV re-spreading remains.

In June 2003, the SARS pandemic was first noted. An 11% fatality rate was linked to the occurrence in 8422 cases (Morens & Fauci, 2020). Although it is believed to have been eliminated, the virus will probably resurface soon and continue to infect animals. Of the seven coronaviruses, the ones that can cause severe respiratory syndrome are SARS-CoV-2, SARS-CoV, and MERS-CoV, which have fatality rates of roughly 6.76%, 9.6%, and 35.5%, respectively. According to whole-genome scans, SARS-CoV-2 and SARS-CoV share 79% and 50% of their similarities, respectively (Hu et al., 2020).

Prevention and Protection

To prevent the spread of SARS-CoV and the illness it causes, strict preventive measures need to be implemented. These include good hygiene practices such as regular hand washing, using a face mask when sick, maintaining physical distance from sick people, and avoiding close contact with animals that may be reservoirs of the virus. Since the SARS outbreak in 2002-2003, intensive research has been conducted to understand the virus better and develop an effective vaccine. However, these efforts are faced with a number of challenges, including the virus's ability to mutate and multiply rapidly (van der Valk & In ’t Veen, 2021).

The finding that bats are natural reservoirs of SARS-CoV has important implications for public health and future prevention efforts (Li et al., 2005). Prevention of zoonotic diseases such as SARS-CoV involves a deep understanding of the interactions between humans, intermediate animals, and natural reservoirs of the virus (Kamel et al., 2023). Preventive measures include close monitoring and surveillance of live animal markets, where interactions between humans and animals can increase the risk of virus transmission. In addition, continued research on bats and the viruses they carry is needed to identify potential new threats and develop more effective prevention strategies (Neo & Tan, 2017).

Although the SARS outbreak in 2002-2003 has passed, the presence of SARS-CoV is still a global concern. Continued efforts in research, vaccine development and implementation of preventive measures are needed to address the potential threat of this virus in the future. SARS-

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CoV is a reminder of the importance of global vigilance and international co-operation in dealing with serious public health threats (Cascella et al., 2024).

MERS-CoV

Middle East Respiratory Disease Middle East Respiratory Syndrome (MERS) is a severe respiratory disease that is caused by the coronavirus (MERS-CoV). Due to its possibility for cancer, MERS-CoV has caused concern since it was discovered in 2012. In Saudi Arabia, MERS-CoV was initially discovered in 2012 when several individuals started exhibiting symptoms of a serious respiratory disease. Through international travel, the virus subsequently spread to several Middle Eastern nations as well as to other parts of the world (WHO, 2022).

Bats in MERS-CoV cases

Direct proof of bats' involvement in the transmission of MERS-CoV is still lacking, despite the fact that bats have been found to be natural reservoirs for a number of coronavirus types, including viruses related to MERS-CoV (Han et al., 2015). According to scientific studies, MERS-CoV-like viruses have been discovered in bats, especially in parts of the Middle East (Omrani et al., 2015). Nevertheless, there is no proof that bats actively contribute to the virus's spread to people. To fully comprehend the part that bats play in the spread of MERS-CoV, more investigation is required. Since MERS-CoV is a zoonotic virus, it most likely spreads from animals to people via middlemen. In some cases, camels have been identified as the main intermediary in the transmission of this virus to humans. Direct contact with infected camels or animal products derived from infected camels may increase the risk of MERS-CoV transmission (Omrani et al., 2015).

Symptoms of MERS can vary from mild to severe, including fever, cough, breathing difficulties and pneumonia. Some cases may also progress to more serious illnesses, such as kidney failure or respiratory failure. Transmission of MERS-CoV mainly occurs through direct contact with an infected person, although animal-to-human transmission has also been reported, particularly from camels (Aleebrahim-Dehkordi et al., 2021). Although the MERS-CoV outbreak was not as large as the SARS outbreak in 2002-2003, the virus remains a threat due to its high mortality rate (around 35%) and its ability to cause extensive localised outbreaks. Since 2012, there have been numerous small and sporadic outbreaks of MERS-CoV in several countries in the Middle East (Omrani et al., 2015; Peeri et al., 2020).

Prevention and Protection

Important preventive measures to reduce the risk of MERS-CoV transmission between humans include good hygiene practices, such as regular hand washing, avoiding close contact with sick people, and avoiding consumption of raw or undercooked animal products, especially products derived from camels. Ongoing research on MERS-CoV is key to understanding the virus better and developing more effective prevention strategies. Vaccine development has also been a major focus for fighting MERS, although there are still several challenges to overcome in this process (WHO, 2022).

