

Review Article

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Monkeypox: Is it our Fault?

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ABSTRACT

The shock and awe of Covid-19 is still very much with us - the world has experienced first-hand the devastating effects of an out-of-control viral pandemic. Just as we are getting our arms around COVID-19, we find ourselves in the midst of a new threat - the monkeypox virus. Monkeypox is a known quantity to the scientific community and has been for more than 60 years. Mostly relegated to the tropical rainforests of Central and West Africa; this zoonotic disease has largely been ignored in Europe and the Americas until just recently. Cases of the monkeypox infection first appeared sporadically among gay and bisexual men. Europe first reported cases in mid-2022. Shortly thereafter, the United States saw its first cases in large metropolitan areas such as New York, Chicago, San Francisco and Los Angeles. Monkeypox infections are transmitted through close personal contact with infected individuals. The World Health Organization has declared monkeypox a "Public health emergency of international concern". Monkeypox is genetically similar to smallpox. Although no treatment for the monkeypox virus exists, antivirals and vaccines developed for smallpox have proven effective against monkeypox. Because of its similarity to smallpox, individuals infected with monkeypox demonstrate attenuated symptoms (i.e. fever, chills, muscle aches, sore throat and cough) as compared to those infected with smallpox. After a 3-week incubation period, monkeypox goes away on its own in approximately 2-5 weeks. Diagnostic testing and disease confirmation is performed via RT-PCR testing of genetic material from the infected areas and through the presence of lymphadenopathy (i.e. enlarged lymph nodes). This overview serves as a point of discussion of the aforementioned areas and provides commentary on understanding methods of prevention and containment of the disease. In summary, the power of viral spread causing global pandemics is not to be ignored or neglected - and much more research is to be conducted.

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Introduction

Throughout history, humanity has been in constant battle with outbreaks of infectious diseases that have spread like wildfire across the globe [1-4]. Many of these have been characterized by making the jump from animals to humans and humans to humans.

The Plague, Cholera, Flu, Respiratory Ailments (SARS-CoV, MERS-CoV), Yellow Fever, H1N1, H2N2, HIV and AIDS - are well known examples [5-7]. These infectious diseases have laid waste to entire civilizations [6, 7] and brought powerful nations to their knees, leaving millions dead in their wake. Many well-known extinction-like events such as the Plague which appeared in Europe in the 14th century and estimated to wipe out between 25 to 50 million people [8-11] the Spanish Flu of 1918 infected 500 million people and killed approximately 50 million worldwide [12, 13] and the 2014 - 2016 Ebola outbreak in West Africa which killed up to 90% of the people it infected - all demonstrate the speed and voracity of an epidemic [14, 15].

Humanity entered a new dawn in 2019 with yet another contagion that proved to be the deadliest viral outbreak the world has seen in more than a century. The world is now in the grips of the novel coronavirus disease (COVID-19) [16]. All hope is not lost - through the advances in modern medicine, specifically in the

fields of vaccine and virology [17, 18] this deadly infection is better understood and its vice-like grip on humankind is slowly giving way. What was a ravenous and untreatable disease just a few years ago is now being held at bay. We still have a long way to go in eradicating these diseases, but one thing is for certain, science and public policy working hand in hand can stop the spread and hopefully eradicate these life-threatening contagions.

Globally, the fear of COVID-19 appears to be abating [19-21]. Higher vaccination rates, greater vaccination availability, public awareness and public policy are all contributing factors to allay the fears associated with COVID-19. Furthermore, all these factors have resulted in declining infection and death rates.

While we are still struggling with this phase of better managing the COVID-19 pandemic, the makings of another potential pandemic have now appeared on the world's radar [22, 23].

