IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Monkeypox In The 21st Century: An Emerging Zoonotic Threat In The Post-Covid Era

[1]Numan Akhtar, [2]Aiman Tabassum, [3]Aisha Atiur Rahman, and [4]Ayanuddin Salimuddin Mulla, [5]Rubina Sheikh, [6]Dr.sayyad Sajauddin Gulab,

[1]Student, 1Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor, [6]Principal

Central India College of Pharmacy, Lonara, Nagpur, Maharastra, India

Abstract: Human monkeypox is a zoonotic infection caused by an orthopoxvirus, and in many ways its symptoms resemble smallpox. This similarity often makes it hard for doctors to clearly distinguish monkeypox from smallpox or even from varicella (chickenpox) just by looking at the patient. Because of this, laboratory tests remain the key method for confirming cases and keeping track of outbreaks. The problem with monkeypox testing is simple: the tools we have right now are often too slow and not always accurate. That means there's still a big gap in how quickly we can confirm cases, and better tests are badly needed. Most of the infections are still seen in Central and West Africa, usually in rural areas where hospitals and labs are limited, making tracking even harder. Still, health workers have found that simple guides and training materials can make a difference in spotting and reporting cases. Another issue is that since smallpox vaccination stopped years ago, people have lost the natural protection it used to give against related viruses. This has left whole communities more open to outbreaks. To understand how things are shifting, researchers are turning to new epidemiological studies to map out how monkeypox is spreading and what burden it carries.

Index Term - Monkeypox, Zoonotic disease, Emerging infectious diseases, post-COVID-19 era, Viral outbreak, Orthopoxvirus, Global health, public health threat, Epidemic preparedness, Disease transmission, Human-to-human transmission, Animal reservoirs, Pandemic lessons, Viral re-emergence, One Health approach

I.INTRODUCTION

Monkeypox (MPX) is no longer a distant, rare infection—it's now a growing public health concern across the globe. In just the last two decades, we've already seen wave after wave of viral outbreaks: COVID-19, sudden cases of unexplained hepatitis, resurgent measles, and the relentless spread of dengue. Put together, these show how fragile our world really is when it comes to infectious diseases. And the risks keep climbing, thanks to rapid population growth, shifting food habits, globalization, easy international travel, and the impacts of climate change. For years, monkeypox was thought to be a regional zoonotic disease, mostly confined to certain parts of Africa. Reports outside these areas—like in North America, Europe, or Asia before 2022—were rare, usually linked to travelers or contact with animals such as rodents (prairie dogs being a known culprit). But everything shifted in 2022. Suddenly, cases popped up in people who had no history of travel or animal exposure, proving that the virus had started spreading between humans. By October that year, the numbers told the story—over 71,000 cases and at least 26 deaths in 107 countries. The hardest hit, and the most worrying, are low-income countries like Nigeria and the Democratic Republic of Congo (DRC), where already fragile health systems are struggling with limited resources and competing health crises.

On the positive side, fresh vaccines and treatments are coming up and look promising, but they still need more testing before they can be trusted for regular use in the regions where the virus hits hardest. These studies are important for improving how we watch for, stop, and manage this disease that comes from animals and is becoming more common again.[1] Monkeypox caused by monkeypox virus (MPXV). It is a double stranded DNA virus and it is a zoonotic viral disease that comes under Orthopoxvirus genus in Poxviridae family. In

this group, only 4 members infect humans – monkeypox virus, cowpox virus, vaccinia virus and variola virus (smallpox one, now eradicated). Symptoms of MPX look almost same like smallpox such as fever, rash and swollen lymph nodes, but the death rate is less compared to smallpox. On the basis of Genes, MPXV is categorized in 2 clades: Central African clade and West African clade. Cameroon is the only country where both are found. Central African type is more dangerous because it spreads fast and causes severe disease, while West African type is less virulent but still made many outbreaks in Nigeria, Liberia, Sierra Leone, Ivory Coast and even USA (imported from Ghana). The Central African clade has been reported in outbreaks from places like Gabon, Cameroon, Republic of Congo, Central African Republic, Sudan and DRC. Because of this it stays as a big public health issue in central Africa.

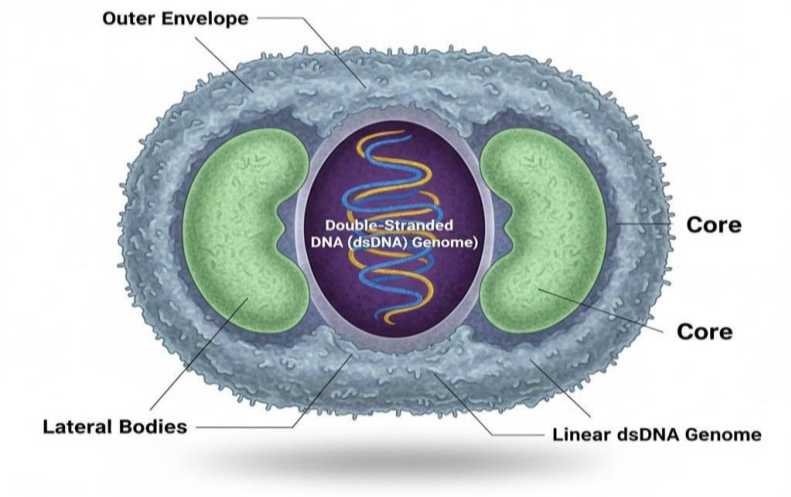
When we look at the bigger picture of viral outbreaks, monkeypox becomes even more important as a global concern. After 2019, the new corona virus (SARS-CoV-2) came up and caused a huge pandemic, totally changing healthcare systems and how public health works around the world. At the same time, outbreaks of other viruses like influenza A, Japanese encephalitis, Ebola, yellow fever and MERS-CoV also keep disturbing health sector. In this situation, the reappearance of monkeypox outside its usual endemic areas of west and central Africa is very alarming. In 2022, a big multi-country outbreak was seen in many European countries and also in the USA, where earlier monkeypox was almost unknown except for some rare imported cases. This showed that MPX is not just a local zoonotic disease anymore, but something with international importance. It clearly needs global level monitoring, proper preparedness and countries working together to control it.