Although the role of bats in MERS-CoV transmission is still the subject of ongoing research, an understanding of the relationship between humans, intermediate animals and the virus is critical to developing effective prevention strategies. Appropriate preventive measures, including good hygiene practices and avoiding contact with animals that may be infected, are key in reducing the risk of MERS-CoV transmission (Han et al., 2015).

Continued research on the role of bats in the spread of MERS-CoV is needed to strengthen our understanding of the virus and to identify other potential sources of transmission. Collaborative

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efforts between scientists, health agencies and governments are needed to support this research and to develop better prevention strategies.

Hendra

Hendra virus is a zoonotic virus that was first identified in 1994 in Australia. The virus can cause serious disease in horses and humans, with a high mortality rate in infected cases (Field et al., 2010). Research has shown that bats are natural reservoirs of Hendra virus, and their role in the transmission of this virus has become a major focus of scientific research and disease control efforts. The diseases caused by Hendra virus demonstrate the complexity of interactions between humans, animals and the environment. Understanding the role of bats as natural reservoirs of Hendra virus is an important step in disease control and prevention efforts (Han et al., 2015).

Classification and Ecology of Hendra Virus-Carrying Bats

The Hendra virus is carried by several species of bats in the genus Pteropus, commonly referred to as "big fruit bats." These species are widely distributed throughout Australia's tropical and subtropical areas, as well as in a number of other Southeast Asian and Pacific nations. They are fruit-eating mammals that are crucial to the ecosystems of tropical forests, but they can also communicate with humans and other animals (Weatherman et al., 2018).

Transmission of Hendra Virus from Bats to Other Animals

The Hendra virus is typically spread from bats to other animals especially horses through contact with their saliva, urine, or dung. Horses can contract the disease by eating tainted feed or by coming into close contact with sick bats. Horses can spread the potentially deadly Hendra virus to people once they become infected (Weatherman et al., 2018).

Transmission of Hendra Virus from Animals to Humans

Humans can contract the Hendra virus from animals, such horses, by direct contact with infected bodily fluids like blood or mucus, or by inhaling aerosols made from these bodily fluids. Farmers or medical personnel who have frequent contact with sick animals are frequently the ones that contract the Hendra virus in humans (CDC, 2022).

Hendra Virus Control and Prevention Efforts

Hendra virus control involves several strategies; Animal Surveillance: It is important to monitor the health of animals, especially horses and other animals with potential exposure to Hendra virus. Public Education: The public needs to be informed about the risk of Hendra virus transmission and steps that can be taken to reduce that risk. Personal Protection: Health workers and farmers need to be equipped with appropriate protective gear when interacting with potentially infected animals. Further Research: Further research on Hendra virus ecology and interactions between bats and other animals is important to develop more effective prevention strategies (Middleton et al., 2014).

Rabies

Rabies is one of the deadliest viral diseases and is characterized by infection of the central nervous system. The disease is usually transmitted through the bite or scratch of an animal infected with the rabies virus. Although rabies can be prevented by vaccination, the disease is still a significant public health problem in many parts of the world, especially in areas where vaccination and animal control are limited (WHO, 2021).

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Causes and Transmission

Rabies is caused by an RNA virus of the Rhabdoviridae family and Lyssavirus genus. The virus usually enters the human body through a bite or scratch wound from an infected animal. The most common animals that transmit rabies to humans are dogs, cats, foxes, raccoons and bats. Rarely, rabies can also be transmitted through exposure of an infected animal's body fluids to an open wound or human mucous membrane (WHO, 2021).

Bats are often associated with the spread of rabies, and while bats can be carriers of the rabies virus, a deeper understanding of their role in the spread of the disease is needed to avoid panic and act effectively in prevention. Although bats can be carriers of the rabies virus, only a small proportion of the bat population is actually infected. Most bats live without carrying rabies. In wild bat populations, rabies levels are usually low. This means that the risk of rabies transmission from bats to humans is also low. Bats can act as reservoirs of the rabies virus, meaning that they can carry the virus without showing symptoms of the disease. However, this does not mean that all bats are infected (Gibbons et al., 2002).

Symptoms and Disease Progression

Once infected, the rabies virus multiplies at the bite site and then spreads through the central nervous system. Initial symptoms of rabies are often similar to the flu, including fever, headache, and fatigue. However, as the disease progresses, neurological symptoms may develop, including anxiety, confusion, seizures and paralysis. Once neurological symptoms appear, rabies usually leads to death within a few days to weeks (WHO, 2021).

Prevention and Treatment

Prevention of rabies is very important and can be done through vaccination. Rabies vaccines are effective and safe for preventing rabies after exposure to the virus, provided they are given as soon as possible after contact with a suspected rabid animal. Once rabies symptoms appear, there is no effective treatment and the disease almost always leads to death (Kemenkes, 2019).

