

Monkeypox Virus Outbreak 2022: Key Epidemiologic, Clinical, Diagnostic, and Prevention Considerations

Jeffrey Kwong, DNP, MPH, ANP-BC, ACRN, FAAN, FAANP* • Katherine C. McNabb, MSN, RN, ACRN • Joachim G. Voss, Ph.D., RN, ACRN, FAAN • Alanna Bergman, MSN, AGNP-BC, AAHIVS • Kara McGee, DMS, MSPH, PA-C, AAHIVS • Jason Farley, PhD, MPH, ANP-BC, AACRN, FAAN, FAANP

Abstract

Monkeypox is a zoonotic infection that manifests as dermatologic lesions that may be painful or pruritic and can appear on the face, trunk, extremities, genitals, and mucosal surfaces. In 2022, cases of monkeypox increased exponentially and it was declared a public health emergency by the World Health Organization and the U.S. Department of Health and Human Services. Unlike previous monkeypox outbreaks, the current situation has disproportionately affected men who have sex with men and seems to be associated with lower mortality. Options for treatment and prevention are limited. The distribution and availability of vaccines and antivirals has posed challenges for patients, clinicians, and public health systems. Early recognition and management of persons with monkeypox is critical in controlling the spread of this infection. This article reviews key features of monkeypox and highlights current recommendations for clinical management, prevention, and considerations for persons with HIV. Implications for public health and nursing are discussed.

Key words: clinical management, HIV, monkeypox, nursing

Monkeypox was declared a public health emergency by the World Health Organization (WHO) and the U.S. Department of Health and Human Services (U.S. DHHS) in the summer of 2022 (WHO, 2022e; U.S. DHHS, 2022). This zoonotic infection was first identified nearly 65 years ago and has been considered endemic in West and Central Africa for decades (Kozlov, 2022). However, the rapid global spread of the disease in 2022 has brought monkeypox to the attention of health officials, policy makers, and clinicians from around the world. This article describes the current epidemiology, clinical features, diagnosis, treatment, and prevention of monkeypox disease. Considerations for persons with HIV (PWH) and implications for public health and nursing practice will also be discussed.

Background

Monkeypox was initially detected in 1958 among colonies of research monkeys in Africa with the first

reported human case occurring in 1970 (Centers for Disease Control and Prevention [CDC], 2022a). Outbreaks of monkeypox have occurred on multiple occasions in West and Central Africa since 1970; however, our knowledge of the extent and true incidence has been limited due to persistent challenges with diagnostic capabilities (Durski et al., 2018). These cases of monkeypox were believed to be limited to those with direct animal contact and their household contacts.

A 2017 outbreak in Nigeria offered evidence of a changing infection with a greater incidence occurring among adults (median age, 29 years), most of whom were male (84%) living in urban centers (Ogonia et al., 2019). Additionally, these cases were noted to have a high prevalence of genital lesions (65%) and occurrences in households/congregate settings (Ogonia et al., 2019). The outbreak would eventually include 61 confirmed and 172 suspected cases. Additional cases thought to be related to the 2017 outbreak were later identified in travelers to Nigeria who came from Israel and the United Kingdom, each presenting with genital ulcerations as the site of initial vesicular lesion (Erez et al., 2019; Vaughan et al., 2018).

Previous cases in the United States have been short-lived and easily contained with limited person-to-person spread. In 2003, 47 cases were identified in six states in the United States (CDC, 2022m). These cases were thought to originate from pet prairie dogs imported from Ghana. In these cases, no noted person-to-person

Jeffrey Kwong, is a Professor, Rutgers School of Nursing, Newark, New Jersey, USA. Katherine C. McNabb, MSN, RN, ACRN, is a doctoral candidate, Johns Hopkins School of Nursing, Baltimore, Maryland, USA. Joachim G. Voss, is a Professor, Frances Payne Bolton School of Nursing, Case Western Reserve, Cleveland, Ohio, USA. Alanna Bergman, is a doctoral candidate, Johns Hopkins University School of Nursing, Baltimore, Maryland, USA. Kara McGee, DMS, is an Associate Professor, Duke University School of Nursing, Durham, North Carolina, USA. Jason Farley is an Endowed Professor of Nursing Innovation and Leadership, Johns Hopkins University School of Nursing, Baltimore, Maryland, USA.

*Corresponding author: Jeffrey Kwong, e-mail: kwongj@sn.rutgers.edu

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transmission occurred. Further analysis of the outbreak suggested that the type and route of exposure to the animal influenced the type and severity of clinical illness. This may offer some insight into the current outbreak and the assumptions of a high degree of person-to-person spread among sexual networks. In 2021, 2 unrelated monkeypox cases were identified in the United States after individuals traveled to Nigeria in July and November, but these cases resulted in no additional occurrence of disease (CDC, 2022m).