Monkeypox is not some brand-new virus, it actually has a long but less noticed history. Scientists found proof of MPXV infection in stored samples of African rope squirrels (Funisciurus sp.) collected from central Africa more than 100 years back, the oldest one going till 1899. This shows that MPXV has been present in animal hosts for over a century. Some experts even think that a few old outbreaks of pox-like disease might actually have been monkeypox and not variola virus. Still, monkeypox didn't get much attention for many years, because other famous viral diseases and the success story of smallpox eradication took all focus. After smallpox vaccination was stopped in 1980s, people lost that cross-protection against Orthopoxviruses, which created a big group of vulnerable population. Along with factors like international travel, exotic pet trade, environmental changes and more urbanization, this immunity gap helped MPXV to spread worldwide.

The recent outbreak shows that monkeypox (MPX) is changing a lot in how it spreads and also makes us think about many questions like how exactly it transmits, how the disease develop, and why symptoms are looking little different now. Before, it was mostly seen in remote areas of central and West Africa, and usually after animal to human jump. But now it has turn into a global health issue with continuous human to human spread. This shift means we need to study not only the virus itself but also the social, environmental and people behavior reasons behind its spread. So, this review mainly tries to give an updated overview of MPX, like its epidemiology, ways of transmission, clinical features, prevention and treatment options. By putting together what we already know with new problems, the review wants to improve understanding of MPX and help in making better global plans to control future outbreaks.[2]

II. ETIOLOGY AND VIROLOGY OF MONKEYPOX VIRUS

Monkeypox virus (MPXV) is a zoonotic virus which has double stranded DNA and it belongs to the Orthopoxvirus group in the Poxviridae family. It is kind of related to smallpox, cowpox and also vaccinia virus. The virus is quite big in size, around 200–250 nm, and looks like brick in shape. The virus got an outer covering (envelope) and it multiplies inside cytoplasm of the host cell. It can enter the host cell either by attaching to glycosaminoglycans or by copying the process of cell death (apoptotic mimicry). Since it has chances to cause outbreaks, WHO have marked it as a virus that can create epidemic or even pandemic risk.



1: monkeypox virus (MPXV) structure

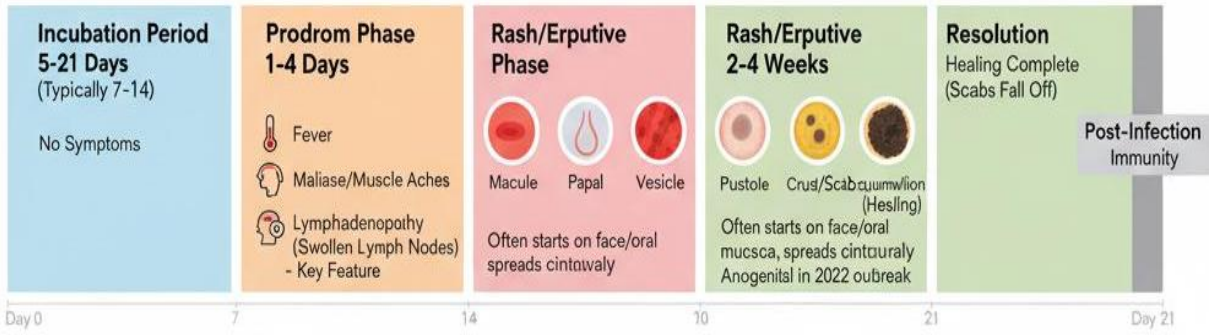
MPXV is mainly divided into two types called clades. Clade I is mostly seen in Central Africa and it spreads more easily and also has more deaths, almost up to 10% in people who are not vaccinated. Clade II is found in West Africa and is again divided into IIa and IIb, but this one usually makes milder form of disease. Earlier monkeypox was only in forest areas of Africa, but now it has spread worldwide.In 2022 there was a big outbreak, it spread in more than 70 countries. Because of this WHO said it is a Public Health Emergency of International Concern. [3] [4]

III. EPIDEMIOLOGY OF MONKEYPOX VIRUS

The Orthopoxvirus family includes different different viruses such as vaccinia, variola, cowpox, and monkeypox (Mpox). Mpox has been reported from several African nations including Benin, Cameroon, Central African Republic, Democratic Republic of Congo, Gabon, Ivory Coast, Liberia, Nigeria, Republic of Congo, Sierra Leone, and South Sudan. The virus was first identified around 1958 inside a lab, and later in 1970 the first human case was recorded in a 9-month-old child who showed smallpox-like signs.