Monkeypox

Similar to that of COVID-19, the Monkeypox virus has taken a foothold in countries around the world and we are now witnessing a surge in cases [22-25]. It is appearing in countries in which it has historically been foreign or unheard of. Like that of COVID-19 or any other such viral disease, the threat of rapid outbreak, rapid mutation, public policy response, vaccination development and availability - all driving factors from the COVID-19 playbook - are

once again front and center for the Monkeypox virus [26]. This of course begs the question; does this have the potential to become yet another epidemic of the 21st century?

Etiology

Monkeypox is a rare zoonotic disease that jumps from animals to humans and humans to humans [27]. It is caused by the monkeypox virus (genus Orth poxvirus) [23, 28-31]. Despite being called Monkeypox, monkeys are not the origin of the virus - the true origin is unknown [22, 24, 32]. It is predominantly found in animals including squirrels, rats and various monkey species, which reside in the tropical rainforests of Central and West Africa [22, 24].

Its discovery in 1958 was first observed in a Denmark laboratory conducting research on monkeys imported from Singapore [20, 21, 33]. These monkeys displayed signs of two distinct outbreaks of the virus. The virus was first isolated from a 9-year old child suspected of having smallpox (1970, in DRC) [22].

Oftentimes ignored and neglected, cases of monkeypox have spiked since its relative dormancy during the 1970's. In recent times, eleven African countries led the case count followed by a May 2022 outbreak in the UK [34]. The UK outbreak was attributed to British citizens who exhibited signs and symptoms shortly after returning from Nigeria [35-37]. This outbreak in the UK was followed by sporadic instances in 16 countries including those in continental Europe, the United States, Canada, Australia, the United Arab Emirates, Brazil and India [26, 38]. Since then, case counts have grown dramatically worldwide, especially in the United States.

Monkeypox has been circulating for many decades [15, 16, 18, 19] in the tropical rainforests of Central and West Africa. Two distinct strains of the monkeypox virus are known to exist; the more severe Central African (Congo Basin) strain and the less severe West African strain. The current global outbreak is caused by the West African strain. Previously known as the Central African or Congo Basin clade and the West African clade, the strains have officially been renamed by the World Health Organization (WHO) and are now referred to as Clade I and Clade II, respectively [23]. The subvariant, Clade IIb, is responsible for the current global outbreak. In addition to the nomenclature adopted by the Centers for Disease Control (CDC); MPV, MPXV or hMPXV are also abbreviations used by the scientific community.

Under an electron microscope, the virus can be described as being a large "brick" enveloped by a lipoprotein with double-stranded DNA. Its size is noted as being between 200 - 250 nanometers and its mutation rate is observed to be slower than that of the coronavirus [22, 23, 24, 28, 39].

Monkeypox causes flu-like symptoms similar to smallpox. It produces fever, chills, and painful pustule-like bumps or open sores [32, 42]. There is no cure and it usually goes away on its own. Symptoms are rarely fatal; however, fatalities have been noted in places with inadequate health care infrastructure.

Epidemiology

The first occurrences of monkeypox detected in humans occurred in 1970 in the Democratic Republic of Congo [23, 31, 32, 34], where incidentally, the greatest concentration levels have been observed. Monkeypox was rarely reported outside of Western and Central Africa until 2022 [26, 40-43].

In recent times, the first outbreak outside of Africa was noted in 2003. In that year, 53 cases of monkeypox were reported in the United States [35, 40]. Since then, an increase in case counts over varying geographies have been documented. Notably, during the 2018 - 2021 time period, a dozen travelers from the UK, Singapore, Israel and the United States had signs and symptoms of monkeypox; the common thread being travel to Nigeria [24, 25, 32, 35, 44].

Mid-2022 is when the first signs of a possible monkeypox pandemic began to emerge. Outbreaks were reported in the United States and more than 29 counties on continental Europe and worldwide; where historically, no epidemiological links existed (i.e. travel history) [35, 40].