Current Epidemiology of the 2022 Outbreak

On May 6, 2022, a person with recent travel to Nigeria was linked to a cluster of cases among men who have sex with men (MSM) who attended a dance party in the United Kingdom (WHO, 2022c). The infection took advantage of several confluent factors that are believed to have contributed to the current global outbreak. These factors included multiple celebrations of LGBTQ pride events throughout the United Kingdom, Europe, and the United States that involved large gatherings of people from diverse geographic locations; sexual networks of gay, bisexual, and other MSM that may have facilitated person-to-person transmission; and pent-up demand for international travel (Vivankos, et al., 2022; Vusirikala, et al., 2022). As of August 12, 2022, more than 31,799 cases in 89 countries have been reported with more than 9,000 cases occurring in the United States (CDC, 2022r). Although the epidemiology of the current outbreak is highly concentrated among gay, bisexual, and other MSM, cases among cis-gender women as well as children have begun to emerge (CDC, 2022r).

Virology and Pathophysiology

Monkeypox virus belongs to the Poxviridae family of viruses, Orthopoxvirus genus, and is an enveloped double-stranded DNA virus with distinct genetic clades (Weaver & Isaacs, 2008). Clade I, previously known as the Central African or Congo Basin clade, has historically caused more severe disease and is thought to be more transmissible. The current monkeypox outbreak has been linked to two subvariants from Clade II (formerly known as the West African Clade; WHO, 2022b). The subvariants, Clade IIa and IIb, are perceived to have lower mortality and less probability of person-to-person spread (WHO, 2022d). For further review of the phylogenetic differences of the strains, including the factors differentiating virulence, we recommend papers by Weaver and Isaacs (2008) and Chen, et al., (2005).

Monkeypox virus uses a complex intracellular replication process in the cytoplasm of infected cells (McFadden, 2005). The virus preferentially infects CD14⁺ monocytes, and the virus is believed to use several immune-evading mechanisms to avoid CD4⁺ and CD8⁺ T-cell viral defense mechanisms (Hammarlund et al., 2008). It is also believed that the virus down-regulates T-cell host responses, facilitating cell-to-cell transmission and intracellular viremia within the host, thereby allowing systemic dissemination.

Once a person has an exposure leading to infection, the incubation period may range from 5 to 21 days (CDC, 2022g). In the initial report on the outbreak among MSM in 16 countries, the median incubation period was 7 days (range, 3–20 days; Thornhill et al., 2022). It is currently believed that a person becomes infectious after skin lesions have manifested, but the CDC acknowledge that research is limited on whether infection is possible during the incubation period (CDC, 2022q).

Transmission

The infection is known to spread through person-to-person or person-to-animal contact, which includes contact with skin or contaminated environmental surfaces or other fomites (CDC, 2022q). Droplet-based transmission when a person coughs, sneezes, sings, or laughs is also possible. Transmission to contacts within the same household, as well as in congregate settings like prisons, has been documented (Vivancos et al., 2022). Health care worker infections have been documented both in historical outbreaks and in the current 2022 outbreak (Vivancos et al., 2022).

Much speculation has been made about whether monkeypox is a sexually transmitted infection (STI). The virus can unquestionably be transmitted during contact associated with sexual encounters. It remains to be seen, however, whether exposure to sexual fluids is the primary mode of transmission or if exposure to the vesicular lesion and/or fluid is the primary mode of transmission. The virus is present in seminal fluid and there is at least one publication suggesting the virus is replication competent at day 6 of symptom onset (Lapa et al., 2022). It remains unclear, however, if viral replication is occurring in the genital tract. The patient in this report did continue to have low-level virus in his semen for 19 days, whereas the skin lesions tested positive through 17 days. Unfortunately, the study did not collect saliva, which is also known to carry monkeypox virus (Lapa et al., 2022). A team from Barcelona also noted viral shedding in saliva and shedding across multiple bodily fluids, including

