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Monkeypox (Mpx) Disease: Causes, Symptoms, Prevention and Pharmaceutical Marketing Strategies- A Call for International Action

Sudhakar Madhavedi[1], Ravi Varala[*2], Wong Chee Hoo[3], Goh Khang Wen[4]

[1]Assistant Professor & Head, Dept. of Business Management, Kshatriya College of Engineering (under JNTU, Hyderabad), India &Research Fellow, INTI International University, Malaysia

Email ID: reachfirst@gmail.com

Orcid id: https://orcid.org/0000-0002-0961-7977

[2*]Scrips Pharma, Hyderabad, India & Research Fellow in Heath Sciences, INTI International University, Malaysia,

Email ID: ravivarala@gmail.com

Orcid id: https://orcid.org/0000-0002-6466-9454

[3]Associate Professor, Faculty of Business and Communications, INTI International University, Nilai, Malaysia.

Email ID: cheehoo.wong@newinti.edu.my

Orcid id: https://orcid.org/0000-0003-0691-4463

[4]Professor, Faculty of Data Sciences, INTI International University, Nilai, Malaysia

Email ID: Khangwen.goh@newinti.edu.my

Orcid ID: https://orcid.org/0000-0001-6686-7019

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ABSTRACT

The monkeypox virus, which belongs to *the Orthopoxvirus* genus, is the cause of the uncommon viral zoonotic illness known as monkeypox. Occasional breakouts beyond of its endemic regions have brought it international notice. The goal of this perspective paper is to give a thorough description of mokeypox, covering its origins, biological makeup, invasion of humans, mortality rate, process of multiplication, treatment plan, availability of medications, drug patents and their and market strategies. This paper advocates for the affordability and accessibility of vaccines and medicines for all nations affected by monkeypox, thereby contributing to the achievement of United Nations Sustainable Development Goal 3, Good health and Wellbeing.

Keywords: *Public health, Disease, Monkeypox, Pandemic, Vaccine, Pharmaceutical Patents.*

1. INTRODUCTION

Monkeypox (MPX) is a member of the "*Poxviridae*" family under the genus "*Orthopoxvirus*". This complex double-stranded DNA virus has lateral bodies responsible for replication functions and a central core that houses the viral genome. Its hard lipid coat allows it to penetrate easily and survive under various environmental conditions. Monkeypox infects human cells by attaching to receptors *via* endocytosis. Once inside, it replicates and assembles using its own machinery to produce additional virions, which are then released to infect nearby cells. The disease pathology arises from the immune system's response to this replication process (Varala & Madhavedi, 2022).

It was first identified in 1958 during outbreaks in monkeys kept for research in Denmark. The first human case was reported in 1970 in the Democratic Republic of the Congo, and since then, the number of MPX cases has steadily increased in recent years. Between January 2022 and August 2024, more than 120 countries reported cases of monkeypox. Based on data submitted to the World Health Organization (WHO), there are currently over 100,000 laboratory-confirmed cases and more than 220 deaths among confirmed cases. Initially, MPX was regionalized to parts of Central and West Africa, raising concerns about its potential for global spread. Several factors influence the severity of monkeypox, including age, pre-existing medical conditions, and access to treatment. Vulnerable groups-such as children, pregnant women, and

individuals with weakened immune systems-are at a higher risk of severe illness, which can sometimes be fatal. For instance, immunocompromised individuals may struggle to mount an adequate immune response, leading to prolonged illness and an increased likelihood of complications. Children, whose immune systems are still developing, are particularly prone to severe outcomes, including secondary bacterial infections such as pneumonia.

Early detection plays a critical role in reducing disease severity and mortality. Prompt access to medical care, including supportive treatments and antivirals, not only mitigates the risk of severe disease but also reduces the strain on global health systems. This is especially important in under-resourced conditions, where controlling the spread of infection and improving survival rates among high-risk populations can have a profound impact. Although the overall case fatality rate is low, monkeypox remains a significant public health concern due to its global spread and the risks it poses to susceptible groups. Continued surveillance, targeted interventions, and international collaboration are essential to managing outbreaks and preventing further transmission.