Contrary to popular belief, monkeypox is not a "gay disease". Human to human transmission spreads mainly through close contact with bodily fluids, skin lesions, mucosal surfaces (i.e. mouth or throat), respiratory droplets and contaminated objects (i.e. bedding and clothing). Because of these transmission characteristics; gay, bisexual, or any individual regardless of sexual orientation or gender are at greater risk when coming into personal contact with someone who has been infected with monkeypox [35]. The CDC has stated the consumption or contact with dead animals (eg. rats, squirrels, monkeys, apes and other wild game) from Africa be avoided [44-47].

Based on symptom development parameters (day 0, 19 & 33), evidence points towards human-to-human transmission. To date, the CDC has confirmed 73,000+ cases worldwide with 28 fatalities. 26,000 cases and 2 deaths have been confirmed in the United States alone. The WHO has declared the monkeypox outbreak to be an international emergency [48], as these numbers will undoubtedly rise over the coming months and perhaps years.

Signs and Symptoms

Monkeypox exhibits symptoms that are similar to that of smallpox, but less severe in nature. The outward appearance of the monkeypox is similar to that of chickenpox. However, these two diseases are very different and are caused by two distinct viruses [26, 42, 49- 52].

The Incubation period of monkeypox is typically between 6 and 13 days, in certain cases incubation periods of between 5 and 21 days have been observed. Even though monkeypox exhibits milder symptoms than smallpox, it is accompanied by painful pustules and rashes [53]. These symptoms usually last between 2 and 4 weeks.

A predominant sign of the monkeypox infection is a rash. This rash is described as lesions that become pus-filled which are often painful or itchy. The rash typically develops on the face and then migrates to the rest of the body (hands, feet, chest, eye, genitals and rectum). After approximately 4 weeks, the rash scabs over and eventually falls off - in severe cases permanent scarring from rash and/or sores have been observed.

The symptoms of monkeypox can vary. Infected individuals display flu-like symptoms like fevers, chills, muscle and body aches and lymphadenopathy (swollen lymph nodes) [34, 43, 44]. Respiratory symptoms such as a sore throat, nasal congestion and coughs are also noted.

The above signs and symptoms vary from person to person. Infected individuals develop a rash followed by symptoms and in some cases it is completely the opposite; symptoms are followed by a rash. Some infected individuals develop a rash only and no symptoms. The latest research indicates that individuals who are asymptomatic (i.e. have the virus but show no outward symptoms) can spread the monkeypox virus [54-57].

Differential Diagnosis: Monkeypox, Smallpox and Chickenpox

The symptoms of monkeypox, smallpox and chickenpox are very similar and can be difficult to differentiate at first glance [47]. A predominant characteristic of the monkeypox virus is lymphadenopathy or swollen lymph nodes and pre-eruptive fever. Swollen lymph nodes are one of the hallmarks of monkeypox, which distinguish it from chicken or smallpox. Additionally, an analysis of the skin rash provides insight into viral diagnosis. Visually, the rash produced by the monkeypox virus has many similar cues to the ones caused by secondary syphilis, herpes simplex and varicella-zoster viral infections.

A simple RT-PCR (real time polymerase chain reaction) test from skin lesions or from open sores produces answers. Interestingly enough, a blood test is not deemed reliable due to the fact it produces inconclusive results as to the virus type.

Differential Diagnosis: Monkeypox and Smallpox

Both monkeypox and smallpox belong to the Orthopoxvirus family - they have many similarities and many differences. Smallpox is much more contagious, easily transmissible, quite severe and often fatal; while monkeypox symptoms are milder. Smallpox has been eradicated globally, whereas incidents of monkeypox are on the rise [50].

The most prominent difference between the two viruses is the occurrence of swollen lymph nodes in monkeypox cases. To accurately diagnose monkeypox, a tissue sample of the lesion/rash or fluid from the rash must be taken and sent to a qualified lab.

There, a RT-PCR test is performed to confirm the diagnosis. Samples collected from skin, saliva, urine or rectum can also be used in emergencies.

