



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## Correspondence

## Monkeypox: A global threat to domestic and wild animals – Correspondence

## ARTICLE INFO

## Keywords

Monkeypox  
Containment  
Dog  
Wild animals

## Dear Editor

The monkeypox virus belongs to the orthopoxvirus that is genetically different from the others members of the poxviridae family. Monkeypox was first reported in a monkey in 1958 and hence got the name. The virus was found to be zoonotic in 1970 when a small child acquired the infection in the Democratic Republic of the Congo [1]. On 17 August 2022 the World Health Organization (WHO) reported that the incidence of monkeypox infection continue to rise globally, with more than 35,000 cases across 92 countries and territories including 12 deaths (<https://news.un.org/en/story/2022/08/1124892>). The majority of cases are being reported from United states and Europe, and mostly among men who have sex with men. Surprisingly, the recent outbreaks in the United States, the United Kingdom, Italy, Belgium, Spain, Portugal, Sweden, Netherlands, France, Canada, Australia, and Germany does not follow the pattern of spread observed in the previous outbreaks outside of Africa, almost all of which have been linked with immigration or movement of people from Africa or exposure to infected exotic pets [2]. So far, 98% of cases occurred outside of Africa where the virus is endemic. This atypical outbreak of monkeypox raised the concern of global researchers and health agencies to contain it at the earliest (Fig. 1). Subsequently, WHO declared the monkeypox virus as Public Health Emergency of International Concern (PHEIC).

The virus has a wide range of hosts and many animal species may become infected with monkeypox virus under natural conditions, including squirrels, non-human primates, and rats. Earlier investigation of the 2003 outbreak of monkeypox in USA identified an international shipment of about 800 small mammals from Ghana to Texas as the probable source for the introduction of monkeypox virus into the USA. These mammals were of six genera of African rodents: rope squirrels (*Funisciurus* spp), tree squirrels (*Heliosciurus* spp), Gambian giant rats (*Cricetomys* spp), brushtail porcupines (*Atherurus* spp), dormice (*Graphiurus* spp), and striped mice (*Hybomys* spp) [3]. The virus was imported in 2003 into the United States of America via Gambia rats, wild squirrels (all African species), and infected prairie dogs, then crossed the species barrier to humans. Human to human transmission of the virus mainly occurs through close contact with the lesions, body fluids, contaminated clothing and bedding, and respiratory droplets from infected people (Fig. 2). The current outbreak is mainly occurring in men

who have sex with men, and has been associated with unexpected anal and genital lesions. In this context the possibility of sexual transmission of the virus needs to be thoroughly investigated.

Poxviruses infect almost all domestic animals but till today no poxvirus infecting domestic cats and dogs have been reported. Recently, the first case of monkeypox virus infection in dogs has been reported that might have been transmitted from infected human being [4]. The male Italian greyhound dog, aged 4 years, presented to the clinics with pox like lesions, including abdomen pustules and a thin anal ulceration. Skin scrapings and swabs of the anus and oral cavity of the dog were tested positive for monkeypox virus by PCR. Sequence analysis of this isolated monkeypox virus confirmed the isolated virus to be of hMPXV-1 clade, lineage B.1, which has been spreading in nonendemic countries since April 2022. In the current episode of monkeypox virus outbreak, the virus has crossed the species barrier to cause infection in dogs. In this context, the possibility of further spillover of the virus to new animal species cannot be overlooked. However, care should be taken to isolate the pets and wild animals kept in zoos, circuses and sanctuaries from human beings infected with monkeypox virus.

The jumping of species barrier by the monkeypox virus is an alarming situation for veterinary professionals and researchers. During recent decades, cowpox virus infections have been reported to re-emerged in domestic cats and other animals, including wild animals in captivity [5,6], and have increased in humans subsequent to transmission from rodents, cats, zoo and circus animals [7,8]. Since, the monkeypox virus is also crossing the species barriers like cowpoxvirus and other orthopoxviruses, the host range of this virus must be investigated, and further monitoring of monkeypox virus in domestic and wild animals is crucial. Strict surveillance of the virus among domestic felines and canines is utmost necessary to contain the virus. In addition, strict healthcare monitoring of domestic and wild animals, isolation of pets from infected human beings, proper healthcare monitoring of zoo attendees and implementation of recommended healthcare guidelines in zoos and circuses are the key to control further spillover of the virus. Furthermore, there is a wide scope for researchers to confirm secondary transmission of virus through pets and wild animals.

<https://doi.org/10.1016/j.ijso.2022.106974>

Received 8 September 2022; Accepted 27 October 2022

Available online 31 October 2022

1743-9191/© 2022 IJS Publishing Group Ltd. Published by Elsevier Ltd. All rights reserved.