2. LITERATURE REVIEW

The main objective of monkeypox research in the early years of the decade (2010-2015) was to understand the natural history and epidemiology of the disease. Research conducted in Africa, where the majority of cases were reported, indicated that monkeypox was primarily zoonotic in origin, with rodents and primates being the most common reservoirs. Besides reporting cases in remote rural areas of Central and West Africa, the studies by Reed et al. (2011) and Jezek et al. (1986) established animal-to-human transmission. Most of the research done at this time was on the virus's limited ability to spread outside of Africa and the rare cases of human-to-human transmission. Similarly, because the virus caused little harm to public health outside of Africa, the clinical characteristics and treatment methods were little described.

Monkeypox awareness rose between 2016 and 2020, mostly due to rare outbreaks outside of Africa and a greater realization of the disease's potential for global transmission. Important research from WHO brought attention to the rise of monkeypox cases in nations like the US and the UK, which are frequently linked to foreign travel or imported animals. This study addressed the call for better surveillance and diagnostic approaches, and also contributed to an understanding of the impact of monkeypox at a public health level. For clarity on the diversity of clades and how monkeypox is affiliated with the broader *Orthopoxviruses* and smallpox, studies like that from McCollum et al. (2018) have more lately focused on gene sequencing of monkeypox. Their efforts further illustrated the likelihood of cross-species transmission.

Important studies that focused on the role of sexual transmission, particularly in men who have sex with men (MSM), and the importance of rapid identification and isolation in preventing further spread included Jaleel et al. (2024) and Xu et al. (2023). In addition, the development of vaccines and antiviral therapies became a focus area of study. Studies on the effectiveness of the JYNNEOS vaccine, a modified live-virus vaccine for smallpox, in preventing and controlling outbreaks have been conducted since it was discovered to have potential use for monkeypox. Several reviews have highlighted the role of the Center for Disease Control (CDC) and WHO in the international response, with a focus on the critical need for international collaboration in the distribution of medical countermeasures, diagnostic testing, and surveillance. Expanded studies on the effectiveness of JYNNEOS and other antivirals (such as tecovirimat) showed promising results, including viral load reduction, symptom alleviation, and the slowing and cessation of outbreaks.

Investigations into the mutation of the virus continued, with numerous studies, including those by Cunningham et al. (2023), looking at the impact of various strains on transmission and disease severity. These new strains came in the form, raising fears that some changes might enhance the ability of the virus to multiply or evade immune responses. The studies have compared the immune response to monkeypox with smallpox and other poxviruses. Research conducted by Chandran et al. (2022) explored the immunological responses associated with monkeypox infection and the markers of severe disease. Predicting the course of disease and creating therapeutic approaches depend on an understanding of the immunological systems at play. As monkeypox outbreaks spread beyond Africa, the demand for accurate and rapid diagnostics grew. To accelerate detection in epidemics, several studies have explored the development of diagnostic assays, such as PCR tests, serological tests, and rapid antigen tests. The gold standard for detecting monkeypox viral DNA has been the PCR method. To increase sensitivity and minimize false positives, researchers like Ishikawa et al. (2022) focused on enhancing PCR assays. In the field, these improvements have been vital in diagnosing cases, especially in remote settings where healthcare facilities may not be adequate.

Developing serological assays which could differentiate between smallpox and other *Orthopoxviruses* and monkeypox has been instrumental since viruses are highly related. Miller et al. (2023) have conducted research on improving ELISA-based testing for identifying monkeypox antibodies, which allows for surveillance of previous infections and evaluation of community immunity. Rapid diagnostic tests (RDTs) were developed in response to the 2022 monkeypox outbreak, which highlighted the need for field-friendly diagnostics. According to preliminary findings from research like Martin et al. (2020), RDTs are promising but require more improvement for wider clinical application because of their variable sensitivity and specificity. One of the main instruments for managing the 2022 epidemics was the JYNNEOS vaccine, which was authorized for smallpox and monkeypox. The effectiveness of this vaccination was validated by studies by Williams et al. (2022) and Duffy et al. (2024), particularly when given early in the exposure period.

Outbreak Response: According to studies conducted by national health authorities, the CDC, and the WHO, prompt response strategies-like contact tracing, quarantine regulations, and immunization campaigns-are essential for managing outbreaks. The global monkeypox outbreak in 2022 exposed these systems' weaknesses and prompted calls for upgrades to the infrastructure supporting disease management.

Risk Communication: Another important component of the epidemics in 2022 was public health messaging. Particularly in the populations facing high disease transmission rates, studies on risk communication strategies (e.g., by Hirani et al., 2023) especially highlighted the importance of clear and unambiguous information to counter stigma and promote safe behaviors.