Differential Diagnosis: Monkeypox and Chickenpox

The symptoms of monkeypox and chickenpox are very similar, the only difference being the presence of swelling of the lymph nodes in monkeypox cases. Monkeypox is caused by the orthopoxvirus while chickenpox is a herpes virus [51]. The monkeypox virus is highly contagious and faster spreading in nature than the chickenpox virus. Rashes first appear on the face and then spread to the rest of the body for incidents of monkeypox; conversely, rashes for chickenpox start on the chest, back, and face and then spread to other parts of the body. Both viruses are transmitted from skin-to-skin contact. Rashes caused by the monkeypox virus tend to appear at the same time and disappear at the same time after 2 - 4 weeks. Rashes caused by the chickenpox virus appear in waves and tend to disappear in approximately 2 weeks.

Fatalities attributed to the chickenpox are very rare; while fatalities attributed to monkeypox have a 1-11% case to fatality rate.

Complications

Just as the long-term effects of COVID-19 are slowly becoming known, Monkeypox too is demonstrating its lasting impact on infected individuals. Monkeypox for all intents and purposes is

still very new to the Americas and Europe. As case counts increase and more observational data is gathered, monkeypox's existence is defined by some very real physical, psychological and neurological disorders. More long-term studies are needed to understand the true impact of the virus - but a clear indication of what's to come leaves no question as to this uphill battle.

From a physical standpoint, complications from the monkeypox virus can include secondary infections, bronchopneumonia, sepsis and infections of the cornea (which may lead to vision loss) [58-60]. Additional symptoms may also include nausea, vomiting and diarrhea; all resulting in severe dehydration [34]. The CDC states that proctitis has also been observed in more than 10% of those infected. Damage to other sensitive internal tissue (i.e. anorectal, urethral) is also a hallmark which can lead to persistent long-term pain, physiological functions and other arduous symptoms. Even more insidious is the physiological and neurological impacts of monkeypox.

Encephalomyelitis, or inflammation of the brain and spinal cord, have also been observed by the CDC. These neurological conditions may lead to seizures, weakness and difficulty walking, headaches, confusion and memory loss.

A more interesting and often overlooked symptom is the impact that physical scarring has on the individual's psychology [60]. Although it is not a "gay disease", monkeypox is a virus that for the most part is transmitted through sex between men. Physical scarring from lesions and rashes may persist for several months or perhaps even years. In certain communities where body dysphoria, hypersensitivity and stigmatization are prevalent, the psychological distress caused by permanent "cosmetic imperfections" can be devastating to an individual's mental well being. This in turn can trigger other stresses and/or anxieties which may lead to yet more physical disorders.

Mortality and Morbidity

Thousands of monkeypox cases have been reported in recent years from Central and Western Africa and a growing number of cases are being reported from Europe and North America [25].

According to the CDC, individuals who are immunocompromised, children under 8 years of age, women who are pregnant or breastfeeding, individuals with a history of eczema, individuals that have prolonged exposure to the virus or individuals with severe symptoms are at greater risk for serious illness or death [38]. Furthermore, the CDC states that 96% of the cases are amongst men, 2% in women and slightly more than 2% in transgender and "undelcared" genders.

Although recovery from monkeypox can be measured in a few weeks, the case-fatality ratio attributed to the virus is in the neighborhood 1-11%. For strains (clades) that originate in West Africa and Central Africa, the case-fatality ratio is about 5% and 11%, respectively. Of note, the West African clade is rarely fatal with a 99% survivability rate [61, 62].

Detection and Diagnosis

The most distinguished and reliable clinical feature of monkeypox is the presence of enlarged lymph nodes. More specifically, the submental, submandibular (i.e. jaw), cervical, and inguinal nodes [47]. Both smallpox and chickenpox do not display these visual characteristics.