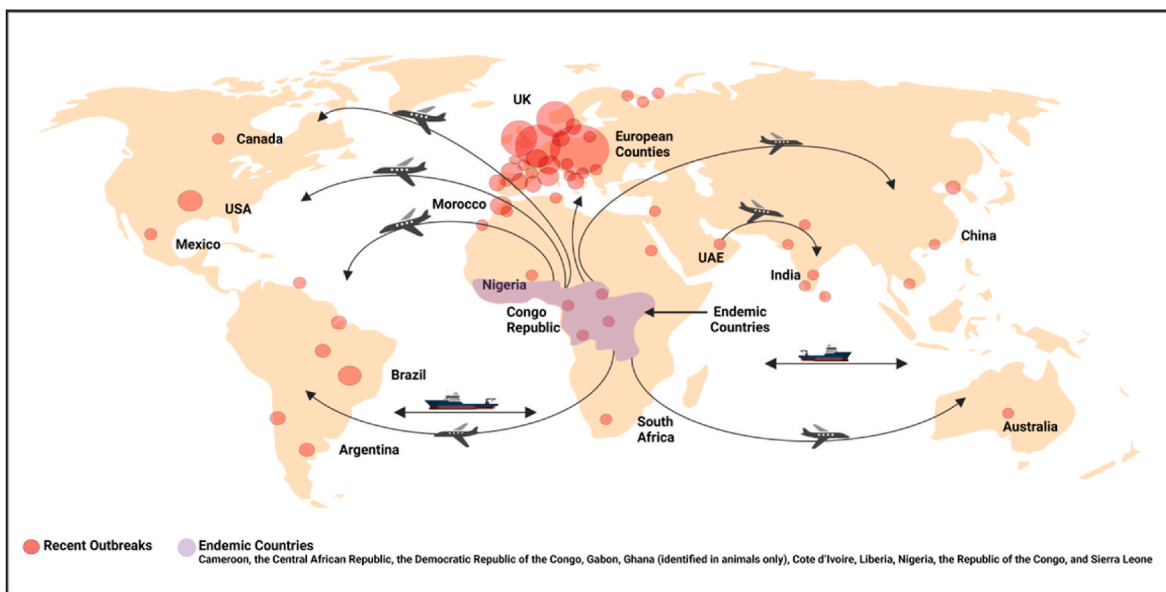


Fig. 1. Epidemiology of monkeypox. The figure was created with [BioRender.com](https://www.biorender.com).

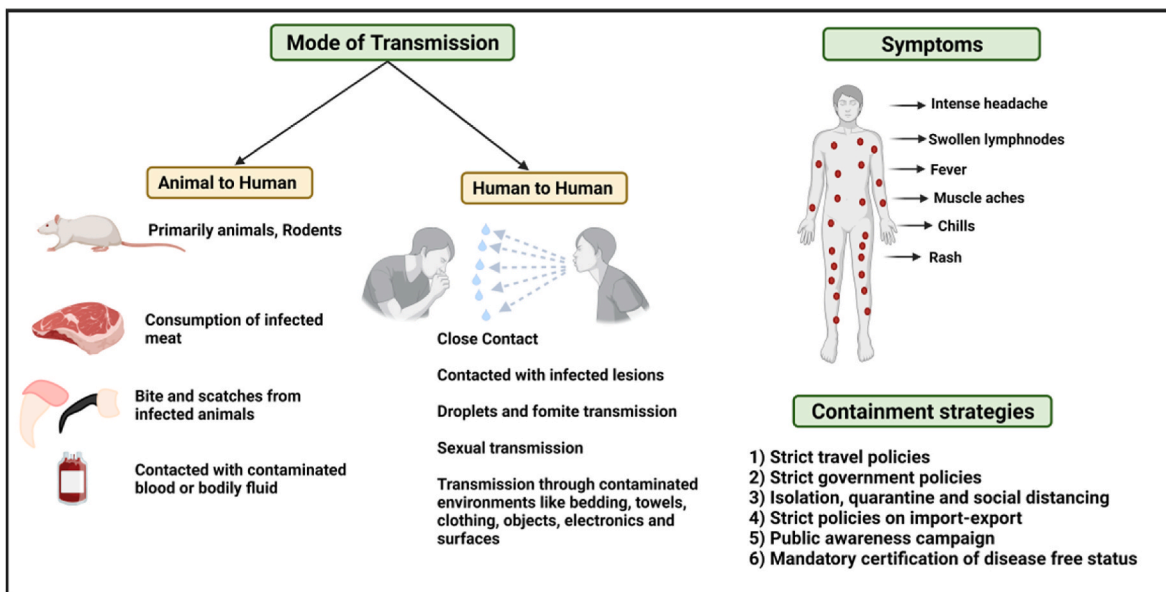


Fig. 2. Transmission, Clinical signs and Containment strategies of monkeypox. The figure was created with [BioRender.com](https://www.biorender.com).

**Ethical approval**

Not Applicable.

**Source of funding**

No.

