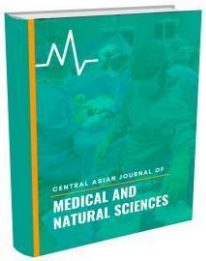

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Article

Monkeypox: A Comprehensive Analysis of The Virus and its Implications for Public Health

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Abstract: Monkeypox (MPX) is a contagious disease caused by a virus related to smallpox. First discovered in the Democratic Republic of the Congo in 1970, it has historically affected parts of West and Central Africa. However, the World Health Organization declared a global health emergency in July 2022 due to its unprecedented spread to Europe, North America, and Oceania, which has raised international concern. The disease poses a significant public health issue, partly because over 70% of the global population is no longer vaccinated against smallpox, which also provides some protection against monkeypox. Despite advancements in treatments and diagnostics, monkeypox continues to cause severe health and economic impacts, with over 85,000 cases reported by January 2023. Vaccines are currently used against monkeypox: two are smallpox vaccines repurposed for monkeypox, and the third is designed for biological threats. The first vaccine is a non-replicating smallpox vaccine suitable for people with weakened immune systems. The second, ACAM2000, is a second-generation smallpox vaccine recommended for monkeypox prevention but not for people with certain health conditions or during pregnancy. The third, LC16M8, is a modified smallpox vaccine aimed at reducing side effects while generating broad immune responses. The effectiveness of these vaccines against the current outbreak remains uncertain. There is a need for new, safer vaccines, with some experts suggesting that vaccines targeting specific immune responses might be more effective. This review seeks to provide updated information on the epidemiology, clinical features, diagnosis, management, and prevention of monkeypox.

Keywords: Antibiotic Profile, Bacteria Isolated, Urinary Tract Infection, Babylon, Iraq

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1. Introduction

Monkeypox (MPX) is a viral disease that affects the animal and plant and occurs due to a dual -chain virus of DNA , He is a member of the Poxviridae family and the gender of Orthopoxvirus, which also includes smallpox virus, known as smallpox virus[1]. The virus was initially discovered at the monkeys at the Statens Serum Institute in Copenhagen, Denmark, in 1958, which led to the appearance of the title 'monkey chickenpox'; A group of children from the Democratic Republic of the Congo represented the first cases that were discovered in 1970 [2]. There are two types of monkey chickenpox virus (MPXV): West Africa variable, with the percentage of mortality of the estimated cases (CFR) less than 4 % and a higher spread among HIV patients and the variable of the Congo basin (Central Africa), with 10 % deaths [3] Historically, smallpox vaccination provides mutual protection against MPX [2]. However, after the declaration of smallpox in 1980 by the World Health Assembly, vaccination against smallpox stopped, and according to estimates, more than 70 % of people around the world are immune to smallpox. Since May 13, 2022, many MPX cases have been reported from many unveiled countries in Europe, North America and

Australia [4], which represents an unusual general health problem and disturbingly given that the disease is not directly related to human or animal travel , Indeed the number of cases reported is amazingly high; There is no direct link between the spread of disease and travel from the infested areas, and it is not clear whether the virus has developed a greater ability to transmit between humans, because we only know little about its general viral development and dynamics [1]. In addition, despite the generally low death rate and the fact that no deaths are reported during the outbreak of the current disease, many unusual aspects are generally concerned. Moreover, despite reporting cases in unspecified areas in recent years, including the outbreak of the disease in 2003 and 2021 in the United States of America and Israel, the disease was spread in September 2018 in the United Kingdom, and the disease was spread in May 2019 in Singapore, The current global epidemiological pattern has not been recorded by [5]. The outbreak of monkeys virus in several countries has gained global attention. Until May 25, 250 confirmed injuries have been reported by monkeys among humans worldwide. Monkey chickenpox causes monkey chickenpox virus, which belongs to the gender of orthopoxic viruses and smallpox viruses. Monkery is often self -infection, as symptoms last for two to four weeks with a death rate ranging between 3 % and 6 %. Monkey chickenpox is transmitted to humans Direct contact with an infected person or animal or contact with a substance contaminated with the virus. Human monkeypox infection may lead to various medical complications such as fever, rash, and enlarged lymph nodes. Pneumonia, encephalitis, eyesight-threatening keratitis and subsequent bacterial infection are all possible complications of monkeypox [6].