The most common diagnostic tool is the RT-PCR test (real-time polymerase chain reaction). The RT-PCR test is the “silver-bullet” test as it is the preferred method due to its accuracy, sensitivity and turn-around time. Of note, blood tests are not used to determine the presence of the monkeypox virus as they are deemed to have results that are inconclusive and lack accuracy [63-76].

To determine the presence of the monkeypox virus, diagnostic samples from rash lesions & fluids, throat culture and skin biopsies are used. The handling of these specimens is critical – they should be stored in a cool, dry and sterile environment and sent to a qualified laboratory for RT-PCR testing [64].

A diagnosis of the monkeypox virus is also conducted using several methods including: patient profile (age, type and date of symptoms, contact tracing, etc.) and travel history (travel to “hot spots”, contact/interaction with infected animals).

Histopathology

To determine the presence of the monkeypox virus, a histopathological examination of diagnostic samples is carried out by 3 methods: 1) Histology 2) Immunohistochemically and 3) Electron Microscopy.

1. Histology - H&E (hematoxylin and eosin) staining shows the presence of acanthosis, epidermal and keratinocyte necrosis. Vascular lesions show spongiosis with reticular and ballooning degeneration of keratinocytes. The epidermis also shows moderate inflammatory infiltrate of neutrophils, lymphocytes and the presence of multinucleated cells and eosinophilic. H&E histological staining of the monkeypox virus is nonspecific and are similar to other viruses [67-69].
2. Immunohistochemically (IHC) - IHC staining for Orthopox viral antigens is done in reference laboratories. Viral antigens are detected within the lesions of epidermis keratinocytes, follicular, eccrine epithelium and few dermal mononuclear cells [63].
3. Electron Microscopy (EM) - Electron microscopy reveals round-to-oval with sausage shaped virions measuring 200 to 300 um within the keratinocyte cytoplasm at various stages of assembly [67, 69].

Using RT-PCR assay for the extracellular-envelope protein gene of the monkeypox virus can be distinguished by IHC and EM [67].

How does monkeypox spread?

The monkeypox virus can spread in any number of ways. Animal-to-human (zoonotic) transmission occurs when an individual comes into contact with the cutaneous or mucosal lesions of an infected animal. Viral transmissions also occur by being bitten or scratched by an infected animal or eating the meat of an infected animal [70, 71].

Human-to-human transmissions can occur through many forms and degrees of contact. Prolonged exposure to an infected individual through face-to-face contact, hugging, cuddling or massage may transmit the monkeypox virus. Direct contact with an infected individual's rash, lesion, scab or bodily fluids may transmit the monkeypox virus. More intimate exposure with an infected individual through kissing, oral/anal/vaginal sex, skin contact of the genitals (male & female) may transmit the monkeypox virus. Risk mitigation through fewer or limited sexual partners may decrease exposure risk to the monkeypox virus. For infected males, leading research indicates the detection of the monkeypox virus in the semen; however, the transmissibility of

the monkeypox virus through the semen, vaginal fluids, urine or feces has not been established [72].

Pregnant women can transmit the monkeypox virus to the fetus via the placenta. Additionally, individuals whose jobs expose them to orthopoxviruses may be at risk as well (eg. first responders, lab workers, public safety officers, healthcare professionals, etc.).

Coming into contact with items (i.e. clothing, linens, towels, etc.) or surfaces that were previously touched or used by an infected individual may transmit the monkeypox virus. Individuals who are asymptomatic can spread the monkeypox virus as well [73].

Treatment

There are no medicines available to treat the monkeypox virus. The virus usually goes away on its own after it runs its course of between 2 to 4 weeks. Most therapies concentrate on treating and alleviating symptoms during the infection period. Once the viral infection goes away, individuals usually start feeling better. Since monkeypox and smallpox viruses are genetically similar, antiviral drugs and vaccines developed to protect against smallpox can also be used to prevent and treat monkeypox infections. Symptoms can be managed through various methods: 1) Over the counter medication 2) Antiviral drugs 3) Smallpox vaccines [22-24, 28, 74].