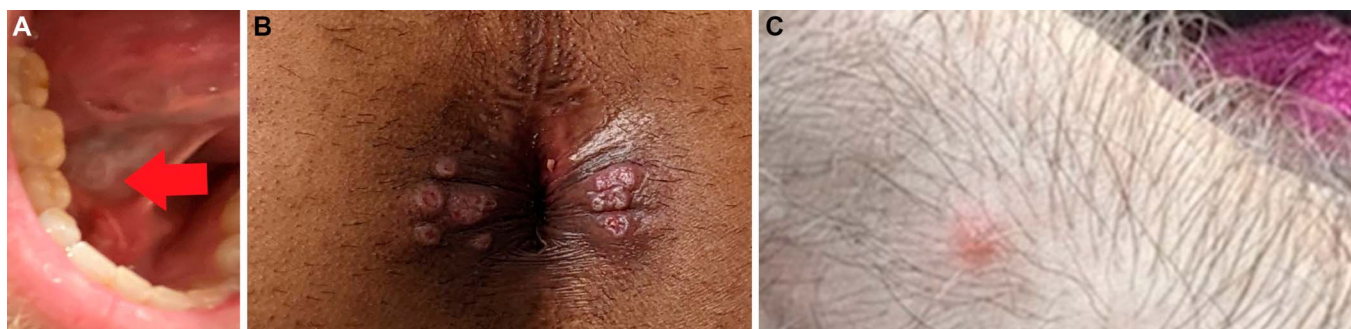


Figure 1: Monkeypox lesions. This figure is available in color online www.janacnet.org.

seminal fluid, urine, and feces, for up to 16 days after illness onset (Pieró-Mestres et al., 2022).

Clinical Presentation and Diagnosis

The clinical presentation of monkeypox is characterized by the eruption of itchy or painful dermatologic lesions that evolve from macules to papules then to vesicles that eventually form scabbed lesions (CDC, 2022q). The initial lesions are typically firm, round, and well-demarcated and can range in size from 2 to 5 mm in diameter. Lesions may appear as single discrete lesions or can be clustered into larger confluent lesions (Thornhill et al., 2022).

Dermatologic manifestations can occur on any part of the body, including the face, trunk, extremities, palms, soles, or genitals. Lesions may also begin on the mucosal surfaces of the rectum, urethra, vagina, or oral pharynx (Adler et al., 2022; Thornhill et al., 2022). Please see Figure 1 for illustrations of monkeypox lesions on different anatomical sites. In these situations, a patient's initial complaint may be painful sensations in these areas without any external lesions. Therefore, monkeypox should be considered in people who report symptoms consistent with proctitis, tenesmus, urethritis, stomatitis, or vulvodynia.

Some individuals may experience a prodromal syndrome characterized by fever, fatigue, malaise, and localized lymphadenopathy. Data from the initial cases seen in the current U.S. outbreak have found that 42% of cases did not have prodromal symptoms as an initial symptom (Philpott et al., 2022). Thus, the absence of these symptoms should not exclude monkeypox as a diagnosis. Information from cases reported to the CDC between May and July 2022 demonstrate that genital lesions occurred in nearly half of all cases (Philpott et al., 2022). This aligns with initial data from a case series of monkeypox cases reported in 16 countries between April and June 2022, in which anal–genital lesions accounted for nearly 73% of cases (Thornhill et al., 2022).

The differential diagnosis of monkeypox is broad and includes herpes, syphilis, chancroid, folliculitis, measles, contact dermatitis, proctitis, acne vulgaris, coxsackie virus, chancroid, scabies, lymphogranuloma venereum, and molluscum contagiosum, among others (CDC Health Alert Network, 2022). As part of the history, clinicians should assess potential exposure through close contact with individuals who may have similar symptoms, travel history, occupational exposure, or sexual exposure. Persons who may have an exposure that may put them at risk for an STI, or those who have symptoms suggestive of an STI, should be screened for these conditions. Concurrent STIs have been documented in the current outbreak, with nearly 30% of documented cases having a co-occurring STI diagnosis (Thornhill et al., 2022).

Laboratory Testing. Monkeypox infection is confirmed through direct detection of orthopox virus from lesions. Polymerase chain reaction testing of lesions is now offered through many state and commercial laboratories. The protocol for obtaining specimens varies by laboratory, so clinicians should consult with their local laboratory vendor for specimen collection requirements. Most require a swab of the lesion using a nylon, polyester, or Dacron swab (CDC, 2022l). Some laboratories require the top layer of a skin lesion to be removed or opened up before swabbing to get a better sample of the lesion, whereas other laboratories do not require the lesion to be opened. Regardless of the laboratory in which the specimens are processed, most require swabs from two to three different lesions. Specimens should be kept refrigerated until processed (CDC, 2022l). Results of specimens submitted for testing can range from 24 to 72 hr depending on the laboratory.

Treatment and Management

Although monkeypox is a self-limiting condition that usually resolves within 2 to 4 weeks of symptom onset,

there are potential complications that may have lingering effects. Other complications of monkeypox infection include secondary bacterial infections of the lesions, respiratory distress, bronchopneumonia, encephalitis, loss of vision if there is ocular involvement, vomiting, diarrhea, and dehydration (WHO, 2022a). Additionally, in people with urogenital manifestations, there is the possibility of stricture development. It is important to note that the dermatologic manifestations of the illness may result in permanent skin changes, leaving patients with hypopigmented and hyperpigmented scarring and alopecia to some areas (CDC, 2022q).

