Microbes and Infectious Diseases 2025; 6(3): 967-971

Microbes and Infectious Diseases

Journal homepage: https://mid.journals.ekb.eg/

Review article

Monkeypox: A comprehensive review of virology, epidemiology, and global health implications

Dr.Sheetal Goenka*

Govind Ballabh Pant Institute of Postgraduate Medical Education and Research .New Delhi, India

ARTICLE INFO

Article history:
Received 2 September 2024
Received in revised form 28 September 2024
Accepted 28 September 2024

Keywords:
Monkeypox
virus
zoonotic disease

ABSTRACT

Background: *Monkeypox*, a zoonotic disease caused by the *Monkeypox virus* (MPXV) belongs to the genus *Orthopoxvirus* within the *Poxviridae* family. *Monkeypox* is a large, enveloped, double-stranded DNA virus with a complex structure typical of poxviruses. It is closely related to variola virus (the causative agent of smallpox), vaccinia virus, and cowpox virus, has emerged as a significant global health concern in recent years. This review provides a comprehensive analysis of *Monkeypox* , including its virology, epidemiology, clinical manifestations, diagnostic approaches, treatment options, and prevention strategies. Special emphasis is placed on the current global scenario, highlighting the unprecedented spread of *Monkeypox* beyond its traditional endemic regions. Recent outbreaks have challenged our understanding of *Monkeypox* transmission dynamics and underscored the need for enhanced surveillance, rapid diagnostic capabilities, and effective public health interventions. This review article synthesizes the latest research findings and expert opinions to provide an up-to-date perspective on *Monkeypox*, aiming to inform healthcare professionals, researchers, and policymakers in addressing this evolving public health challenge.

Introduction

Monkeypox first discovered in 1958 in a colony of research monkeys and identified in humans in 1970, has historically been confined to Central and West Africa [1]. However, the landscape of *Monkeypox* epidemiology has dramatically shifted in recent years, with increasing cases reported globally, including in non-endemic regions [2]. This review aims to provide a comprehensive overview of *Monkeypox* , with a particular focus on recent developments and the current global scenario.

Virology

Taxonomy and Structure

Monkeypox virus belongs to the genus Orthopoxvirus within the Poxviridae family. It is closely related to variola virus (the causative agent of smallpox), vaccinia virus, and cowpox virus [3]. MPXV is a large, enveloped, double-stranded DNA virus with a complex structure typical of poxviruses [4].

Genomic Characteristics

Two distinct genetic clades of MPXV have been identified: the Central African (Congo Basin) clade and the West African clade [5]. Recent genomic analyses have revealed that the virus responsible for the 2022 global outbreak belongs to the West African clade, which is associated with milder disease and lower mortality rates compared to the Central African clade [6].

DOI: 10.21608/MID.2024.317587.2187
* *Corresponding author:*Sheetal Goenka
E-mail address: drsheetalgoenka@gmail.com

Viral Evolution and Adaptation

Recent studies have highlighted the potential for *Monkeypox* to evolve and adapt to new host environments. Genomic analyses of isolates from the 2022 outbreak have identified mutations that may influence transmissibility and pathogenicity [7]. These findings underscore the importance of ongoing genomic surveillance to monitor viral evolution and its potential impact on disease dynamics.

Epidemiology

Historical Context

Prior to 2022, *Monkeypox* cases outside Africa were rare and typically associated with travel to endemic regions or contact with imported animals [8]. Sporadic outbreaks have occurred in the Democratic Republic of Congo, Nigeria, and other Central and West African countries [9].

Current Global Scenario

The year 2022 marked a significant shift in *Monkeypox* epidemiology, with a large multi-country outbreak affecting non-endemic regions [10]. As of August 2023, over 50,000 cases have been reported across more than 100 countries, prompting the World Health Organization to declare a Public Health Emergency of International Concern (PHEIC) [11].