From 1970 to 1990, around 400 monkeypox cases were seen in Africa, with the majority coming from the Democratic Republic of Congo. In 1996, a big outbreak happened with over around 500 confirmed cases in the next year. By 1999, few more cases were reported, and between 2001–2004 labs confirmed 51 positive out of 136 suspected samples. In 2003, monkeypox went outside Africa for the first time when infected rodents were brought into USA, which caused 71 confirmed or suspected cases in six states. Later genetic study showed this outbreak was from West African clade, which spreads between humans but not very easily.

From year 2010 to 2018 different cases of monkeypox appearing in Africa. In year 2017, Nigeria had a big outbreak where 122 confirmed or suspected cases were found in 17 states, and 6 people died, giving around 6% death rate. In 2018, few cases were also reported in UK and some other parts of Europe, which were linked to travelers who came back from Nigeria.



2: phases of monkeypox

In 2022, monkeypox (Mpox) suddenly spread worldwide at a very big level. On 23 July 2022, WHO declared it as a Public Health Emergency of International Concern. By March 2023, the outbreak had reached 110 countries with more than 86,000 cases. What was shocking is that 94% of these countries never had Mpox before, and almost all the cases (99%+) were in new non-endemic regions. United state of America had the most numbers between 28,000 to 35,000 cases and almost 20 deaths, which was about 30 to 35% of total global cases.

Research found that most monkeypox cases were spreading through close sexual contact and also inside family or household settings most cases were seen in younger men, many of them from the group of men who have sex with men, and a large number had never taken the smallpox vaccine. The average age came out to be around 34 years. Many of them said they were bisexual, and a good number were also living with HIV.

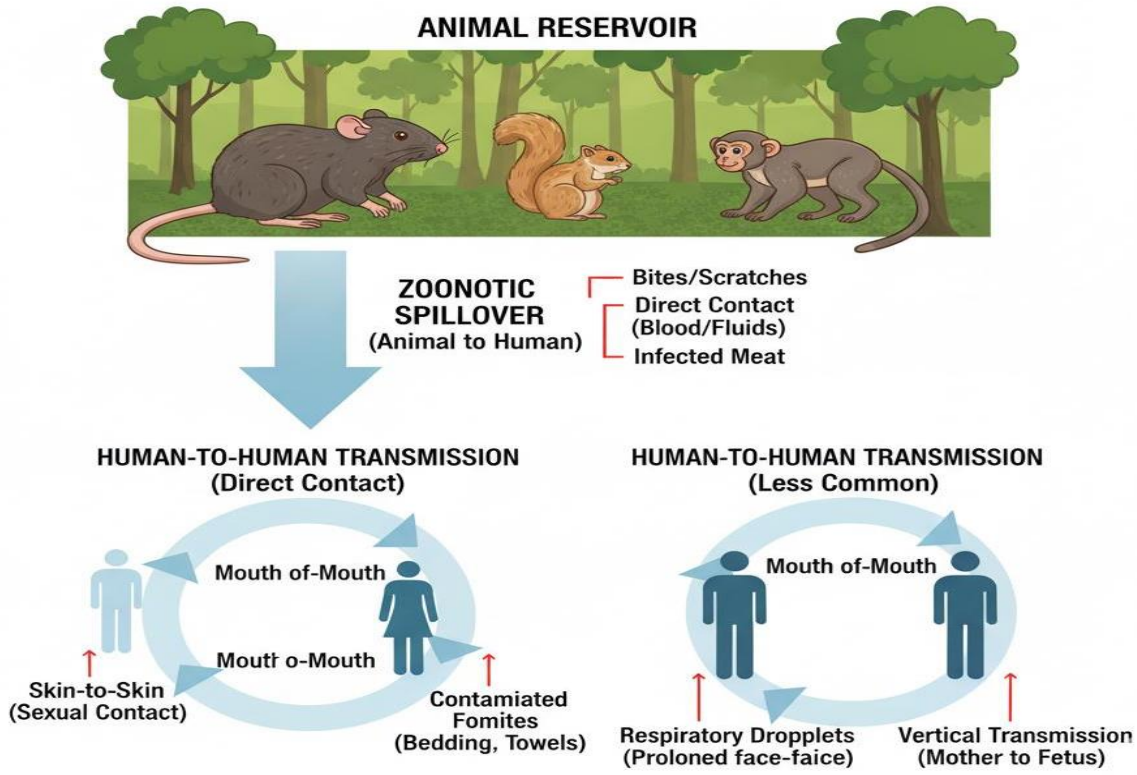
Between Jan 2022 and Nov 2023, WHO reported around 93,000 monkeypox cases and 171 deaths from 116 countries in all 6 regions. This clearly shows how Mpox has shifted from being just a forgotten disease in Central and West Africa to now becoming a worldwide health issue, even having pandemic kind of risk.[5]

IV.TRANSMISSION DYNAMICS OF MONKEYPOX VIRUS:

Pre-exposure vaccination and equal access to vaccines is really important everywhere. In May 2022, monkeypox cases suddenly went up across the world, with more than 70,000 people infected, and almost 99% of these were in countries that never had monkeypox before. By the end of August 2022, the cases started going down slowly. But still it's not fully clear if the outbreak actually ended or if new waves can happen again. To understand this, we need to know better how the virus is spreading, so future prevention steps can be planned.

In one study from the UK, Ward and his team tried to estimate two key things about the monkeypox outbreak—the serial interval and the incubation period. They found that the time between one person getting sick and the next was usually shorter than the time it takes for symptoms to first show up. This means that many people were already spreading the virus before their symptoms even showed up or got detected.

The study had a pretty good number of cases and they did the right stats adjustments to fix some bias in the data. They also checked it by using case and contact pairs to back up the results. But one issue was that a lot of info came from what patients themselves said, so there could be mistakes in memory or how they answered.