**Author contribution**

Nikhil K. C.: Conceptualization, Writing - review & editing. Jigyasa Rana: Writing - review & editing. Shailesh Kumar Patel: Conceptualization, Writing - review & editing. Aditya Agrawal: Writing - review & editing. Kumar Govil: Writing - review & editing. Alok Singh: Writing - review & editing. Megha Katare Pandey: Writing - review & editing. Dhruv Nitinkumar Desai: Writing - review & editing. Sita Prasad Tiwari: Writing - review & editing.

**Trail registry number**

Not Applicable.

**Guarantor**

Dr Shailesh Kumar Patel.

**Provenance and peer review**

Not commissioned, internally peer-reviewed.

**Data statement**

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- [1] I.D. Ladnyj, P. Ziegler, E. Kima, A human infection caused by monkeypox virus in Basankusu Territory, Democratic Republic of the Congo, *Bull. World Health Organ.* 46 (5) (1972) 593–597. PMID: 4340218; PMCID: PMC2480792.
- [2] Who, World Health Organization. Monkeypox - United Kingdom of Great Britain and Northern Ireland, 2022, 18 May 2022, [www.who.int/emergencies/disease-outbreak-news/item/2022-DON383](http://www.who.int/emergencies/disease-outbreak-news/item/2022-DON383). (Accessed 19 May 2022).
- [3] D.B. Di Giulio, P.B. Eckburg, Human monkeypox: an emerging zoonosis, *Lancet Infect. Dis.* 4 (1) (2004 Jan) 15–25, [https://doi.org/10.1016/s1473-3099\(03\)00856-9](https://doi.org/10.1016/s1473-3099(03)00856-9). Erratum in: *Lancet Infect Dis.* 2004;4(4):251.
- [4] S. Seang, S. Burrell, E. Todesco, V. Leducq, G. Monsel, D. Le Pluart, C. Cordevant, V. Pourcher, R. Palich, Evidence of human-to-dog transmission of monkeypox virus, *Lancet* (2022 Aug 10), [https://doi.org/10.1016/S0140-6736\(22\)01487-8](https://doi.org/10.1016/S0140-6736(22)01487-8). S0140-6736(22)01487-8.
- [5] D. Baxby, D.G. Ashton, D. Jones, L.R. Thomsett, E.M. Denham, Cowpox virus infection in unusual hosts, *Vet. Rec.* 104 (1979) 175, <https://doi.org/10.1136/vr.104.8.175-a>.
- [6] J. Wisser, J. Pilaski, G. Strauss, H. Meyer, G. Burck, U. Truyen, et al., Cowpox virus infection causing stillbirth in an Asian elephant (*Elphas maximus*), *Vet. Rec.* 149 (2001) 244–246, <https://doi.org/10.1136/vr.149.8.244>.
- [7] T.F.W. Wolfs, J.A. Wagenaar, H.G.M. Niesters, A.D.M.E. Osterhaus, Rat-to-human transmission of cowpox infection, *Emerg. Infect. Dis.* 8 (2002) 1495–1496.
- [8] A. Kurth, G. Wibbelt, H.P. Gerber, A. Petschaelis, G. Pauli, A. Nitsche, Rat-to-elephant-to-human transmission of cowpox virus, *Emerg. Infect. Dis.* 14 (2008) 670–671, <https://doi.org/10.3201/eid1404.070817>.

Nikhil K. C\*

*Department of Veterinary Physiology and Biochemistry, College of Veterinary Science and Animal Husbandry, Rewa, M.P., India*

Jigyasa Rana

*Department of Veterinary Anatomy, Faculty of Veterinary and Animal Sciences, RGSC Banaras Hindu University, Barkachha, Mirzapur, U.P., India*

Shailesh Kumar Patel\*\*

*Department of Veterinary Pathology, College of Veterinary Science and Animal Husbandry, Rewa, M.P., India*

Aditya Agrawal

*Department of Veterinary Physiology and Biochemistry, College of Veterinary Science and Animal Husbandry, Rewa, M.P., India*

Kumar Govil

*Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Rewa, M.P., India*

Alok Singh

*Department of Veterinary Pathology, College of Veterinary Science and Animal Husbandry, Anjora, Durg, C.G., India*

Megha Katare Pandey

*Department of Translational Medicine, All India Institute of Medical Sciences, Bhopal, M.P., India*

Dhruv Nitinkumar Desai

*Department of Pathology, College of Medicine, Ohio State University, Ohio, USA*

Sita Prasad Tiwari

*Nanaji Deshmukh Veterinary Science University (NDVSU), Jabalpur, M.P., India*

\* Corresponding author.

\*\* Corresponding author.

*E-mail address:* [nikhilkc505@gmail.com](mailto:nikhilkc505@gmail.com) (N. K. C).

*E-mail address:* [shaileshpatel624@gmail.com](mailto:shaileshpatel624@gmail.com) (S.K. Patel).