Symptomatic Treatment. Given that monkeypox is a self-limited disease, the mainstay of patient management is symptom control (CDC, 2022j). A variety of options exist for symptom relief (Table 1). It is important to note that the degree and severity of lesions may not reflect the intensity of symptoms (CDC, 2022h). Specifically, patients with internal lesions (such as oral, urethral, rectal, or vaginal) may have limited external lesions but experience severe, debilitating pain. Some patients require hospitalization for pain control. For people with urogenital or rectal pain who require topical or targeted pain relief that is unrelieved with readily available formulations, it may be helpful to work with a local compounding pharmacy to identify special preparations of topical anesthetics (such as rectal suppositories), that patients can use for pain relief.

Antiviral Treatment. There are no drugs approved for the treatment of monkeypox by the U.S. Food and Drug Administration (FDA). The antiviral, tecovirimat (TPOXX), which is FDA approved for smallpox, has shown some efficacy against monkeypox in vitro and in animal studies (CDC, 2022j). This medication has been made available for people with monkeypox through an emergency use investigational new drug (IND) application process (CDC, 2022n). Tecovirimat acts by inhibiting the VP37 structural proteins on the envelope of the monkeypox virus. It is available in two forms—oral and intravenous (IV). The oral formulation comes in 200 mg capsules and is dosed based on weight. The most common dose is 600 mg twice daily for 14 days for persons weighing between 40 and 120 kg or 600 mg 3 times daily for those weighing over 120 kg (CDC, 2022n). The medication is best taken within 30 min of a high-fat meal. Side effects include headache, abdominal pain, nausea, and vomiting. Known drug interactions include repaglinide and midazolam (CDC, 2022n).

The IV formulation is usually reserved for those unable to take the oral formulation. There is a renal dose restriction on the IV formulation. Persons with a creatinine clearance <30 mL/min should not receive IV

tecovirimat (CDC, 2022n). IV tecovirimat should be used with caution in persons with mild renal impairment (creatinine clearance 30–50 mL/min) and for pediatric patients <2 years of age.

There are no human data on the use of tecovirimat in persons who are pregnant or breast feeding. Animal studies have not shown any adverse fetal outcomes. Therefore, the use of tecovirimat in persons who are pregnant or breastfeeding should be used if the risks outweigh the benefits (CDC, 2022n). Any adverse events should be reported to the FDA.

Tecovirimat is available in the United States through a national stockpile. Clinicians who wish to prescribe tecovirimat need to register as a prescriber through the United States' Centers for Disease Control and

Table 1: Symptom Management for Monkeypox Infection

Symptom	Suggested Therapies or Interventions
Mild to moderate pain	Nonsteroidal anti-inflammatories or acetaminophen
Severe pain	Opioids ^a
Pruritis	Antihistamines
	Cool showers
Rectal pain	Topical anesthetics
	Gabapentin
	Sitz baths
	Stool softeners
Urethral pain	Nonsteroidal anti-inflammatories or acetaminophen
	Topical anesthetics
	Voiding in a tub or shower with warm water
Nausea/vomiting	Antiemetics
Oral pain/stomatitis	Topical anesthetics/magic mouthwash

^a Opioids may be required for severe pain but has the potential to lead to constipation. Use in conjunction with stool softeners for people who may have severe rectal pain. The risks and benefits of opioid use should be considered on an individual basis.

Note: Adapted from New York City Health. (2022). *Interim Guidance for Treatment of Monkeypox*. Accessed August 14, 2022 from <https://www1.nyc.gov/assets/doh/downloads/pdf/cd/monkeypox-treatment-guidance-interim.pdf> [open-source document available in the public domain].

Prevention (CDC, 2022n). Information on how to access tecovirimat can be found at: <https://www.cdc.gov/poxvirus/monkeypox/clinicians/obtaining-tecovirimat.html>. At the time of this writing, patients who are prescribed tecovirimat must sign an informed consent form and are requested to keep a clinical log to document their treatment experience (CDC, 2022n). Some institutions may require local Institutional Review Board approval before prescribing. Distribution at the local level is handled by each state jurisdiction. Tecovirimat is recommended to be used in select circumstances or patient populations, such as those who are immunocompromised, pregnant, those with retractable pain, individuals with ocular involvement, or those at risk for stricture development (CDC, 2022n).