3: monkeypox virus (MPXV) transmission cycle diagram

Some studies say monkeypox might spread even before a person shows symptoms. The virus was found in anal swabs of some men who have sex with men, even when they had no signs of illness. But just because PCR test is positive, it doesn't always mean the person can spread it. So people started asking if monkeypox really depends on symptoms for transmission or not.

If Ward and his team's findings are proved by other studies, it means monkeypox can spread even before a person shows signs. This is important for infection control worldwide. Just giving vaccines after someone is exposed, like in "ring vaccination," might not be enough if people can spread it without symptoms. That's why in US and UK, vaccine plans already changed — now they also give vaccines before exposure to some people who are at higher risk.[6]

V. PATHOPHYSIOLOGY OF MONKEYPOX VIRUS:

The monkeypox virus (MPXV), which is under the Orthopoxvirus classification, is similar to smallpox but less severe than smallpox. Typically, infection occurs when a small number of viral particles enters the body through the nasopharynx or respiratory mucosa. Once inside, the virus replicates in the nearby lymph nodes and spreads to the major lymphoid organs, including the spleen, bone marrow, and other lymph nodes. This is followed by the first viremia (approximately the third or fourth day after the initial infection) which is usually asymptomatic.

By the eighth day of illness and presumably during the second viremia, infected leukocytes distribute the virus throughout the body, including the mucous membranes and skin vasculature. Approximately 12–14 days after exposure patients will typically develop systemic symptoms. High fever, malaise, fatigue, headache, and backache are the most common symptoms experienced by patients at this stage. Soon thereafter, the rash appears and starts first in the mouth and throat, and then to the face, arms, body, and legs.

The rash progresses through several stages:

1 Macules (flat spots)
2. Papules (raised lesions)
3. Vesicles (fluid-filled blisters)
4. Pustules (pus-filled lesions with deep embedding in the skin)
5. Crusts that eventually fall off, sometimes leaving scars.

The lesions in the mouth and throat have tremendous amounts of virus and will result in the virus being released in saliva. For this reason, a patient is most contagious during the first week of illness. By the second week of illness, some people will have excessive immune activation, resulting in a cytokine The lesions in the mouth and throat release large amounts of virus into saliva, making patients highly contagious during the first week of illness. By the second week, some individuals may experience excessive immune activation, leading to a cytokine storm that can worsen the disease. Although most cases resolve, complications such as secondary bacterial infections, respiratory distress, pneumonia, gastrointestinal involvement, corneal infection, encephalitis, sepsis, and dehydration may occur. In severe cases, these complications can lead to vision impairment or death.

storm which will worsen consumption of the viral infection. While most cases of monkeypox will resolve, patients can experience further complications in the form of secondary bacterial infections, respiratory distress, pneumonia, gastrointestinal involvement, cornea infections, encephalitis, sepsis, and dehydration in really bad cases, it can mess with eyes and sometimes even cause death.

A defining clinical symptom of Mpox that differentiates it from other diseases is lymphadenopathy (swollen lymph nodes). Lymphadenopathy develops early in the prodromal phase of the disease with fever and headache, and follows within 1–3 days; the rash follows. The illness lasts typically 2–4 weeks, and the skin lesions will heal and the scabs fall off after 6-8 weeks.

Current outbreaks have shown different manifestations of disease compared to classical representation. Usually the rash of monkeypox begins on the face, but in some cases it first comes on the genitals, near the anus, or inside the mouth. This is not the usual way, and it may or may not move to other parts of the body. The spots or wounds are often sore or itchy, which makes the person feel very uneasy.

Mpox looks kind of similar to smallpox in how the sickness runs, but it's not as deadly. Smallpox use to give people heavy fever, wide spread rash and leave deep scars, while mpox is mostly lighter and often clears on its own. But if someone's body defense is weak, mpox can turn serious, spread all over and make them very ill.

Inside the body, the virus first grows in the lymph nodes, then it enters the blood and later shows up on skin and mouth as rashes. The immune system fights against it, but that fight also causes many of the signs and problems we see. Knowing how this happens helps in making better treatments and stopping bad outcomes in weak or risky patients.[7]

VI. CLINICAL FEATURES OF MONKEYPOX VIRUS:

Monkeypox (Mpox) don't look same in everyone. In some cases it is mild and cure by itself, but in people who have weak immune system it can get serious and even danger to life. The gap time from virus entering body to first signs (incubation) is usually 2–21 days. In the new Clade IIb outbreak, most cases showed symptoms around 7–10 days, and many were linked with sexual contact. After this gap, there is a short early stage (prodromal phase) which last 1 to 5 days. During this time, people often feel fever, headache, muscle pain, swollen lymph nodes, tiredness etc. One main difference from smallpox is the swelling of lymph nodes, which appear early in Mpox. But in some new cases this order is not fixed—sometimes these signs come before rash, sometimes with rash, or even after rash start.

he main sign of Mpox is the rash on skin. It goes step by step — first flat spots (macules), then raised bumps (papules), after that small fluid filled (vesicles), then pus filled (pustules), and finally it dry and form scabs. This whole cycle take around 2 to 4 weeks. A person can spread the virus from starting of symptoms until all wounds are healed and new skin come. Normally the rash start on face and then spread to body, arms, legs and sometimes even on palms and soles.