2. Materials and Methods

An outbreak of monkeypox several countries

From January 1 and June 15, 2022, 42 countries in five regions of the World Health Organization combined about 2103 confirmed laboratory cases, with only one death [7],. Most cases have been identified (98 %) that have been documented since May 2022 in men who have sex with men (MSM), who seek to get care for primary care and sexual health clinics; However, this is not always the case. To date, no travel links have been discovered to the infested areas. Until July 5, 2022, 5949 cases of MPX were identified throughout the European region through international health regulations and public resources from 33 countries. Of the 5266 cases reported in the European monitoring system (TESSY), 5265 laboratory cases were confirmed, and it was confirmed that 99 cases of the West Africa branch where the sequence was available. The closest date reported for the emergence of symptoms was April 17, 2022. Most cases were in individuals between the ages of 31 and 40 years (2214/5258-42 %) and they were male (5209/5230-99.6 %). Among the cases known as HIV, 40 % (364/917) had HIV appeared on the majority of patients (2684/2793; 96.1 %) rash, while it appeared on 1931/2793; 69% had systemic symptoms such as fever, fatigue, muscle discomfort, vomiting, diarrhea, chills, sore throat or headache [8] ,No deaths were recorded in any of the cases . Although some cases related to health professionals are recorded, more research is done to ensure whether the infection is caused by exposure to work [7]. Due to the lack of epidemic links in the infested areas, the unexpected appearance of MPX in many areas indicates that the transmission of infection is not detected may have been happening for a long time. The outbreak of the current disease differs from the previous outbreak in terms of age (most people with the thirties of life), sex (most cases of males), risk factors, and method of transmission, with a great possibility of transmission by sexual communication. In addition to its distinction with pests and leather rash in the genital enemy, which does not often affect the face and limbs, the clinical appearance is not common and distinctive as well. Fever, enlarged lymph nodes, rash, weakness, fatigue and headache are the most common signs and symptoms [9].

Pathophysiology and Clinical condition

MPX's natural tank has not yet been determined, while mice are the most likely suspect. The potential risk factor is eating well -cooked meat and other animal products

from infected animals. People who live in or near the tested areas may also be exposed to indirect or low -level animals. Although MPX is not easily transmitted, it can be transmitted by touching polluted body fluids or scourge, either directly or indirectly [10]. Direct exposure includes contact with tools, respiratory secretions, or skin contact with the skin with MPX patients. Being in the patient's room or 6 feet from the patient can lead to any treatments that may produce a spray of oral secretions or skin lesions or re -suspends dry secretions without wearing a N95 mask and protecting the eye to indirect exposure [11]. The transition can also occur through the placenta (which can cause moral MPX) or through intimate contact during and after birth. After entering, the virus multiplies in the vaccination site, and it first settles in mono -core Balanti cells. Then it is released in the bloodstream, and finally, it settles again in the skin cells. After the first step of reproduction, it spreads to the local lymph nodes, and therefore, the blood virus raises within 10 to 14 days (the potential nursery period) [12]. Distinctive clinical manifestations, which consist of a rash rash, usually precede early symptoms, such as fever, chills, muscle pain, headache, lethargy, and lymph nodes [13]. It is important that patients are interested, starting from the early symptoms until the pests form scales and scales. Usually oral pharynx is the first affected location, after which pests appear on the skin. The clinical display of the MPX cases associated with the current outbreak has been changing so far. Many cases do not appear in this clinical style described classic MPX (fever and lymph nodes, followed by an advanced rash). The presence of only a few or even one lesion, the pests that start in the genital area or perineum / anal and do not spread, and the pests that appear in different stages (unslicated) of development, and the appearance of pests before the appearance of fever, bowing or other constitutional symptoms are some examples of Abnormal properties [13]. The transition mechanisms during sexual contact remain unknown, although it is known that physical and personal contact with the skin to the skin or face to face may lead to the transmission of infection (through direct contact with the affected skin. Clinical symptoms of monkeys chickenpoxes associated with disease outbreaks in 2022 different from previous reports before the outbreak of the disease in 2022, the average period of custody of the infection of the monkeys virus ranged between 5 and 13 days (range 4-21). People with a history of animal bites or scratches may have a shorter nursery period than those who have been touched only (9 days versus 13 days in a row). During the outbreak of the disease in 2022, the intermediate incubation period generally extends from 7 to 10 days after exposure. The cause of the shortest incubation period may be direct viral pollination through sexual transition [11].