Research related to monkeypox has advanced, but there are still a number of hurdles facing it today. It is fundamentally important to address the gaps in global preparedness and response as the virus continues to evolve in new settings, especially in very high-density metropolises. To halt its further spread, monkeypox should be contained while diagnostic techniques and vaccines with greater safety profiles than the current lots should be sustained and epidemic surveillance enhanced. Knowing the history of the virus, its zoonotic transmission patterns, and long-term clinical impacts can also help determine future research priorities and guide international health policy choices. The 2022 monkeypox outbreak received international attention, emphasizing the urgent need for ongoing monitoring and research funding to control the illness and reduce risks in the future. To keep ahead of possible epidemics and safeguard world health, interdisciplinary cooperation between virology, epidemiology, public health, and clinical care will be required [30].

3. TREATMENT PROTOCOL

The primary goals of treatment for monkeypox are symptom management and prevention of sequelae, as there is currently no known cure. The comprehensive treatment aims to reduce the severity of the disease and improve patient outcomes.

1. ***Supportive Care:*** Supportive care is the foundation of monkeypox treatment. This includes maintaining hydration and balancing electrolytes to prevent dehydration, a common complication of fever and lesions. Because monkeypox often causes discomfort due to its characteristic rash and lesions, pain management is also an integral part of treatment. Patients are also treated for secondary bacterial infections, which can occur due to compromised immunity or as a result of the skin lesions getting infected. If secondary infections occur, they can be treated with antibiotics.

2. ***Antiviral Treatment:*** There are a few antiviral drugs that have been licensed or investigated for their ability to cure monkeypox, though there is no widely accepted antiviral treatment for the disease. The most commonly used antiviral drugs to treat monkeypox are FDA-approved Tecovirimat (TPOXX), especially in the US. Tecovirimat is an antiviral agent that stops the virus from becoming mature and further spreading within the host body, increasing the intensity of the symptoms while reducing the duration of the disease. Second-generation antiviral agents may also include cidofovir and brincidofovir, though both have poor toxicity profiles and are associated with renal impairment (kidney problems). These antiviral drugs are typically reserved for patients with more severe monkeypox or those at a higher risk of complications.

3. ***Immunization:*** Immunization is necessary for preventing and reducing the effects of monkeypox, even though there is no specific vaccine for the disease. Post-exposure prophylaxis with the JYNNEOS vaccine, which was originally developed to prevent smallpox, may be administered as soon as possible after exposure and may prevent or mitigate monkeypox. Compared to the previous ACAM2000 vaccine, which carries a higher risk of adverse effects, especially among those with an impaired immune system, JYNNEOS is considered safer. The vaccine enhances the production of the immune system against the monkeypox virus, making it an essential tool in controlling outbreaks and protecting those at high risk of infection.

In order to reduce the impact of the disease and prevent further transmission of the virus, the treatment protocol has put much emphasis on a holistic approach that consists of supportive therapy, antiviral medication, and vaccination. These therapies have been effective in preventing fatalities and outbreaks, particularly in regions where the monkeypox virus is most prevalent, although they are not curative.

Vaccines for Monkeypox:

i. ***Tecovirimat (TPOXX):*** Tecovirimat is one of the key antiviral drugs used for monkeypox treatment under the brand name TPOXX. Initially developed to treat smallpox, the US FDA approved its use for monkeypox in 2018 under the Animal Efficacy Rule due to the challenges in conducting human clinical trials for rare diseases like monkeypox. Tecovirimat binds to the VP37 protein, vital for the virus's maturation, and prevents newly formed virions from being released from infected cells, thus stopping viral replication. Clinical studies and empirical evidence support that tecovirimat reduces viral replication, hastens recovery, and decreases the severity of symptoms in patients with monkeypox. However, the cost of TPOXX is a significant concern, ranging from $1,000 to $1,200 per course in the US, which raises issues for public health agencies. To ensure the drug reaches populations affected by monkeypox, governments and NGOs have pushed for reduced or tiered pricing arrangements. TPOXX's dual-use potential in

bioterrorism preparedness has made it particularly appealing to government agencies concerned with both public health and national security (Mullin, 2024).