But in new outbreaks around the world, Mpox looks a bit different. Many people got rash first in private parts, anal area, or mouth. Sometimes they had only few sores, or spots in different stages in same area. The lesions in these areas were very painful. Some people also had problems like swelling in rectum (proctitis), throat pain (pharyngitis), urine pipe pain (urethritis) or even eye issues. In rare cases, only one sore was seen, usually at the place where virus entered, like a needle injury in health workers.

Usually Mpox last for 2–4 weeks. In most cases it get better by itself, but sometimes complications happen like extra bacterial infection, breathing problems or eye trouble. Because the symptoms are not always same, especially in new outbreaks, it is very important to notice unusual signs early so doctors can treat it fast and stop spreading to others.[8]

VII.DIAGNOSIS:

As mpox cases are now rising in countries where it was not common before, having fast and trustable tests is very important. To confirm mpox, doctors mostly depend on both clinical checkup and lab tests. The main ways of testing can be put into few groups like tests based on nucleic acid, antigen–antibody tests, pathology methods, and some new advance techniques. Also, it is very important to tell mpox apart from other orthopox virus to make sure the case is correctly confirmed.

Nucleic Acid Tests:

The main method to confirm mpox is by checking the virus nucleic acid. The most trusted test is PCR (polymerase chain reaction), since it gives very high accuracy and sensitivity. Mostly doctors do it in two steps: first a general orthopox PCR to see if the virus belongs to this family, and then a PCR only for monkeypox virus (MPXV). Samples can be taken from blood, saliva, swabs from the blisters/pus spots, or even from scabs. PCR usually looks at some fixed genes of the virus like DNA polymerase, RNA polymerase, F3L, envelope protein, and A-type inclusion body gene. The advanced version, real time PCR (qPCR), makes it even more exact and helps in separating MPXV from other orthopox viruses by using melting curve method. Besides PCR, some newer nucleic acid tools are also coming up. Microarray can find many types of orthopox viruses at once. RFLP and gene sequencing are used to identify very close strains. Easy methods like LAMP (loop mediated isothermal amplification) and RPA (recombinase polymerase amplification) are faster and can work in small clinics or poor resource areas. With these techniques, mpox cases can be detected early and diagnosed in more correct way.

Antigen–Antibody Assay:

Serology tests are helpful to see how body fight with mpox and to know if someone had it before. But they are not so good for checking fresh infection. Long time back, tests like radioimmunoassay and protein check (electrophoresis) were used to find orthopox virus. Now mostly ELISA (enzyme linked immunosorbent assay) is used. This test can show IgM and IgG antibodies, which tell if infection is new or from past. But there is one problem, it can cross react with other orthopox virus and also give false result in people who already had smallpox vaccine. So it cannot be used alone for full confirm diagnosis.

To make tests more correct, monoclonal antibody based methods are developed. Example, antigen capture ELISA looks for virus envelope protein and can detect more types, while monoclonal antibody enzyme immunoassay can identify species more exact. Recently, lateral flow tests are becoming more used because they give fast results at bedside or during outbreak situation.

Pathological Diagnosis:

Tests like histopathology and immunohistochemistry can also help in mpox diagnosis. By looking at skin biopsies, scabs, or infected tissue under microscope, doctors can see changes caused by virus (cytopathic effects). This can also help to separate mpox from some other infections like herpes simplex. But these methods are not perfect, they can’t always tell mpox apart from varicella or other orthopox virus. That’s why they are mostly used as support tools, and PCR is still needed for final confirm diagnosis.

Other Diagnostic Approaches:

With time and better tech, new methods are coming for finding mpox. Earlier, electron microscope was used to see virus particles fast, but it can’t really say which exact type it is. Nowadays, researchers try things like fluorescent protein markers to watch how the virus grows inside cells. PET/CT imaging is also tested to check how infection move in the body. There is also a tool called ABICAP, which works like a quick filter test, and it can catch orthopox virus easily, so it may be handy for testing during outbreaks or in field areas.

Diagnostic Considerations:

To check for mpox in a proper way, both clinical signs and lab tests are needed. Tests like serology or pathology can give some support, but they are not enough alone. The most trusted method is nucleic acid tests, mainly PCR, because it is very sensitive and accurate. Usually, doctors follow a step-by-step process: first they look at the patient’s symptoms, then do molecular testing, and after that use confirmatory tests if needed. In areas where proper labs are not available, quick methods like lateral flow test or isothermal amplification can help to make diagnosis faster and more accessible.[9]

VIII. CURRENT MANAGEMENT OF MONKEYPOX VIRUS

Management of Mpox (Monkeypox):

Right now the treatment of monkeypox is mostly just giving support care, like tablets for fever, pain and making sure patient drinks enough water and eat proper. In very bad cases, doctor sometimes give antiviral medicine like tecovirimat. For stopping the spread, smallpox vaccines (ACAM2000 and MVA-BN) are still used, both before exposure and also after someone comes in contact. Along with this, public health steps are very important like tracing the contacts, keeping infected person alone in isolation, telling people to follow safe sex habits, and working together at international level. Recent studies also showing that monkeypox is changing in how it spread and how symptoms appear, so we still need better test methods and more research on vaccines and treatments.

Prevention and Control of Monkeypox:

Some simple measures can help stop monkeypox from spreading:

1. Infection control: Regular checking and separating animals that may be sick helps to stop animal outbreaks.
2. Hygiene habits**:** Keeping good hygiene and cleaning things that may carry the virus can stop new infections.
3. Vaccination: Vaccinia-based vaccines are given to protect animals and sometimes people from the virus.
4. Separate housing: Monkeys or primates from different regions (like Africa and Asia) should not be kept together to avoid spreading the virus.
5. Avoid animal contact: People, especially those who might already be exposed, should not touch rodents or wild primates, as they can carry and spread the disease.