Other Agents. Other agents currently being investigated for monkeypox treatment include cidofovir (Vistide). This medication is FDA-approved to treat cytomegalovirus retinitis in PWH but has been found to have some efficacy in orthopox virus infection in vitro and in animal studies (CDC, 2022j). Cidofovir is associated with severe nephrotoxicity and should be co-administered with probenecid (U.S. FDA, 2000). It is contraindicated in persons with a creatinine >1.5 mg/dl (U.S. FDA, 2000). Renal function should be monitored in these patients. Brincidofovir (Tembexa) is an oral tablet that is FDA approved for the treatment of smallpox in adult and pediatric patients (Chimerix, 2021). Brincidofovir has a better renal side effect profile compared with cidofovir; however, brincidofovir is currently not available. Vaccinia Immune Globulin Intravenous (VIGIV) is FDA approved for persons who develop complications due to a smallpox vaccine, including eczema, progressive vaccinia, and vaccinia skin infections (CDC, 2022j). There are no data available if VIGIV is effective in patients with monkeypox, and use is limited and available under an emergency authorization investigational new drug application process.

Infection Control Considerations for Health care Professionals

Health care professions dealing with monkeypox patients should wear personal protective equipment that includes facemasks with an N95 filter, disposable gown, gloves, and eye protection (CDC, 2022e). Individuals with suspected or confirmed monkeypox should be placed in a single person room and should have a dedicated bathroom (CDC, 2022e). Examination rooms and equipment should be cleaned using an Environmental Protection Agency (EPA)-registered hospital-grade disinfectant (CDC, 2022e). Guidelines on infection control

can be found on the CDC website: https://www.cdc.gov/poxvirus/monkeypox/clinicians/infection-control-healthcare.html#anchor_1653508940308.

Prevention

Vaccines

Two FDA-approved vaccines are available in the United States to help combat the spread of monkeypox, JYNNEOS and ACAM2000 (CDC, 2022q; U.S. FDA, 2018, 2021). See Table 2 for a comparison of available vaccines. Due to its low adverse event profile and safety among key populations affected by monkeypox, JYNNEOS (sold as Imvamune in Canada and Imvanex in Europe) is the preferred vaccine to combat the current monkeypox outbreak (CDC, 2022r). JYNNEOS is a live-attenuated, nonreplicating third-generation smallpox vaccine that is approved for use to prevent both monkeypox and smallpox (U.S. FDA, 2021). Maximal protection against monkeypox is conferred 2 weeks after receipt of the second dose (CDC, 2022i). Side effects are typically mild and include injection site reaction, muscle pain, headache, fatigue, nausea, and chills (Overton et al., 2015; U.S. FDA, 2021). There have been no vaccine-associated serious adverse events shown in the JYNNOS trials (U.S. FDA, 2021). JYNNOS is considered safe and effective for PWH based on Phase II trials that included more than 400 PWH who had CD4⁺ counts as low as 200 cells/mm³ (Overton et al., 2015; U.S. FDA, 2021).

ACAM2000 is a second-generation smallpox vaccine that contains vaccinia virus and is available for use against monkeypox through an Expanded Access IND (U.S. FDA, 2022a). Although not initially FDA approved to prevent monkeypox, smallpox vaccines in general are believed to provide 85% protection against monkeypox (Fine, et al., 1988). Maximal protection from ACAM2000 is conferred 28 days after administration (Rao et al., 2022). ACAM2000 has a less favorable side effect profile than JYNNEOS and has been linked to myocarditis and pericarditis (U.S. FDA, 2018, 2021). Furthermore, ACAM2000 is a live replication competent vaccine, making it contraindicated in PWH due to the potential to develop and/or spread vaccinia (Rao et al., 2022; U.S. FDA, 2018). ACAM2000 is also contraindicated if the recipient cannot isolate from household members, close contacts, or those living with HIV or another immunocompromising conditions (Rao et al., 2022). Given that the current monkeypox outbreak has disproportionately affected PWH and people using HIV pre-exposure prophylaxis, ACAM2000 is a suboptimal vaccine option (Thornhill et al., 2022).

Table 2. Characteristics of Available Monkeypox Vaccines

Vaccine	Dosing	Administration	Serious Adverse Events	Safe in PWH
JYNNEOS	2 doses administered 4 weeks apart	Subcutaneous injection or intradermal	None reported	Yes
ACAM2000	Single dose	Percutaneous scarification	Myocarditis and pericarditis	No

Note: Adapted from Centers for Disease Control and Prevention. (2022, August 5). *Vaccines*. Retrieved from <https://www.cdc.gov/poxvirus/monkeypox/vaccines.html> [open-source document available in the public domain].

PWH = persons with HIV.