3. Results and Discussion

Pathogenesis

Monkeypox viruses can enter the host through the respiratory tract or skin (Figure 1) The route of entry and the monkeypox virus family may affect how the disease manifests [14].

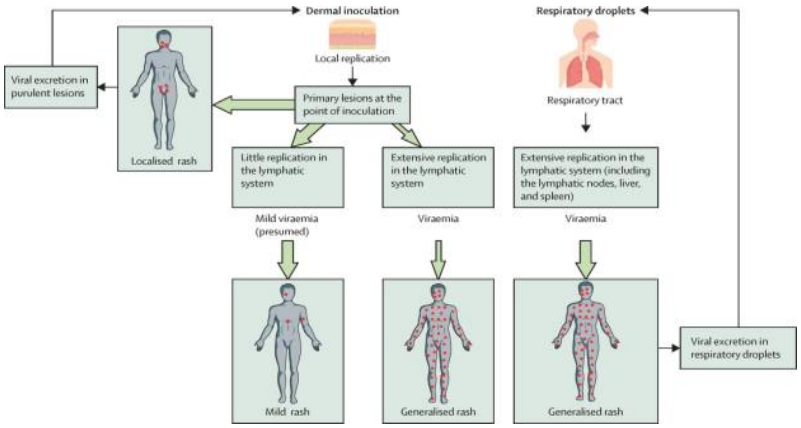

Figure 1. Monkeypox Virus Entry and Pathogenesis.

In the respiratory system, a monkey chickenpox can affect the epithelial cells of the airway, while in the skin, the virus affects keratin cells, fibroids and blanket cells, which leads to productive infection and pathological cells. 55, 56. Moreover, the cells that provide antigens, such as Pamper cells, developed cells, and Langerhens cells (in the skin), are infected with an infection, allowing them to survive enough to carry the antigens to the lymph nodes that drain the blood. The proliferation of viruses, genetic expression and the assembly of virion in cytoplasm the host cell leads to the appearance of mature veins with one fatty membrane, followed by the release of Veriona outside the cell with an additional cover. Surface [15] ,Virus is spreading . Monkeys from the first injury site to the depleted lymph nodes by immigrating cells that provide antigens and viral access to the lymph vessels. After the initial reproduction of the lymph nodes, which leads to a low -grade blood virus, a monkey chickenpox can target other large organs, spleen, and liver, as it enlarges and leads to a second wave of the main blood virus that may allow the virus to spread to distant organs such as lung and kidneys The intestine and skin [16].

Comparison of Monkeypox with Other Orthopoxviruses

Monkeypox is a viral disease caused by the monkeypox virus (MPV), which belongs to the genus *Orthopoxvirus* in the Poxviridae family. This family includes several other notable viruses, such as smallpox, cowpox, and vaccinia.

Monkeypox, a zoonotic disease caused by a poxvirus, has recently gained global attention due to its increasing prevalence and It belongs to the same family as smallpox and shares similarities with chickenpox, often leading to misdiagnosis ,however, monkeypox can be distinguished by its unique rash pattern, with lesions evolving at the same rate, unlike chickenpox where lesions appear in various stages simultaneously [17]. The poxvirus family includes several other zoonotic viruses such as cowpox and orf [18]. Poxviruses have played a significant role in medical history, including the development of the first safe human vaccines and the eradication of smallpox ,with the growing unvaccinated population and changing transmission patterns, monkeypox is now considered the most important poxvirus affecting humans since smallpox eradication [19]. Below is a comparison of monkeypox with other viral diseases in the same family, focusing on key characteristics, transmission, symptoms, and public health implications:

Table 1. Comparison of Monkeypox with Other Orthopoxviruses.