Transmission Dynamics

While zoonotic transmission from animal reservoirs to humans remains a primary route of infection in endemic regions, the recent global outbreak has highlighted the potential for sustained human-to-human transmission [12]. Close physical contact, particularly in the context of sexual networks, has been identified as a significant driver of transmission in non-endemic settings [13].

At-Risk Populations

Recent outbreaks have disproportionately affected men who have sex with men (MSM), although it's crucial to emphasize that *Monkeypox* can affect any individual regardless of sexual orientation or gender identity [14]. Healthcare workers, laboratory personnel, and individuals in close contact with infected persons or animals are also at increased risk [15].

Clinical Manifestations

Incubation and Prodromal Phase

The incubation period for *Monkeypox* typically ranges from 5 to 21 days [16]. The prodromal phase is characterized by fever, intense headache, lymphadenopathy, back pain, myalgia, and profound weakness [17].

Cutaneous Manifestations

The hallmark of *Monkeypox* is a characteristic rash that progresses through several stages: macules, papules, vesicles, pustules, and finally scabs [18]. In contrast to smallpox, *Monkeypox* lesions often appear in successive crops and may involve the palms, soles, and mucous membranes [19].

Systemic Involvement

Severe cases may present with complications such as pneumonitis, encephalitis, sight-threatening keratitis, and secondary bacterial infections [20]. The case fatality rate varies but is generally lower for the West African clade (< 1%) compared to the Central African clade (up to 10%) [21].

Atypical Presentations

Recent outbreaks have highlighted atypical clinical presentations, including cases with few or localized lesions, absence of prodromal symptoms, or anal and genital lesions preceding systemic symptoms [22]. These atypical presentations pose diagnostic challenges and underscore the need for increased awareness among healthcare providers.

Diagnosis

Clinical diagnosis of *Monkeypox* can be challenging due to its similarity to other exanthematous diseases. A thorough history, including potential exposures and travel history, is crucial [23].

Laboratory Confirmation

Polymerase chain reaction (PCR) testing of lesion material remains the gold standard for diagnosis [24]. Other methods include virus isolation in cell culture, electron microscopy, and immunohistochemistry [25].

Serological Testing

While serological tests can detect anti-orthopoxvirus antibodies, they are less specific and mainly used for epidemiological studies rather than acute diagnosis [26].

Differential Diagnosis

The differential diagnosis includes varicella-zoster virus infection, smallpox (in the event of a bioterrorist attack), measles, and other causes of pustular or vesicular rashes [20].

Treatment[16-20].

Supportive Care

The mainstay of treatment for *Monkeypox* is supportive care, including fluid balance, pain management, and treatment of secondary bacterial infections .

Antiviral Therapy

Several antiviral agents have shown promise in treating *Monkeypox* :

- **Tecovirimat:** An inhibitor of the orthopoxvirus VP37 envelope wrapping protein, approved by the FDA for the treatment of smallpox and used for severe *Monkeypox* cases under an expanded access protocol .
- **Brincidofovir:** A lipid conjugate of cidofovir with activity against orthopoxviruses, though its role in *Monkeypox* treatment is still being evaluated .
- **Cidofovir:** A nucleotide analog with broad-spectrum antiviral activity, used in severe cases despite potential nephrotoxicity .

Immunotherapy

Vaccinia Immune Globulin (VIG) has been used in severe cases, although its efficacy in *Monkeypox* treatment remains to be fully established.

Prevention and Control

Vaccination

Smallpox vaccines provide cross-protection against *Monkeypox* . The MVA-BN vaccine (Jynneos) has been specifically approved for *Monkeypox* prevention. Ring vaccination strategies have been employed in outbreak settings, targeting close contacts of confirmed cases .

Infection Control Measures

Proper isolation of confirmed and suspected cases, use of personal protective equipment by healthcare workers, and thorough contact tracing are essential components of outbreak control .

Public Health Interventions

- Effective public health responses include:
- Enhanced surveillance and rapid case identification
- Risk communication and community engagement
- International cooperation and data sharing [26]

One Health Approach

Given the zoonotic nature of *Monkeypox* , a One Health approach integrating human, animal, and environmental health is crucial for long-term prevention and control .