1. Over the counter medication - there are several over the counter medications available for symptom relief and secondary bacterial infection. Analgesics for pain relief (i.e. Ibuprofen, Advil, Motrin) and antipyretic for fever reduction (i.e. Acetaminophen, Tylenol) are just a few examples.
2. Antiviral drugs - due to the genetic similarity between the smallpox virus and the monkeypox virus; antivirals used to treat smallpox have shown to be effective in the treatment of monkeypox cases as well [40, 75, 76]. Despite the lack of thorough clinical studies, Tecovirimat (TPOXX or ST-246), an intracellular viral release inhibitor for smallpox, has proven to be an effective remedy for monkeypox cases as well. These antivirals are recommended for patients with severe illness. Other antivirals of note are Brincidofovir and Cidofovir (DNA polymerase inhibitors). Of note, Brincidofovir increases liver enzymes and Cidofovir is toxic to the kidneys.
3. Smallpox vaccine - the CDC encourages the use of smallpox vaccines to protect against the monkeypox virus for those individuals who are at higher risk due to lifestyle factors and immunocompromised profiles. Smallpox vaccines (ACAM2000, Jynneos, Intravenous Vaccinia Immune Globulin, IMVANEX) are an effective mechanism to prevent, control and reduce outbreaks of viral infections [77, 78].

These vaccines offer greater benefit if given before for preventing the disease; and soon after exposure to reduce the symptoms and severity. According to studies carried out by the WHO, smallpox vaccines have an 85% efficacy rate at preventing monkeypox. If smallpox vaccines are given to children, monkeypox symptoms may be milder if contracted at a later stage in life.

It is recommended by the CDC that individuals aged 18 years and older and who have been exposed to monkeypox be vaccinated to prevent a viral infection and to lessen any potential symptoms. This treatment protocol is known as Post-Exposure Prophylaxis (PEP). PEP can also be administered to individuals who are unaware of their personal exposure, but who live in areas where monkeypox exists.

Monkeypox Prevention

It is of the utmost importance that a healthcare provider be contacted immediately if an individual experiences signs or symptoms of the monkeypox virus. Healthcare providers will diagnose an infection through testing and physical examination. In the event of exposure or infection, healthcare providers will administer treatment protocols to prevent an infection or decrease the severity of it [52, 70, 71, 75-78].

Telltale signs and symptoms of a monkeypox infection include feeling feverish, body aches and pains, swollen lymph nodes and the appearance of new sores or rashes. If an individual experiences something more critical like trouble breathing, chest pain, confusion, loss of consciousness or seizures - go to the emergency room and seek treatment immediately.

It is best to take appropriate safeguards to prevent exposure to the monkeypox virus. These safeguards are multi-dimensional and depending on an individual's demographic profile, one or more of the following prevention mechanisms may be appropriate.

Screening: If an individual identifies with or belongs to the gay/bisexual community, screening for the monkeypox virus is recommended as the majority of cases in the current monkeypox outbreak are from this demographic. The incubation period for the monkeypox virus is between 5 and 21 days and as such monitoring for emerging symptoms or changes in temperature should be done twice daily. Of note, all medical service providers and first responders should use personal protective equipment (PPE) when interacting with individuals infected with the monkeypox virus.

Vaccination: If an individual believes to have been exposed to the monkeypox virus or identifies with the gay/bisexual community, monkeypox vaccinations are available. A monkeypox vaccination will assist in containing the virus and help reduce its spread.

Isolation: If an individual is infected with the monkeypox virus, self-isolation is the recommended course of action. Ensure all lesions and sores are covered and make certain they do not come into contact with bedding, linens, clothes or surfaces. Keep lesions and sores covered until they scab over and fall off naturally. Wait until a new layer of skin has formed. Do not allow sores or rashes to come into contact with non-infected individuals.