Characteristic	Monkeypox	Smallpox	Cowpox	Vaccinia
Causative Agent	Monkeypox virus (MPV) [1],[2]	Variola virus [20]	Cowpox virus [21]	Vaccinia virus [20]
Transmission	Zoonotic; human-to-human via close contact or respiratory droplets [22]	Human-to-human via respiratory droplets [23]	Primarily from animals to humans [23]	Human-to-human [24]and via vaccination[25]
Symptoms	Fever, fatigue, lymphadenopathy, rash [26]	Fever, fatigue, rash, scarring [23]	Mild lesions, often asymptomatic [27]	Fever,Chills,Muscles and joint pain [28]
Incubation Period	4-21 days [29]	10-14 days [1]	8-12 days [21],[23]	2 days [30]
Severity	Generally self-limiting; severe in immunocompromised individuals [31], [32]	High mortality rate (30%) [33]	Typically mild, rarely severe [34]	Generally mild; used for immunization [35]

Vaccination	Vaccination available; effective against MPV-BN [36]	ACAM2000,APSV,Imvamune [37]	No specific vaccine; exposure to cows can provide immunity[37]	Used htisorically for smallpox vaccination[35]
Current Status	Endemic in Central and WestAfrica; recent outbreaks in non-endemic regions[19],[22],[26]	Eradicated in 1980 [23],[33],[37]	Rare, mostly in veterinary contexts [27],[34]	Used in smallpox vaccination programs [20],[24]

Monkeypox Diagnosis

Monkeypox (mpox) diagnosis has evolved significantly, especially following the recent global outbreaks. The following outlines the key diagnostic methods and considerations based on recent literature.

Diagnostic Methods

1. Polymerase Chain Reaction (PCR):

PCR remains the gold standard for diagnosing monkeypox due to its sensitivity and specificity. A dual-target PCR approach is recommended, targeting both a conserved sequence of the Orthopoxvirus genus and a monkeypox-specific sequence [38]. This method helps in confirming infections accurately, especially given the serological cross-reactivity among orthopoxviruses.

2. Real-Time PCR:

A retrospective study highlighted the effectiveness of a commercially available real-time PCR kit for routine testing in clinical laboratories. This method demonstrated satisfactory clinical parameters, making it a viable option for rapid diagnosis [39].

3. Rapid Amplicon Nanopore Sequencing (RANS):

This innovative approach allows for the differential diagnosis of monkeypox and other vesicle-forming pathogens. It utilizes multiplex PCR amplification followed by nanopore sequencing to accurately identify pathogens, which is crucial in distinguishing monkeypox from similar diseases like chickenpox and herpes simplex [40].

4. Serological Assays:

While PCR is preferred for confirmation, serological tests can also be employed. However, due to cross-reactivity, they are not as reliable for definitive diagnosis as molecular methods [38].

5. Sample Types :

Various clinical specimens can be used for diagnosis, including skin lesions, throat/nasopharyngeal swabs, urine, semen, and blood. Proper sample collection and transport are critical and should follow biosafety precautions [38].

Management and treatment of monkeypox

1. Epidemiology and Clinical Presentation

Monkeypox is caused by the monkeypox virus (MPXV), a DNA virus of the Poxviridae family and Orthopoxvirus genus [41].

Two distinct clades of MPXV have been identified: the Central African (Congo Basin) and West African clades. The Central African clade leads to higher transmission rates, mortality, and more severe disease, As of October 2022, nearly 70,420 monkeypox cases have been reported across 107 countries and territories, with 27 deaths (Ahmed et al.,2024). The most common symptoms include rash and fever, followed by cough, vomiting, anogenital pain/bleeding, conjunctivitis, diarrhea, and genital edema [42].

Preventive measres and infection control

1. Measures to Prevent Monkeypox

Monkeypox is a viral disease that can be prevented by taking several measures. Here are the key prevention strategies:

a. Vaccination

Imvamune, a live non-replicating smallpox vaccine, is approved for active immunization against monkeypox in adults at high risk of exposure ,during periods of adequate vaccine supply, Imvamune should be offered as a two-dose primary series with at least 28 days between doses , When supply is limited, extended dosing intervals and fractional intradermal dosing can be used to maximize vaccine coverage for those at highest risk [43].

Imvamune is a vaccine designed to prevent monkeypox (Monkeypox) and other viruses belonging to the Orthopoxvirus family, such as smallpox. This vaccine was developed as part of public health efforts to combat viral threats and is known for its effectiveness in stimulating a strong immune response. Imvamune works by activating the immune system to produce antibodies that target the monkeypox virus. When exposed to the virus, the immune system responds quickly and begins producing antibodies that recognize and help eliminate the virus , The vaccine contains an inactivated or genetically modified smallpox virus, meaning it cannot cause the disease but is capable of stimulating the immune system to develop immune memory. This memory enables the body to quickly recognize the virus in the future, helping to reduce the severity of the infection or prevent it altogether. Since Imvamune belongs to the same family of viruses as smallpox, it also provides protection against other viruses in the same family, enhancing its role in preventing related viral diseases [44].