ii. ***Brincidofovir (Tembexa)/Cidofovir):*** Similar to tecovirimat, brincidofovir is another antiviral drug used for the treatment of monkeypox. It was designed to treat smallpox, and the FDA approved it for monkeypox treatment under the Orphan Drug Act in 2021. Brincidofovir works by preventing viral DNA replication, specifically by disrupting the monkeypox virus's DNA polymerase, which stops the virus from replicating inside host cells. Despite promising preclinical and clinical results, its adverse effects, such as liver damage and gastrointestinal upset, limit its use (Chimerix inc, 2021). The drug costs about $2,500 per course, raising concerns about accessibility in low-resource settings. Brincidofovir is considered an adjuvant therapy to tecovirimat, serving as an alternative when tecovirimat may not be suitable. *Chimerix*, the manufacturer of Tembexa, has marketed the drug with an emphasis on emergency preparedness and acquiring government contracts. The drug's high cost remains a barrier to its widespread use, especially in countries with recurrent monkeypox outbreaks. (WHO, 2024)

iii. ***Jynneos (Imvamune):*** JYNNEOS, developed by Bavarian Nordic, is an essential vaccine for preventing monkeypox. This vaccine inhibits the virus's multiplication within the host body, making it safer for immunocompromised patients. Originally licensed to combat smallpox, JYNNEOS is now also licensed for monkeypox prophylaxis by regulatory agencies, including the US FDA. The vaccine has shown robust protective benefits against both smallpox and monkeypox. Clinical testing reveals that it significantly reduces the chance of infection by triggering a strong immune response. The cost per dose is estimated to be between $250 and $300 in the United States. JYNNEOS is widely used in controlling outbreaks and protecting those at high risk of exposure.

iv. ***ACAM2000:*** ACAM2000, a live-virus smallpox vaccine produced by Sanofi Pasteur, has been used as a fallback option in a few monkeypox outbreaks. Though not the recommended vaccine for monkeypox, it may be used in emergencies when other vaccines are unavailable. ACAM2000 carries a higher risk of adverse events, such as encephalitis and myocarditis, especially for immune-compromised and medically unstable individuals. Despite these risks, ACAM2000 is effective for both smallpox and monkeypox, though its use is restricted due to its safety concerns. The cost per dose ranges from $50 to $100, making it less expensive than JYNNEOS. ACAM2000 is typically used in emergency settings or military stockpiles, where safety monitoring can be more closely managed.

4. CURRENT SITUATION & CALL FOR INTERNATIONAL ACTION

4.1 Global Implications:

Recent outbreaks of monkeypox outside of Africa underscore how much international cooperation and surveillance are needed. Although the disease is not nearly as transmissible as COVID-19, the spread of the disease shines a spotlight on shortcomings in public health infrastructure and the need for prophylactic measures (Varala and Sudhakar, 2023). The global MPX scenario is still changing as of January 2025. More than 110 nations have reported MPX infections since the global outbreak started in May 2022. The situation is being closely watched by the WHO and other health agencies. In December 2024, Kosovo reported its first MPX case, which involved a tourist returning from West Africa. The more virulent Clade I lineage has a higher historical case-fatality rate, and its emergence into the United States late in 2024 raised concern. Meanwhile, cases of Clade I b were confirmed in the UK, particularly in tourists returning from Uganda. In August 2024, the WHO declared MPX a PHEIC, calling for international cooperation. According to the ECDC, it is reported that more than 24,000 cases were registered globally in 2024, causing 600 deaths.

To control this virus, some preventive measures still required are immunization, health education, and antiviral medication (Kurra et al. 2022). However, access to the medicines and vaccines differs regionally; therefore, the international actions should be directed toward the rectification of these situations. There's a need to be vigilant, and reaction plans in the face of a new appearance of severe strains and cases in regions considered previously free is essential (WHO, 2024).

4.2 Critical Research Areas of Focus:

- Zoonotic Transmission: The primary area of research to date on monkeypox within endemic regions concerns its animal-to-human transmission, mostly from rodents and primates.
- Epidemiology and Surveillance: In order to monitor the spread of the virus and enhance early detection, epidemiology and surveillance networks are being expanded in both endemic and non-endemic areas.
- Clinical Features and Pathogenesis: All aspects of the clinical range of monkeypox disease—from its intermediate to severe manifestations, through consequences as secondary bacterial infections or encephalitis—have been investigated. Priority has been given to understanding molecular underpinnings of immune response and disease progression.
- Vaccines and Therapeutics: An area of development of antivirals such as tecovirimat and brincidofovir and smallpox vaccines (JYNNEOS, ACAM2000) have been applied in the treatment. Smallpox treatments may also be repurposed for treating monkeypox, according to clinical investigations.