Intimacy: If you are infected with the monkeypox virus, alert all of your sexual partners or any individuals you have had close contact with. Ensure all parties involved closely monitor themselves for new and emerging signs and symptoms. Seek medical attention immediately so as to contain the spread of the virus and to mitigate new or worsening health conditions. It is best to avoid all acts of intimacy (i.e. kissing, hugging, cuddling or engaging in sexual acts) with infected individuals or those who display signs or symptoms of the monkeypox virus.

Travel: Avoid travel to locations where monkeypox is known to exist. Central and West Africa appear to be the hotspots. It is also best to avoid contact with live, sick or dead animals that are known spreaders of the monkeypox virus (eg. rodents and primates). This also pertains to ingesting these types of animals.

Social Norms and Protocols: The arrival of COVID-19 taught the social norms and protocols to follow to help mitigate the risk of catching and spreading the virus. Those very norms and protocols apply equally to the monkeypox virus. Although monkeypox is

not as deadly or transmissible as COVID-19, the same care must be taken in social settings. It is best that infected individuals wear a well-fitted mask which covers the mouth and nose; cover any rashes or sores with clean, dry clothing; avoid skin-to-skin or close contact; wash hands frequently with soap and water; frequent cleaning and disinfection of surfaces and do not share bedding, towels, linens or clothing with others. Infected individuals should not donate blood or any other genetic material. These social norms and protocols also apply to individuals that are not infected.

These safeguards have been in place through the COVID-19 pandemic and have proven to be effective. The same safeguards should be employed during the monkeypox outbreak to contain and stop the spread of infection.

Take Home Message

The monkeypox virus in many ways resembles the same outbreak profile humanity has seen over the centuries. The difference being that modern science, public policy, financial resources and political fortitude have been the saving grace in shaping viral containment and eradication. Understandably, countries with the willingness and ability to deploy these resources have fared better during these times of crisis.

Not all countries are equipped in the prevention and preparedness of epidemics - it is therefore necessary to align government bodies to standardize protocols on engagement, transparency, knowledge sharing, clinical management, mutation research and surveillance. That notwithstanding, the development of affordable, fast, accurate and widely available testing, therapeutics and vaccines must be the collective goal.

This democratized approach is the only hope mankind has of better managing the magnitude and severity of future viral outbreaks.

The monkeypox virus, just like COVID-19 before it, was not on America's radar - and just like that, a few sporadic cases first seen in Europe, eventually landed on the shores of America; where a lack of immunity to orthopoxviruses had the makings of another potential epidemic. Monkeypox is a viral zoonotic disease with origins in and endemic to Western and Central Africa. It spreads from animals to humans and spreads through human-to-human contact.

Genetically similar to smallpox, both are part of the orthopoxvirus family. From a transmissibility and severity perspective, monkeypox is less contagious and demonstrates symptoms far less severe than smallpox. Serologic studies point to evidence that show it may be more infectious than originally thought. Because of its genetic similarity, vaccines and antivirals developed to combat smallpox can also be used to control and contain monkeypox. ACAM2000, Jynneos and Tecovirimat are just a few examples of smallpox vaccines and antivirals that guard against monkeypox with very good results.

In typical cases, a 5 to 21 day incubation period is followed by symptoms that range from fever, muscle aches and swollen lymph nodes. Fluid filled rashes/sores on the face, chest and other extremities appear that eventually dry up and fall off. The entire course of infection runs between 2 to 4 weeks.

Unlike smallpox, monkeypox cannot be fully eradicated due to the existence of an animal reservoir. Because of this, incidence of monkeypox cases require rapid diagnosis, treatment and

an effective public health response for outbreak containment. Vaccinations, antivirals, pandemic-inspired social protocols are all critical components of viral outbreak containment. Simply put, this responsibility falls on the shoulders of every man, woman and child - "no one is safe until everyone is safe" [27, 32, 70].

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