How they control monkeypox outbreak:

When monkeypox spread, some basic steps are done to stop it:

1. Quarantine: The sick animals are kept away for like 6 weeks so they don't pass virus to others.
2. Finding contacts**:** People or animals who been around the sick one are checked, so we can stop more spread.
3. Cleaning: The place where infected animal stayed is washed and disinfected properly.

Other things they do...

1. They follow rules from govt health dept or CDC website.
2. They tell people about how monkeypox spread, its signs and how to stay safe.
3. Doctors, health workers and animal keepers all work together so outbreak don't go big.

By doing all this, spread of monkeypox can be controlled and chances of outbreak reduce a lot.[10]

IX. HERBAL PERSPECTIVE [CAMELLIA SINENSIS]:

Origin and Early Use of Tea Plant: As per an old Chinese story, tea was first found by Emperor Shen Nong around 2700 B.C., when some tea leaves dropped by chance into hot boiling water. At first, tea was only known in Asian regions, but by the 16th century it started spreading across the world because of European traders.

Plant Features of Camellia sinensis:

Camellia sinensis, the tea plant, belongs to the Theaceae family. It can grow like a small bush or sometimes a tree. On farms it usually grows 0.6–1.5 m tall, but in the wild it can reach up to 10–15 m. The leaves are narrow and long, with small teeth at the sides, hard in touch, about 5–30 cm long, dark green when older, and soft with tiny hairs when young. The flowers are white, smell nice, about 2.5–4 cm big, and have many yellow-tipped stamens. The fruit is a three-sided capsule that holds nut-like seeds.[11]

Old Uses of Green Tea (Traditional use):

Green tea (Camellia sinensis) was use from long time in Chinese traditional medicine. People drink it for keeping health good, helping in digestion, and also for stopping some infections. In old days, they also believe tea can "remove heat and bad things" from body and make immunity strong. Green tea got natural stuff like polyphenols, especially catechins like EGCG, which are thought to fight germs and virus. Because of this, many times it was used as natural way to prevent flu, common cold and fever type sickness.[12]

Phytochemistry:

Traditional Use of Green Tea:

Since very old times, people in China were drinking green tea (Camellia sinensis) as a kind of natural medicine. They used it to stay healthy, for better digestion, and also to fight against small sickness. In old Chinese practice, it was said to "remove body heat and bad toxins" and also to make the body's defense system strong. Green tea has some natural stuff inside like polyphenols, mostly catechins such as EGCG, which are believed to stop germs and viruses from spreading. Because of this, it was often used against common cold, flu, fever and similar problems, so people started to see it as a natural drink for protecting from infections.[13]

How it Works (Mechanism):

The main catechins in green tea (Catechin, EGCG, EC, EGC) may stop the Mpox virus from growing. They do this by blocking an important enzyme called VP39, which the virus needs for making its RNA and multiplying. Computer-based studies showed that these natural compounds can stick to VP39 and disturb the virus life cycle. Also, they follow Lipinski's rule and have good safety profile, which means they can be useful in making new antiviral drugs in future.[14]

Evidence Against Mpox:

Green tea (Camellia sinensis) from the Theaceae family is often called a "polyphenol factory" because it contains many useful natural compounds. The main ones are catechin, epigallocatechin (EGC), epicatechin (EC), and epigallocatechin gallate (EGCG). These compounds are well known for their antiviral, antioxidant, and immune-supporting effects.

Studies on viral diseases show that green tea polyphenols can block important viral proteins and enzymes. For example, during COVID-19, they showed activity against the main protease of SARS-CoV-2. This means they may work as broad antiviral agents against different viruses.

For monkeypox virus (MPXV), one key target is an enzyme called VP39, which helps the virus protect its RNA and multiply. Recent computer-based studies (in-silico) found that green tea compounds can attach strongly to VP39, in some cases even better than sinefungin, a known inhibitor.

These studies also checked drug properties like safety, absorption, and bioavailability. The results were positive, suggesting that green tea compounds may be safe and effective. Among them, EGCG appears the most promising.

Overall, tea polyphenols could be explored as natural and affordable supportive treatments for monkeypox, with further research needed in labs and clinical studies.[15]

X. SAFETY AND TOXICITY PROFILE:

A 91-day study was done to check the safety of polyphenol-rich green tea extract (PGTE) when given orally. The results showed no treatment-related deaths. At very high doses (2500–5000 mg/kg/day), a few animals did die, but this was linked to errors during gavage dosing rather than the extract itself. The animals that received PGTE maintained normal body weight and food intake, and no unusual symptoms appeared before death. From this, it can be concluded that PGTE has a wide safety margin and is generally well tolerated even when given at high levels.[16]

Herbal formulation & preparation:

Formulations of Camellia sinensis (Green Tea) Green tea extracts, especially those packed with catechins like EGCG are well known for showing antiviral effects. Water-based extracts are mostly used because they are easy to make and considered safe. These extracts have also been turned into gels by mixing with ingredients like carbopol, glycerin, and preservatives. The gels stay stable for longer, release the active compounds slowly, and can be applied directly on skin or mucosal areas to stop viruses from entering or multiplying.