During the recent monkeypox outbreaks, Imvamune was widely used, and studies have shown its effectiveness in reducing the risk of infection among high-risk groups, such as healthcare workers and people living in outbreak areas. Additionally, Imvamune is part of comprehensive prevention strategies that also include other vaccines and treatments, such as Tecovirimat, which is used to treat infection after exposure to the virus [44].

There are several vaccines available for the prevention of monkeypox, aside from the Imvamune vaccine. Among these vaccines is ACAM2000, an inactivated smallpox vaccine administered through a skin scarification method. It has been approved in the United States as an alternative option for monkeypox prevention. However, it is important to note that ACAM2000 can cause serious side effects, such as heart problems, making it less preferred compared to some other vaccines, Another option is the JYNNEOS vaccine, which is also approved in the United States for monkeypox prevention. This vaccine is an inactivated or genetically modified smallpox vaccine administered via subcutaneous injection. Studies suggest that JYNNEOS has fewer side effects than ACAM2000, while providing similar effectiveness in preventing monkeypox infection [45].

In addition to these approved vaccines, there are other vaccines under development or in clinical trial stages, such as mRNA vaccines, which have shown promising effectiveness in animal studies, These developments highlight the need to create a new generation of vaccines that are safe and effective, whether they are inactivated vaccines or mRNA vaccines, to combat monkeypox more effectively [45].

Overall, ACAM2000 and JYNNEOS are currently the two main approved options for preventing monkeypox, with JYNNEOS offering a clear advantage in terms of safety. Despite the availability of these options, there remains a pressing need to develop new, safer, and more effective vaccines to fight this disease.

b. Infection Prevention and Control Practices

Recent research on Monkeypox (Mpox) infection prevention and control practices highlights the importance of understanding transmission routes and implementing targeted measures. Studies consistently show that direct physical contact, particularly sexual contact, is the primary mode of transmission , Airborne transmission alone has not been reported, suggesting minimal impact of respiratory interventions, Key prevention strategies include avoiding physical contact, covering lesions, and wearing medical masks, while home isolation may have limited additional benefit for mild cases, it remains a recommended measure [46]. Men who have sex with men are identified as the most

vulnerable population, with healthcare workers and pet owners also at risk , The elderly, immunocompromised individuals, pregnant women, and children face potentially severe outcomes if infected , Effective risk communication and community engagement are crucial for outbreak control [47].

2. Contact Tracing and Monitoring

Contact tracing and monitoring played a crucial role in managing monkeypox outbreaks across different regions. In Virginia, USA, a comprehensive system identified 991 contacts, with 28 (2.8%) developing mpox. Risk categories were strongly associated with infection likelihood, and vaccination was administered to 333 individuals [48] Similarly, in Massachusetts, USA, an investigation of the first US case in the 2022 outbreak identified 166 contacts, categorizing them into risk levels. Despite initial case recognition delays, no secondary transmissions occurred after the 21-day monitoring period [49]. In South Korea, following the first imported case, 49 contacts were identified and monitored based on risk exposure levels. Active monitoring of medium-risk contacts and passive monitoring of low-risk contacts revealed no secondary transmission over 21 days [50]. These studies demonstrate the effectiveness of contact tracing and monitoring in preventing monkeypox spread.

4. Conclusion

In conclusion, monkeypox is a rare viral disease that has recently garnered increasing attention due to its outbreaks in several countries beyond its traditional endemic regions. The spread of the disease is attributed to a complex set of factors, including globalization and increased human mobility. A deeper understanding of the virus's pathogenicity and its different types helps guide efforts towards prevention and treatment. Comparing the various types of monkeypox viruses reveals differences in symptom severity, modes of transmission, incubation periods, and risk levels, necessitating tailored strategies for managing each type. Although some vaccines are available, their efficacy and distribution remain challenging, especially given the limited availability of vaccines in all affected areas. Based on the current data, curbing the spread of monkeypox requires international cooperation and intensified research to achieve effective and sustainable health solution.

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