- Public Health and Global Preparedness: International health organizations have researched containment strategies, which focus on public health education, contact tracing, and diagnostics. Understanding the dynamics of viral outbreaks, such as monkeypox, has been important in preparing for a pandemic, since these viruses might become a threat in the future due to the interconnection of the world through international travel.

4.3 Vaccines and Medicines Marketing Strategies:

The marketing of monkeypox vaccines and medications is heavily influenced by government-driven efforts. Pharmaceutical companies such as SIGA Technologies (Tecovirimat), Chimerix (Brincidofovir), Bavarian Nordic (JYNNEOS), and Sanofi Pasteur (ACAM2000) target government health agencies and international organizations to create emergency stockpiles for preparedness against bioterrorism.

Public health messaging plays a key role in educating the public about the importance of vaccination and preventive measures, especially as monkeypox has moved outside of its usual endemic regions. Emphasis has been placed on risk communication strategies to counter stigma and promote safe behaviors, particularly among high-risk groups such as medical personnel, visitors to endemic areas, and close contacts of affected individuals. Partnerships with global institutions such as GAVI (Global Alliance for Vaccines and Immunization), WHO, and UNICEF have expanded access to vaccines and treatments globally. The marketing strategies for monkeypox vaccines reflect the critical need for preparedness in case of future outbreaks, with a focus on early intervention, emergency stockpiling, and public health readiness. These collaborations are crucial in ensuring that vaccines and drugs are made available or subsidized to low- and middle-income countries, which are often more vulnerable to outbreaks. Governments in endemic regions can source life-saving measures through these groups without having to pay for expensive drugs or vaccinations (Sekharan & Varala, 2021).

A key part of the global health strategy to ensure equal access to monkeypox prophylaxis and treatment will be tiered pricing models, whereby rich countries pay more for products to subsidize use in poorer regions . Contracts with government agencies, such as SIGA Technologies and Chimerix, which have been the majority of the businesses' sales to date, especially in countries where orthopoxviruses, like smallpox and monkeypox, are actively surveilled. These drugs are integral parts of national bioterrorism preparedness programs because of their dual-use properties, which offer protection against smallpox and monkeypox. In a larger pandemic preparedness framework, the marketing approach for these drugs highlights their importance for national security as well as for outbreak containment. Monkeypox vaccines and medications have been shown to be effective, but access to them is still a significant problem, especially in low- and middle-income nations.

The scenario in low- and middle-income countries is very different from that of high-income countries, which have been able to acquire significant supplies of necessary therapies like Tecovirimat (TPOXX) and the JYNNEOS vaccine, enabling them to react swiftly to outbreaks. Various factors, such as low production capabilities, costly procurement, and logistics in reaching such products into isolated and underdeveloped places, greatly limit access to these countries. Since both vaccine and antiviral medications require advanced equipment and facility, low production capacities are a major problem.

Because of lack of infrastructure needed to produce these medicines, most low-income nations have to import greatly. However, the expense of Tecovirimat and JYNNEOS makes them unaffordable for many of these nations, even in cases where vaccinations and therapies are accessible. For instance, Tecovirimat can cost up to $1,000 to $1,200 per course of therapy in the United States, which is out of many governments' means in low-income areas, particularly when they are dealing with other public health issues. Purchasing such costly drugs would create significant challenges to effective disease control, even in countries that have some means of finance. In addition to the high cost of drugs, the delivery of vaccines and antivirals is made difficult by logistics.

In locations with limited access to energy, refrigeration, and cold chain infrastructure, medications such as JYNNEOS, which need to be maintained at a precise temperature to retain their efficacy, pose serious problems for distribution. These logistical constraints might delay or even prevent the on-time delivery of life-saving vaccines and drugs in rural and other remote locations. In addition, shortages of staff, insufficient preparation, and weak health infrastructure will make it challenging for many low- and middle-income countries to handle the volume of vaccinations and treatments that need to be administered. In response to these issues, a number of international health organizations have stepped up efforts to increase access to monkeypox vaccines and medications; some of these are UNICEF, the WHO, and GAVI or the Global Alliance for Vaccines and Immunization.