Although all eligible populations should seek vaccination, it is recommended that to prevent monkeypox symptoms, exposed individuals receive their first vaccination within 4 days of exposure because the vaccine provides negligible benefit after symptom onset (CDC, 2022i). Questions still surround the current level of protection conferred by first- and second-generation smallpox vaccinations received before 1980 during mass vaccination campaigns; however, the CDC currently recommends that anyone with a monkeypox exposure who has not received a smallpox vaccine in the last 3 years should be vaccinated (CDC, 2022a).

Some health departments have prioritized getting the initial dose of JYNNEOS to as many people as possible and only plan to make the second dose available as the vaccine supply improves (County of Los Angeles Public Health, n.d.). At this time, the protection conferred by one dose of JYNNEOS and nonstandard dosing timelines is uncertain.

Some evidence shows that rates of seroconversion may be lower with one dose compared with two, especially in PWH (Overton et al., 2015). Until more evidence on the efficacy of various emergency vaccination strategies is available, providers should encourage patients to engage in other methods of monkeypox prevention even after receiving one vaccine. Further, the FDA has issued emergency use authorization for the use of fractional intradermal dosing of the JYNNEOS vaccine to increase the number of vaccine doses available (U.S. FDA, 2022b). Based on data from other types of vaccinations, fractional intradermal dosing has been found non-inferior to intermuscular or subcutaneous dosing of the same vaccination, but data specific to JYNNEOS do not yet exist (Schnyder et al., 2020).

Behavioral Strategies

In addition to vaccination, other prevention and harm reduction strategies can be used to prevent the spread and acquisition of monkeypox. Current prevention

recommendations include the avoidance of close, skin-to-skin contact with people with monkeypox lesions and their fomites, in addition to frequent handwashing (CDC, 2022k). Historically, spillover from animal reservoirs has played a huge role in the spread of monkeypox (Bunge et al., 2022). Accordingly, avoidance of contact with sick, dead, or monkeypox-exposed animals, especially rodents, is another important prevention strategy (CDC, 2022k). This advice extends to domesticated animals, including household pets and wildlife (CDC, 2022d). The first documented case of human-to-dog transmission was recently reported among a couple, both with active lesions, whose dog slept in their bed (Seang et al., 2022). This indicates the need to separate cases from their household pets to avoid infection.

Human-to-human spread of monkeypox is a relatively new phenomenon (Bunge et al., 2022). To inform evidence-based recommendations on the prevention of human-to-human transmission, more research is needed on modes of transmission, as well as the possibility for asymptomatic and presymptomatic monkeypox spread. Current recommendations dictate that to prevent monkeypox transmission, exposed individuals monitor their temperature twice a day for 21 days and self-isolate once a fever or other monkeypox symptoms develop (CDC, 2002c). This recommendation may change as evidence accrues.

Monkeypox transmission through close contact during sex is thought to be a driving factor in the current outbreak, especially among MSM (Thornhill et al., 2022). Open, honest communication with sexual partners about potential monkeypox exposures, limiting or avoiding anonymous sexual contact, and limiting overall number of sexual partners are recommended harm reduction strategies until monkeypox vaccines can be appropriately scaled up (CDC, 2022o). The role of condom use in the prevention of monkeypox is unclear. Condoms may prevent acquisition via contact with anogenital lesions; however, condoms alone will not effectively prevent monkeypox acquisition (CDC, 2022o).

Patient Education

Care escalation

For patients who have been diagnosed with monkeypox, education on illness expectations and transmission prevention is imperative. Most cases of monkeypox are self-limiting, requiring only supportive care, including adequate hydration and pain management. In the current outbreak, the main reasons for escalation of care are pain management and secondary infection (Thornhill et al., 2022). We recommend that patients contact their provider if they (a) develop lesions in the mouth or throat that may affect the ability to drink, eat, or breathe; (b) develop lesions in or near their eyes; (c) experience pain that cannot be adequately managed in the outpatient setting; or (d) develop signs of a secondary infection, including increased warmth or tenderness around the lesions, worsening erythema, abscess formation, or purulent drainage. The aforementioned signs and symptoms may lead to complications requiring additional supportive therapies, antibiotics or other adjuvant medications, and/or specialty referrals (Abdelaal et al., 2022; Reynolds et al., 2017; Thornhill et al., 2022).

Patients should seek emergency care if the signs and symptoms of more serious complications develop, including bronchopneumonia, sepsis, or encephalitis (Reynolds et al., 2017). These signs may include difficulty breathing, change in mental status, seizure, or other new-onset neurologic symptoms, stiff neck, and new-onset fever.