One problem with EGCG is that it doesn't dissolve well in water and doesn't last long in the body. To fix this, researchers are working with nanoparticle systems and mix formulations that combine EGCG with other natural or synthetic agents. These new approaches help improve absorption, expand the range of antiviral action, and lower side effects. In short, green tea formulations look like a useful, patient-friendly option for both prevention and treatment of viral infections.[17]

Modern Proof of Antiviral Effect:

These days, many computer-based studies show that green tea compounds can fight against viruses. Researchers collected catechins and polyphenols from online chemical databases and checked them for things like drug-like behavior, safety, and possible viral targets. Docking studies found that some of these compounds stick well to the main protease of SARS-CoV-2, which is needed for the virus to multiply. This suggests green tea may slow down viral growth. Some studies also showed that these compounds might affect human genes linked to immunity. All this gives scientific support to the old use of green tea as an antiviral, with EGCG and similar catechins looking useful for new drug ideas.[18]

Future Herbal Research Prospect

Even though green tea catechins like EGCG are strong, they don't work well in the body because they break down fast, don't dissolve easily, and have short life. To fix this, researchers are testing nano-drug delivery systems, like tiny particles made from chitosan or PLGA. These systems can protect EGCG, help it stay longer in blood, and make it absorb better in the stomach. They also improve how well it works, as seen in some cancer studies. In future, more focus should be on making safe, cheap, and disease-specific nano carriers, so the full health benefits of green tea polyphenols can be used.[19]

XI. CHALLENGES AND FUTURE PERSPECTIVES

Problems in Monkeypox

1. Hard to catch early – Monkeypox looks like other sickness in starting, so doctors sometimes confuse it and late diagnosis happen.
2. Less treatment choice – There is not many medicine for monkeypox, most people just get normal care like fever tablet, fluids etc.
3. Vaccine problem – Vaccine is there but not easy for everyone to get, specially in poor area, so outbreak control is still hard.
4. Lack of awareness – Many people don't know much about monkeypox, so they don't take care until it get serious.

Future of CRISPR for Monkeypox

1. Better and fast test – CRISPR can make test more fast and correct, so patient can be treated in starting only.
2. New type medicine – In future, CRISPR maybe help to make new drugs for monkeypox and other virus disease.
3. Simple kit use – Small CRISPR kit can be used anywhere, like in small clinic or village, just like rapid test.
4. Cheaper option – If CRISPR test become low cost, then even small hospital can use it.

What CRISPR Means for Us

1. Less time, less work – CRISPR reduce lab work and give quick result in less time.
2. Not only DNA/RNA – New CRISPR type may check other thing also, not just genetic stuff.
3. Help in other field also – Not only in health, CRISPR can help in farming, food safety, and animal disease control.
4. More trust on test – People may trust result more if it is quick and correct, so treatment start faster.[20] [21]

XII. CONCLUSION:

The monkeypox outbreak in recent years showed us how serious this virus can get and why we should be more careful in future. Since it is a zoonotic disease, it can spread from animals to humans and also from person to person, which makes it a big problem for public health. Poor countries suffer more because their health system is not strong enough. For controlling future outbreaks, we need better testing methods, some effective medicine, and proper prevention plans. Also, knowing more about how this virus spreads, live in nature, and act inside human body will help to make good health policies and stop the disease in better way.

Monkeypox: A Growing Public Health Problem

Monkeypox is a rare illness that looks a lot like smallpox, and it is caused by the MPXV virus. In recent years, it has started showing up again, which makes it a public health concern. The death rate is usually low, but in some cases, especially in children, the disease can get worse. The severity mostly depends on things like:

1. How much virus the person is exposed to
2. The health condition of the person before getting sick
3. The type of problems or side effects that happen
4. How quickly the patient gets proper treatment
5. How strong or weak the person's immunity is

This paper tries to collect what we already know about monkeypox and also talks about the new problems that are coming up. The aim is to give a better understanding of the disease and help in making plans to stop future outbreaks.

REFERENCES:

1. Andrea M. McCollum, Inger K. Damon, Human Monkeypox, Clinical Infectious Diseases, Volume 58, Issue 2, 15 January 2014, Pages 260-267, https://doi.org/10.1093/cid/cit703

2. Hamdana, A. H., Mohsin, H., Tharwani, Z. H., Masood, W., Furqana, A. Q., Sohail, A., Durdana, A. R., Ashraf, M. T., Uddin, N., Islam, Z., Essar, M. Y., Marzo, R. R., & Habib, Z. (2023). Monkeypox virus and other emerging outbreaks: An overview and future perspective. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. Advance online publication. https://doi.org/10.1177/00469580231175437
3. Edouard Lansiaux, Nityanand Jain, Sniedze Laivacuma, Aigars Reinis, The virology of human monkeypox virus (hMPXV): A brief overview, Virus Research, Volume 322, 2022, 198932, ISSN 0168-1702,
4. Shayan Zamani, Elahe Noroozi, Alireza Hasanzadeh, Erfan Zamani, John C. Trinidad, Alireza Firooz, Mpox infection: A state-of-the-art overview of epidemiological, molecular, and clinical aspects following the 2024 public health emergency, Journal of Infection and Public Health, 10.1016/j.jiph.2025.102940, **18**, 10, (102940), (2025)

5. Srivastava S, Laxmi , Sharma K, Sridhar SB, Talath S, Shareef J, Mehta R, Satapathy P and Sah R (2024) Clade Ib: a new emerging threat in the Mpox outbreak. *Front. Pharmacol.* 15:1504154. doi: 10.3389/fphar.2024.1504154