Future Directions and Challenges

Research Priorities

Key areas for future research include:

- Development of rapid, point-of-care diagnostic tests
- Evaluation of antivirals and new therapeutic approaches
- Understanding the ecological drivers of *Monkeypox* emergence
- Elucidating the mechanisms of human-to-human transmission

Vaccine Development and Distribution

Ensuring equitable access to vaccines, particularly in endemic regions, remains a significant challenge. Development of new generation vaccines with improved safety profiles and efficacy is an ongoing area of research.

Global Preparedness

The *Monkeypox* outbreak has highlighted the need for enhanced global health security measures and pandemic preparedness. Strengthening health systems, particularly in resource-limited settings, is crucial for effective response to emerging infectious diseases.

Conclusion

The recent global spread of *Monkeypox* has challenged our understanding of this once-rare zoonotic disease and highlighted significant gaps in our preparedness for emerging infectious threats. As we continue to navigate this evolving situation, concerted efforts in research, public health interventions, and international collaboration are essential. By synthesizing our current knowledge and identifying key areas for future investigation, we can work towards more effective strategies for prevention, control, and ultimately, global health security in the face of emerging infectious diseases like *Monkeypox* .

Conflict of interest:

None.

Financial disclosure:

None.

References

1- Di Giulio DB, Eckburg PB. Human Monkeypox : an emerging zoonosis. Lancet Infect Dis 2004;4(1):15-25.

2- Bunge EM, Hoet B, Chen L, Lienert F, Weidenthaler H, Baer LR,et al . The changing epidemiology of human Monkeypox -A potential threat? A systematic review. PLoS Negl Trop Dis. 2022 Feb 11;16(2):e0010141.

3- McCollum AM, Damon IK. Human Monkeypox . Clin Infect Dis 2014;58(2):260-7.

4- Moss B. Poxviridae: the viruses and their replication. In: Knipe DM, Howley PM, eds. Fields Virology. 6th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2013:2129-59.

5- Likos AM, Sammons SA, Olson VA, Frace AM, Li Y, Olsen-Rasmussen M, Davidson W, Galloway R, Khristova ML et al. A tale of two clades: Monkeypox viruses. J Gen Virol. 2005 Oct;86(Pt 10):2661-2672.

6- Isidro J, Borges V, Pinto M, Sobral D, Santos JD, Nunes A et al. Phylogenomic characterization and signs of microevolution in the 2022 multi-country outbreak of Monkeypox virus. Nat Med. 2022 Aug;28(8):1569-1572.

7- Happi C, Adetifa I, Mbala P, Njouom R, Nakoune E, Happi A et al. Is Urgent need for a non-discriminatory and non-stigmatizing nomenclature for Monkeypox virus. PLoS Biol. 2022 Aug 23;20(8):e3001769.

8- Yinka-Ogunleye A, Aruna O, Dalhat M, Ogoina D, McCollum A, Disu Y et al. CDC Monkeypox Outbreak Team. Outbreak of human Monkeypox in Nigeria in 2017-18: a clinical and epidemiological report. Lancet Infect Dis. 2019 Aug;19(8):872-879.

9- Rimoin AW, Mulembakani PM, Johnston SC, Lloyd Smith JO, Kisalu NK, Kinkela TL, et al. Major increase in human Monkeypox incidence 30 years after smallpox vaccination campaigns cease in the Democratic Republic of Congo. Proc Natl Acad Sci U S A. 2010 Sep 14;107(37):16262-7.

10- Hornhill JP, Barkati S, Walmsley S, Rockstroh J, Antinori A, Harrison LB, et al .SHARE-net Clinical Group. Monkeypox Virus Infection in Humans across 16 Countries - April-June 2022. N Engl J Med. 2022 Aug 25;387(8):679-691.

11- World Health Organization. Multi-country outbreak of Monkeypox , External situation report 7 - 10 August 2022. Geneva: WHO; 2022.