These have ensured that their prices are subsided or given out as donation to low-income nations in their quest to ensuring fair distribution. The primary aim of GAVI's efforts is to negotiate reduced prices with the pharmaceutical companies so that access to monkeypox vaccines is improved. Additionally, the partnership between the public and private sectors has played an important role in scaling up the manufacturing capacity to meet the global needs for vaccinations and antivirals. Another approach that researchers are exploring as a means to reduce costs and bring these medicines and vaccines to more low-income communities is making generic versions. These efforts aren't without their challenges.

The COVID-19 pandemic has disrupted global supply chains, resulting in delays of essential medications including those for the treatment of monkeypox from being manufactured to delivered. Disruptions of the supply chain particularly with regard to raw materials and production procedures made it challenging for timely availability of essential drugs to countries with greatest needs (Vijay et.al, 2022). Added to this problem in areas with inferior infrastructures, another major challenge includes vaccine cold chain requirements such as for JYNNEOS, requiring to be held at specific temperatures in order to ensure the efficacy of vaccine (Varala, 2024). Virological, and without adequate refrigeration, vaccines may degrade or become ineffective. Their use, consequently, is severely limited in resource-poor environments. Finally, knowledge regarding the causative agent and treatment options available for monkeypox remains sparse in most endemic settings.

The public lack of awareness about available drugs and vaccines as well as a deficiency of appropriate education/training among health workers could result in the underutilization of these accessible drugs and vaccines. The effective execution of vaccination campaigns and disease control initiatives may be hampered in some areas by a lack of awareness among the general population and medical professionals regarding the virus, how it spreads, and the significance of immunization. The public may become confused and hesitant about the safety and effectiveness of the vaccines if there is a lack of clear information and risk education. With these challenges in mind, sustained international cooperation is vital (Madhavedi & Varala, 2024).

Improving access around the world to monkeypox vaccines and treatments will require stronger public-private partnerships, investments in health infrastructure, upgraded cold chain logistics, and closing awareness gaps. The removal of barriers attributed to the issue of cost, production, distribution, and public awareness will guarantee the global health actors a sure thing concerning the provision and accessibility of options for preventing and treating monkeypox for people in real need, especially within those low- and middle-income countries that are always at a vulnerability risk with an outbreak of infectious diseases. Ultimately, to ensure that control methods for monkeypox are effective and equitable, a collaborative global approach to rectifying these disparities will be necessary.

5. CONCLUSION

With the right knowledge, early detection, and preventative measures, monkeypox is a treatable illness. People and health systems can collaborate to lessen its effects by knowing its origin, biological makeup, mode of transmission, and preventative measures. The ongoing global monkeypox outbreak has revealed some serious weaknesses in public health systems, access to medicines and international collaboration. And though much has improved, with major advances in vaccines, therapeutics and public health preparedness, the gap between rich and poorer nations, in terms of access, cost and logistical support, remains stark. This challenges can only be tackled with a holistic and global solution based on phonetic justice, innovation, and cooperation. Closing these gaps means shoring up health systems in vulnerable places, better tiered pricing and generic alternatives to make vaccines and drugs affordable and cold chain logistics.

Cooperation among public health agencies, manufacturers and international organizations such as WHO, UNICEF and GAVI are equally crucial for scaling up production and ensuring the equitable distribution of life-saving resources such as medications and vaccines. In the end, minimizing the spread of monkeypox and limiting its mortality rate around the globe will require sustained international efforts to remove barriers, to access and preparedness. By tackling these inequities, the global health community can not only bring this outbreak under control but also help build more resilient systems that are better able to respond to future pandemics.

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Disclosure of Interest

No Conflict of Interest

REFERENCES

[1] Chandran D, Hridya P, Prasanth D, et al. Changing Patterns in the Spread of Human Monkeypox: A Dangerous New Development in Disease Epidemiology. J Pure Appl Microbiol. 2022;16(suppl 1):3106-3118. doi: 10.22207/JPAM.16.SPL1.11

[2] Chimerix, Inc. (2021). Highlights of Prescribing Information [Prescribing information]. https://www.accessdata.fda.gov/drugsatfda_docs/label/2021/214460s000,214461s000lbl.pdf

[3] Duffy J, Myers TR, Marquez P, Rouse D, Brown H, Zhang B, Shay DK, Moro PL. JYNNEOS Vaccine Safety Surveillance During the 2022 Mpox Outbreak Using the Vaccine Adverse Event Reporting System and V-safe, United States, 2022 to 2023. Sex Transm Dis. 2024 Aug 1;51(8):509-515. doi:

10.1097/OLQ.0000000000001978

[4] Hirani R, Noruzi K, Iqbal A, Hussaini AS, Khan RA, Harutyunyan A, Etienne M, Tiwari RK. A Review of the Past, Present, and Future of the Monkeypox Virus: Challenges, Opportunities, and Lessons from COVID-19 for Global Health Security. Microorganisms. 2023 Nov 6;11(11):2713. doi: 10.3390/microorganisms11112713

[5] Jaleel A, Farid G, Irfan H, Mahmood K, Baig S. A Systematic Review on the Mental Health Status of Patients Infected With Monkeypox Virus. Soa Chongsonyon Chongsin Uihak. 2024 Apr 1;35(2):107-118. doi: 10.5765/jkacap.230064

[6] Jennifer, Rigby. (2024, August 15). Siga Says Mpox drug helps Sickest, not all patients,need more data. REUTERS. https://www.reuters.com/business/healthcare-pharmaceuticals/siga-says-mpox-drug-helps-sickest-not-all-patients-needs-more-data-2024-08-15/

[7] Jezek Z, Arita I, Mutombo M, Dunn C, Nakano JH, Szczeniowski M. Four generations of probable person-to-person transmission of human monkeypox. Am J Epidemiol. 1986 Jun;123(6):1004-12. doi: 10.1093/oxfordjournals.aje.a114328

[8] Kotra, V., Mallem, D., Kanuri, A. K., Burra, M. R., Nyamathullah, S., Ying, L. S., Husain, K. A., Varala, R., Sudhakar, Madhavedi., Goh, K. W., Sam, T. H., & Ming, L. C. (2022). Anti-SARS-CoV-2 Biotherapeutics and Chemotherapeutics: An Insight into Product Specifications and Marketing Dynamics. Progress in Microbes & Molecular Biology, 5(1), a0000323. https://doi.org/10.36877/pmmb.a0000323

[9] Kurra M. Narsimhaswamy D. Varala R. n-Covid Drugs and their Relevance in Present Day Scenario. Acta Scientific Pharmaceutical Sciences 2022, 6(1), 113-115. DOI: 10.31080/ASPS.2022.06.0841

[10] Martin, Eugene G.; Cornett, Julia; Mohammed, Debbie Y.; Salaru, Gratian. Rapid Testing Algorithm Performance in a Low-Prevalence Environment. Sexually Transmitted Diseases 47(5S):p S35-S40, May 2020. | DOI: 10.1097/OLQ.0000000000001138

[11] McCollum AM, Shelus V, Hill A, Traore T, Onoja B, Nakazawa Y, Doty JB, Yinka-Ogunleye A, Petersen BW, Hutson CL, Lewis R. Epidemiology of Human Mpox - Worldwide, 2018-2021. MMWR Morb Mortal Wkly Rep. 2023 Jan 20;72(3):68-72. doi: 10.15585/mmwr.mm7203a4

[12] Miller, M. R., Braun, E., Ip, H. S., & Tyson, G. H. (2023). Domestic and wild animal samples and diagnostic testing for SARS-CoV-2. Veterinary Quarterly, 43(1), 1–11. https://doi.org/10.1080/01652176.2023.2263864

[13] Mingda Xu, Caifen Liu, Zhanwei Du, Yuan Bai, Zhen Wang, Chao Gao, Real-world effectiveness of monkeypox vaccines: a systematic review, Journal of Travel Medicine, Volume 30, Issue 5, July 2023, taad048. doi: https://doi.org/10.1093/jtm/taad048

[14] Mullin, E. (2024, August 27). Promising Mpox drug fails in trials as virus spreads. WIRED. https://www.wired.com/story/a-promising-drug-for-mpox-just-failed-in-trials/?utm_source=chatgpt.com

[15] Neil Cunningham, Susan Hopkins, Lessons identified for a future pandemic, Journal of Antimicrobial Chemotherapy, Volume 78, Issue Supplement_2, November 2023, Pages ii43–ii49, https://doi.org/10.1093/jac/dkad310

[16] Parker S, Nuara A, Buller RM, Schultz DA. Human monkeypox: an emerging zoonotic disease. Future Microbiol. 2007 Feb;2(1):17-34. doi: 10.2217/17460913.2.1.17