Infection Control at Home

The typical clinical course of monkeypox lasts 2–4 weeks from the time the first lesion appears until lesions scab over, those scabs have fallen off, and new and intact skin has formed (Adler et al., 2022; CDC, 2022m). People with monkeypox are considered infectious until their lesions have completely healed (CDC, 2022m). Although patients are symptomatic with a fever or respiratory symptoms, they should avoid any contact with people and animals, ideally only leaving isolation as necessary for medical care (CDC, 2022m). Once fever and respiratory symptoms resolve, patients should wear a well fitting mask and cover all lesions until healed if interactions with others are necessary (CDC, 2022m). Individuals with monkeypox should not share any items that they have worn or handled, such as towels, bedding, or clothes (CDC, 2022m).

Ideally, persons with monkeypox will have a dedicated space to isolate during the infectious period. If spaces must be shared, surfaces contacted by individuals with monkeypox, such as counters, toilet seats, utensils,

cups, and plates, should be disinfected immediately after use by the individual with monkey pox (CDC, 2022m). Close physical contact and crowded settings should still be avoided until all lesions are healed (CDC, 2022m). Further, individuals with monkeypox should not care for pets, and additionally, pets that have been exposed need to be isolated from other pets and people for 21 days (CDC, 2022d). See Table 3 for a summary of infection control recommendations.

After the infectious period, it is important to thoroughly disinfect anything that the individual with monkeypox came in contact with because these items can remain infectious for up to 2 weeks (CDC, 2022f). All disposable items that came in contact with the individual's skin should be disposed of in a sealed plastic bag (CDC, 2022f). All clothing, bedding, and towels should be laundered according to the manufacturer's recommendations (CDC, 2022f). Dry dusting, sweeping, and vacuuming can spread infectious particles and should be avoided (CDC, 2022f). All surfaces should be cleaned with an EPA-approved disinfectant using a mop or damp cloth (CDC, 2022f). For upholstered furniture, it is best to cover the furniture before a person with active infection uses it because it may be difficult to disinfect (CDC, 2022f). These same methods should be used to clean shared spaces during the infectious period if strict isolation is not possible.

Considerations for Persons With HIV

Limited data are available regarding monkeypox infection in PWH. Information from case studies in Nigeria suggests that people with advanced or uncontrolled HIV may experience a prolonged or severe case of monkeypox, including more disseminated, confluent, or genital lesions (Ogoina et al., 2020). To date, the infections that have been identified in the current European and U.S. outbreak among PWH have not shown any increased mortality rate or differences in disease outcomes (Thornhill et al., 2022). The CDC recommends that clinicians' decision to manage PWH with more intensive treatment or prophylaxis be considered on a case-by-case basis (O'Shea et al., 2022).

In PWH diagnosed with monkeypox who are not on HIV antiretroviral therapy (ART), treatment with ART should be started as soon as possible (O'Shea et al., 2022). For PWH currently on ART or opportunistic infection prophylaxis, treatment should continue without interruption. In PWH on ART who require more than symptomatic treatment for monkeypox, it is important to assess for drug–drug interactions using one of the established HIV drug interaction sites, such as the

Table 3. Summary of Community & Household Infection Control Recommendations

For persons with monkeypox infection who are in the infectious stage of illness and living in a shared household, the following precautions are recommended:

1. Patients should isolate from others, including household members and pets
2. All monkeypox lesions should be covered
3. Masks should be used when close contact with others cannot be avoided
4. Patients should avoid picking or scratching lesions
5. Shared items should be disinfected after use with an EPA registered disinfectant
6. Clothing, towels, and bed linens of persons with active infection should be washed in water with detergent and kept separate from other household member's items (if possible)
7. Kitchen utensils should be washed in hot water and soap
8. Dry dusting, vacuuming, and sweeping should be avoided to reduce potential aerosolization of organisms

Note: Adapted from: Centers for Disease Control and Prevention. (2022, August 2). *Isolation and prevention practices for people with monkeypox*. Retrieved from <https://www.cdc.gov/poxvirus/monkeypox/clinicians/isolation-procedures.html> [open-source document available in the public domain].
EPA = Environmental Protection Agency.

University of Liverpool website: <https://www.hiv-drug-interactions.org/checker>.

Based on current evidence, there is a potential drug–drug interaction between tecovirimat and the non-nucleoside reverse transcriptase inhibitors, doravirine and rilpivirine, and the CCR5 inhibitor maraviroc (O’Shea et al., 2022). Drug levels of these HIV ARTs may be decreased when given with tecovirimat and clinicians may consider increasing the dose of these HIV ARTs while on treatment with tecovirimat and for 2 weeks after completion of tecovirimat. In PWH who are on long-acting injectable cabotegravir plus rilpivirine who require tecovirimat, adding an additional 25 mg of oral rilpivirine for the duration of tecovirimat treatment and for 2 weeks after are recommended (O’Shea et al., 2022). If oral rilpivirine is not available, it is recommended that patients switch to their previous oral HIV ART regimen that they were taking before injectable cabotegravir/rilpivirine for the duration of tecovirimat therapy and for an additional 2 weeks after tecovirimat treatment.