12- Bagde H, Dhopte A, Bukhary F, Momenah N, Akhter F, Mahmoud O et al. Monkeypox and oral lesions associated with its occurrence: a systematic review and meta-analysis. F1000Res. 2024 Mar 1;12:964.

13- Bragazzi NL, Kong JD, Mahroum N, Tsigalou C, Khamisy-Farah R, Converti M,et al . Epidemiological trends and clinical features of the ongoing monkeypox epidemic: a preliminary pooled data analysis and literature review. Journal of medical virology. 2023 Jan;95(1):e27931.

14- Titanji BK, Tegomoh B, Nematollahi S, Konomos M, Kulkarni PA. Monkeypox : A Contemporary Review for Healthcare Professionals. Open Forum Infect Dis. 2022 Jun 23;9(7):ofac310.

15- European Centre for Disease Prevention and Control. Monkeypox multi-country outbreak – 23 May 2022. ECDC: Stockholm; 2022.

16- Reynolds MG, Yorita KL, Kuehnert MJ, Davidson WB, Huhn GD, Holman RC. Clinical manifestations of human Monkeypox influenced by route of infection. J Infect Dis. 2006 Sep 15;194(6):773-80.
17- Adler H, Gould S, Hine P, Snell LB, Wong W, Houlihan CF, Osborne,et al. NHS England High Consequence Infectious Diseases (Airborne) Network. Clinical features and management of human Monkeypox : a retrospective observational study in the UK. Lancet Infect Dis. 2022 Aug;22(8):1153-1162.
18- Memariani M, Memariani H. Multinational Monkeypox outbreak: what do we know and what should we do Ir J Med Sci. 2023 Apr;192(2):721-722.
19- Girometti N, Byrne R, Bracchi M, Heskin J, McOwan A, Tittle V, et al . Demographic and clinical characteristics of confirmed human Monkeypox virus cases in individuals attending a sexual health centre in London, UK: an observational analysis. The Lancet Infectious Diseases. 2022 Sep 1;22(9):1321-8.
20- Orviz E, Negredo A, Ayerdi O, Vázquez A, Muñoz-Gomez A, Monzón S, et al . Monkeypox outbreak in Madrid (Spain): clinical and virological aspects. Journal of Infection. 2022 Oct 1;85(4):412-7.
21- Beer EM, Rao VB. A systematic review of the epidemiology of human Monkeypox outbreaks and implications for outbreak strategy. PLoS Negl Trop Dis 2019; 13(10): e0007791.
22- Patel A, Bilinska J, Tam JC, Fontoura DD, Mason CY, Daunt A,et al . Clinical features and novel presentations of human Monkeypox in a central London centre during the 2022 outbreak: descriptive case series. bmj. 2022 Jul 28;378.
23- Alakunle E, Moens U, Nchinda G, Okeke MI. Monkeypox virus in Nigeria: infection biology, epidemiology, and evolution. Viruses. 2020 Nov 5;12(11):1257.
24- Li Y, Zhao H, Wilkins K, Hughes C, Damon IK. Real-time PCR assays for the specific detection of Monkeypox virus West African and Congo Basin strain DNA. Journal of virological methods. 2010 Oct 1;169(1):223-7.
25- Hutson CL, Carroll DS, Gallardo-Romero N, Drew C, Zaki SR, Nagy T,et al . Comparison of Monkeypox virus clade kinetics and pathology within the prairie dog animal model using a serial sacrifice study design. BioMed research international. 2015;2015(1):965710.
26- Karem KL, Reynolds M, Braden Z, Lou G, Bernard N, Patton J,et al . Characterization of acute-phase humoral immunity to Monkeypox : use of immunoglobulin M enzyme-linked immunosorbent assay for detection of Monkeypox infection during the 2003 North American outbreak. Clinical and Vaccine Immunology. 2005 Jul;12(7):867-72.

Goenka S. Monkeypox: A comprehensive review of virology, epidemiology, and global health implications. Microbes Infect Dis 2025; 2025; 6(3): 967-971.