Rabies Control Strategy

Rabies control primarily involves prevention and control of infectious animals. This includes mass vaccination of domestic animals, monitoring and control of wild animal populations, and public education on rabies risks and prevention measures (Kemenkes, 2019). In some areas, oral vaccination campaigns for wild animals, such as foxes and raccoons, have proven effective in reducing the spread of rabies (Wallace et al., 2020).

Bat Vector Control

Bat vector control is an important topic in public health and environmental conservation. (Schneeberger & Voigt, 2015). There has been much evidence regarding the role of bats as vectors of diseases that can endanger the health of humans and other animals. Therefore, controlling bat populations and reducing contact between humans and bats is a priority (Phelps et al., 2019).

A comprehensive bat control program usually involves a combination of methods aimed at managing bat populations, minimizing interactions between bats and humans, and reducing the risk of disease transmission. Here are some of the methods often used in bat vector control:

Inspection and Assessment: Conduct a thorough inspection of buildings, structures and neighboring areas to identify bat roosts and entry points. This helps in understanding the extent of bat infestation and determining appropriate control measures. Seal entry points and gaps in buildings using materials such as caulk, wire mesh, or repellent netting to prevent bats from

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entering or re-entering roosts. This method is often combined with the installation of a one-way repellent device that allows bats to exit but not re-enter the structure.

Environmental Management: Reducing suitable bat habitat around human habitation can help reduce the likelihood of human-bat interactions. This can be done by clearing unused houses, repairing gaps in buildings, and trimming tree branches close to buildings (Festa et al., 2023). Modify habitats to make them less attractive to bats. This can include trimming trees and vegetation near buildings, removing potential roost sites such as loose bark or hollow trees, and reducing sources of standing water that attract insects which are a major food source for bats.

Use of Artificial Nests: Installing artificial roosts in certain places away from human settlements can help divert bats away from undesirable places (Gilmour et al., 2020).

Use of Repellents: Although repellents are not always effective and have limited long-term success, certain chemical repellents or deterrents can be used to prevent bats from roosting in certain areas. However, their use should be in accordance with local regulations and environmental considerations (Arnett et al., 2013).

Disturbance Techniques: Using non-lethal disturbance techniques such as loud noises, bright lights, or air currents to disturb bats and encourage them to move to alternative roosts away from human-inhabited areas (Arnett et al., 2013; Darras et al., 2021).

Population Control: In situations where bat populations pose a significant health risk or property damage, targeted population control methods such as trapping, or euthanasia may be considered. However, these methods are usually applied as a last resort and should be carried out by trained professionals who follow legal and ethical guidelines (Kikuti et al., 2011).

Research, Monitoring and Public Education: Provide information to the public about the dangers posed by bats, as well as ways to reduce the risk of contact with them. This may include knowledge of where bats live and precautions to take when near them (Aguilar-Setién et al., 2022). Understanding migratory behavior, patterns of disease spread, and general bat ecology is critical to vector control efforts. This research can help in the development of more effective strategies in reducing the risk of disease transmission. Implement a monitoring program to track bat populations, roosting behavior and disease prevalence. This information helps in assessing the effectiveness of control measures and making informed decisions for future management strategies (Miguel et al., 2020).

Regulations and Policies: Implementing regulations and policies that restrict activities that may increase the risk of human-bat interactions, such as the use of guano (bat feces) in human crop agriculture, is also an important step in bat vector control (Dimkić et al., 2021).

It is important to note that bat vector control must be done with an eye towards environmental sustainability and the health of the bat population itself, as bats have an important role in the ecosystem as insect eaters and pollinators (Russo et al., 2021). Therefore, a holistic and sustainable approach is required in bat vector control (Roca, Afolabi, Saidu, & Kampmann, 2015). By integrating these methods into a coordinated bat control program, bat populations can be effectively managed while minimizing negative impacts on human health, property and the environment. In addition, engaging stakeholders such as homeowners, property managers, conservation organizations, and government agencies is critical to the success of bat control and conservation efforts.

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CONCLUSION AND SUGGESTION

Conclusion

Bats have been shown in various studies and publications to be carriers and transmitters of dangerous zoonotic viruses including Ebola, Nipah, SARS-CoV, MERS-CoV, Hendra and Rabies. It is important to note that while bats can be carriers of potentially deadly diseases, they also play an important role in maintaining ecosystem balance. By understanding the risks associated with bat-borne diseases, we can take the necessary preventative measures to protect human health and maintain the balance of ecosystems that are essential to our lives.

Suggestion

Efforts to understand and manage interactions between humans and bats wisely are essential for the prevention of zoonotic diseases.

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