Because cidofovir is associated with nephrotoxicity, it is recommended that individuals who receive cidofovir should avoid concurrent use of tenofovir disoproxil fumarate, which may also cause renal dysfunction. Additionally, cidofovir is typically co-administered with probenecid to reduce nephrotoxicity. However, there is a drug–drug interaction between probenecid and zidovudine (ZDV). It is recommended that PWH who are on ZDV therapy temporarily discontinue or dose reduce ZDV by 50% while receiving cidofovir therapy (O’Shea

et al., 2022). Renal function testing in patients receiving cidofovir is recommended.

As previously mentioned, vaccination with JYN-NEOS is recommended for prevention and post-exposure prophylaxis of monkeypox infection in PWH. The safety and immunogenicity of JYNNEOS has been evaluated in PWH, and data on safety and immunogenicity do not seem to be significantly different in PWH compared with those with HIV (Overton et al., 2020). However, in persons with advanced immunosuppression with CD4⁺ counts <100 cells/mm³ or with uncontrolled HIV viremia, there is no data.

With regard to isolation for PWH who have monkeypox, the recommendations for isolation are the same as those for persons without HIV (CDC, 2022m; O’Shea et al., 2022). One limited study suggests that PWH with monkeypox who are not virologically suppressed may be contagious for an extended period of time, though the exact length of time is unknown (Ogoina et al., 2020). Decisions regarding discontinuation of isolation in these situations should be made in collaboration with local health departments (CDC, 2022m).

Nursing Implications

Monkeypox is a stigmatized illness, and the current epidemiology focuses public attention on the spread among the gay, bisexual, and other MSM. Combating stigma begins with nurses being knowledgeable about modes of transmission, sex-positive harm reduction strategies, and general infection control practices. Recognizing clinical

manifestations of the illness can lead to earlier diagnosis, access to care, and prevention activities. Treatment of the illness is well within the scope of practice of primary care and infectious disease nurse practitioners. All nurses should assess and assist patients with recommendations for symptom management and ways to maintain their health during the acute phase of illness. Furthermore, nurses should be engaged in sharing prevention and harm reduction strategies, educating patients, family members, and the community about monkeypox, and advocate for greater prevention and treatment access for all individuals.

Summary

The 2022 monkeypox outbreak continues to evolve. More information regarding the manifestation, transmission, treatment, and management of this infection is needed. Given that many of the world's public health systems have been challenged with the COVID-19 pandemic, it is important to remain vigilant because this emerging infection is gaining momentum. Nurses and other health professionals play a critical role in ensuring that individuals and communities are aware of monkeypox and ways in which people can take action to prevent and control this new global health crisis.

Disclosures

The authors report no real or perceived vested interests related to this article that could be construed as a conflict of interest.

Author Contributions

Jeffrey Kwong was responsible for the overall organization and conceptualization of the manuscript, wrote the majority of the clinical section, and provided leadership in writing. Katherine McNabb was responsible for writing and drafting the vaccine and prevention sections of the manuscript, she helped review and revise drafts of the manuscript. Joachim Voss contributed to the original concept of this manuscript and provided initial draft and feedback on the revisions. Alanna Bergman and Kara McGee reviewed drafts and provided feedback and revisions to the manuscript. Jason Farley collaborated in the overall organization and conceptualization. He contributed to the background, pathophysiology, and public health implications, as well as reviewing and editing of the final draft. All authors met the criteria for authorship as described by the International Committee of Medical Journal Editors and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or

integrity of any part of the work are appropriately investigated and resolved.

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Key Considerations

- Clinicians should remain alert to the possibility of monkeypox as a possible diagnosis, especially in patients who present with dermatologic eruptions, urogenital pain, rectal pain, or a prodromal syndrome characterized by fever and lymphadenopathy.
- Patients with monkeypox should be provided adequate symptom relief, including access to pharmacologic and nonpharmacologic pain measures.
- Preventive vaccination may help prevent or slow the spread of the infection.
- Persons with well controlled HIV who acquire monkeypox infection seem to have similar outcomes as persons without HIV. Nurses working with PWH who acquire monkeypox should reinforce the importance of HIV antiretroviral therapy adherence as part of the treatment plan.

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