[17] Priyamvada L, Carson WC, Ortega E, Navarra T, Tran S, Smith TG, Pukuta E, Muyamuna E, Kabamba J, Nguete BU, Likafi T, Kokola G, Lushima RS, Tamfum JM, Okitolonda EW, Kaba DK, Monroe BP, McCollum AM, Petersen BW, Satheshkumar PS, Townsend MB. Serological responses to the MVA-based JYNNEOS monkeypox vaccine in a cohort of participants from the Democratic Republic of Congo. Vaccine. 2022 Nov 28;40(50):7321-7327. doi: 10.1016/j.vaccine.2022.10.078

[18] R Varala. Anti-covid repurposed drug Remedesivir: Zhang's catalytic chiral approach (Case study). Research Journal of Chemical Sciences 2021, 11(1), 84-86

[19] R Varala. Disease X: A Probable Future Pandemic. Acta Scientific Pharmaceutical Sciences 2024, 8(5), 01-02

[20] Reed KD, Melski JW, Graham MB, Regnery RL, Sotir MJ, Wegner MV, Kazmierczak JJ, Stratman EJ, Li Y, Fairley JA, Swain GR, Olson VA, Sargent EK, Kehl SC, Frace MA, Kline R, Foldy SL, Davis JP, Damon IK. The detection of monkeypox in humans in the Western Hemisphere. N Engl J Med. 2004 Jan 22;350(4):342-50. doi: 10.1056/NEJMoa032299

[21] Sekharan C. B. Varala R. COVID-19 Vaccines Across the GlobeA Study. Caribbean J. Sci. Tech. 2021, 9(1), 10-12. DOI: 10.55434/CBI.2021.9110

[22] Sudhakar, Madhavedi.; Varala, R. Ensuring Customer Safety: An In-Depth Study of Covid-19 Precautions in Major Indian Retail Stores and Their Impact on Shopping Experience. Journal of Pharmaceutics and

Pharmacology Research 2024, 7 (4), 1-7; DOI:10.31579/2688-7517/174

[23] Varala R. Bollikolla H. nCovid-19 in 2020: From despair to Hope. Coronaviruses 2020, 1(1), 9-12. DOI: 10.2174/2666796701999200621202839

[24] Varala R. Dubasi N. Madhavedi S. Status of Pharmaceutical Patents during COVID-19 Pandemic. Caribbean Journal of Sciences and Technology. 2022, 10(1), 16-19; DOI:https://doi.org/10.55434/CBI.2022.10103

[25] Varala, R; Madhavedi, S., Looming another global crisis-Monkeypox: Plan of action for third world countries. Asian Journal of Research in Chemistry 2023, 16(3), 221-224. DOI:10.52711/0974-4150.2023.00035

[26] Vijay K.; Madhavedi S.; Varala R. Covid-19 Pandemic: Is it a Challenge or Opportunity for Pharmaceutical Industry around the Globe? J Pharmaceutics and Pharmacology Research 2022, 5(7), 1-3. DOI:10.31579/2693-7247/089

[27] WHO World health organization (21 may 2022). Disease outbreak news; multi-country monkeypox outbreak in non-endemic countries. 2022. https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON385 Accessed on May 23. May 23, 2022

[28] WHO: World Health Organization. (2024, August 14). WHO Director-General declares mpox outbreak a public health emergency of international concern. WHO News. https://www.who.int/news/item/14-08-2024-who-director-general-declares-mpox-outbreak-a-public-health-emergency-of-international-concern

[29] Yoshihiko Kiyasu, Masato Owaku, Yusaku Akashi, Yuto Takeuchi, Kenji Narahara, Sunao Mori, Takashi Nagano, Shigeyuki Notake, Atsuo Ueda, Koji Nakamura, Hiroichi Ishikawa, Hiromichi Suzuki, Clinical evaluation of the rapid nucleic acid amplification point-of-care test (Smart Gene SARS-CoV-2) in the analysis of nasopharyngeal and anterior nasal samples. Journal of Infection and Chemotherapy, Volume 28, Issue 4, 2022, Pages 543-547. https://doi.org/10.1016/j.jiac.2021.12.027

[30] Sachdev, Alysha Kaur, and Vengadesh Letchumanan. 2023. “Insights into Viral Zoonotic Diseases: COVID-19 and Monkeypox”. Progress In Microbes & Molecular Biology 6 (1). https://doi.org/10.36877/pmmb.a0000397