6. Centers for Disease Control and Prevention. (n.d.). 2022 mpox outbreak global response. https://www.cdc.gov/poxvirus/monkeypox/response/2022/index.html

7. Ogoina, D., & Okwor, T. (2024). Mpox and related poxviruses: A literature review. Asian Pacific Journal of Tropical Biomedicine, 14(8), e14080. https://doi.org/10.4103/2221-1691.391234

8. Thornhill, R., Barkati, S., Walmsley, S., Rockstroh, J., Antinori, A., Harrison, L. B., Palich, R., Nori, A., Reeves, T., Habibi, M., Apea, V., Boesecke, C., Vandekerckhove, L., Yakubovsky, M., Sendagorta, E., Blanco, J. L., Florence, E., Moschese, D., Maltez, F., ... Taylor, G. P. (2024). Mpox clinical presentation, diagnostic approaches, and treatment strategies: A review. JAMA, 332(20), 1727–1737. https://doi.org/10.1001/jama.2024.20036

9. Lin Jiang, Ailan Xu, Lin Guan, Yong Tang,WILEY Online Library A review of Mpox: Biological Characteristics, epidemiology, clinical features, diagnosis, treatment, and prevention strategie 8 October 2024 https://doi.org/10.1002/EXP.20230112

10. Brown K, Leggat PA. Human Monkeypox: Current State of Knowledge and Implications for the Future. Trop Med Infect Dis. 2016 Dec 20;1(1):8. doi: 10.3390/tropicalmed1010008. PMID: 30270859; PMCID: PMC6082047.

11. Mahmood, T., Akhtar, N., & Khan, B. A. (2010). The morphology, characteristics, and medicinal properties of Camellia sinensis tea. Journal of Medicinal Plants Research, 4(19), 2018-2023.

12. Wang, Changjian1; Yang, Zhiying1; Chai, Xin1; Wang, Yuefei1,2; Wang, Weili3,*; Zhang, Min1,2,*. Tea as a natural gift for discovering antiviral candidates. Acupuncture and Herbal Medicine 2(4):p 211-220, December 2022. | DOI: 10.1097/HM9.0000000000000048

13. Zhao, T., Li, C., Wang, S., & Song, X. (2022). Green tea (Camellia sinensis): A review of its phytochemistry, pharmacology, and toxicology. Molecules, 27(12), Article 3909. https://doi.org/10.3390/molecules27123909

14. Shah, S., Harle, U., Yende, S., Arora, S., Kapgate, P., Girdekar, A., & Moharir, K. (2025). Targeting mpox virus proteins with tea phytochemicals: A computational study. Progress in Natural Products Research, 100337. https://doi.org/10.1016/j.prenap.2025.100337

15. Sumit Arora, Pranjali Kapgate, Avanti Girdekar, Keshav Moharir, Subhash Yende, Sapan Shah, Uday Harle. "Targeting Mpox virus proteins with tea phytochemicals: A computational study." Pharmacological Research – Natural Products, Volume 8, September 2025, 100337. https://doi.org/10.1016/j.prenap.2025.100337

16. Karousou, R., Balta, M., Kordali, S., Kokkini, S., & Lanfranco, S. (2012). Ethnobotany of medicinal plants in three villages of the district of Tiriáfe (Pindus mountains, Northwestern Greece). Journal of Ethnopharmacology, 142(2), 358–377. https://doi.org/10.1016/j.jep.2012.04.032

17. Mishra, N. N., Kesharwani, A., Agarwal, A., Polachira, S. K., Nair, R., & Gupta, S. K. (2018). Herbal gel formulation developed for anti-human immunodeficiency virus (HIV)-1 activity also inhibits in vitro HSV-2 infection. Viruses, 10(11), Article 580. https://doi.org/10.3390/v101105808d8044

18. Kanbarkar, N., & Mishra, S. (2020). Matrix metalloproteinase inhibitors identified from Camellia sinensis for COVID-19 prophylaxis: An in silico approach. Advances in Traditional Medicine. Advance online publication. https://doi.org/10.1007/s13596-020-00508-9493f34eb175d

19. Natarajan, S. B., Chandran, S. P., Vinukonda, A., & Rajan, S. (2019). Green tea catechin loaded nanodelivery systems for the treatment of pandemic diseases. Asian Journal of Pharmaceutical and Clinical Research, 12(5), 1–7. https://doi.org/10.22159/ajpcr.2019.v12i5.27308df09c1

20. Hamdana, A. H., Mohsin, H., Tharwani, Z. H., Masood, W., Furqana, A. Q., Sohail, A., Durdana, A. R., Ashraf, M. T., Uddin, N., Islam, Z., Essar, M. Y., Marzo, R. R., & Habib, Z. (2023). Monkeypox virus and other emerging outbreaks: An overview and future perspective. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. Advance online publication. https://doi.org/10.1177/00469580231175437

21. World Health Organization. (2022). Vaccines and immunization for monkeypox: Interim guidance, 24 August 2022. https://iris.who.int/bitstream/handle/10665/361894 /WHO-MPX-Immunization-2022.2-eng.pdf

22. Shahril Raza Khan, Tohed Chand Quresh, Mohammad Sufiyan Ansari, Ayanuddin Salimuddin Mulla, Ganesh Pradip Akone, Rubeena Shiekh, Dr. Sayyad Sajauddin Gulab, Early Onset of Alzheimer's Disease it's Variant and its Herbal Managerial Tools, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 9, 2252-2264. https://doi.org/10.5281/zenodo.17165676