NCPD 2.0 ANCC Contact Hours

Pharmacology Consult
Column Editor: Patricia Anne O'Malley, PhD, APRN-CNS

Another Outbreak! Monkeypox 2022 Infection and Vaccine Considerations for the Clinical Nurse Specialist

Patricia Anne O'Malley, PhD, APRN-CNS

Here in this city visiting the sick,
And finding him, the searchers of the town,
Suspecting that we both were in a house
Where the infectious pestilence did reign,
Sealed up the doors and would not let us forth….
…Nor get a messenger to bring it to thee, so fearful were they of infection
—William Shakespeare, *Romeo & Juliet*, Act 5 Scene 2

From May 6 to July 28, 2022, 21 099 cases of monkeypox (MPX) have been reported worldwide,[1] with 5811 confirmed in the United States.[2] The World Health Organization on July 23, 2022, declared MPX a global health emergency. Uncontrolled spread of infection with intercontinental spread through new modes of transmission not yet understood were the basis of this emergency declaration.[3,4] Of additional concern is emerging evidence that MPX may become an entrenched sexually transmitted disease similar to gonorrhea, herpes, and HIV. Monkeypox is currently endemic in Africa where persons are typically infected via bites from rodents and small animals.[3]

The first cases of human MPX in the United States occurred in 2003. Forty-seven confirmed and probable cases of MPX were identified in 6 states: Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin, after human contact with pet prairie dogs that had been housed near small mammals from Ghana. None of the cases in this outbreak were attributed to person-to-person contact but rather through touching infected pets, scratches, or touching the bedding of the infected animals or through cage cleaning. Restrictions followed this outbreak on the importation of African rodents and remain in place to this day by the Centers for Disease Control and Prevention. A second "outbreak" occurred in July and November 2021, each a resident returning from Nigeria to the United States experienced a travel-related MPX infection.[5]

Monkeypox was first isolated and identified in 1958 when monkeys shipped from Singapore to Denmark research facility became ill. The first human case in 1970 was isolated from a child in the Democratic Republic of Congo.[6] Monkeypox is part of the genus *Orthopoxvirus*, which has more than 50 species that infect animals and humans and include cowpox, which was used to create the first vaccine, and the variola virus, which causes smallpox.[7] Orthopoxviruses (family Poxviridae) have a large, double-stranded DNA structure that enables infection of many animal species and humans.[8,9] Increases in numbers of Infections worldwide may also be related to enhanced surveillance efforts, environmental degradation, and human urbanization of areas where MPX virus is maintained in animal reservoir(s).[9] Also, immunity to MPX was previously achieved with vaccinia vaccination. However, after smallpox was eradicated and vaccines stopped, the way was opened for MPX to reemerge in rural Africa.[6]

Underreporting may be a primary factor contributing to underestimating the potential threat of MPX.[6] Over time, MPX appears to have escalated from animal to human transmission to include human-to-human transmission, and intercontinental expansion of MPX cases suggests that infections may continue to increase. Because MPX is a zoonotic agent sustained in wild-animal populations, the virus is less sensitive to public health measures. As a result, MPX virus may be able to continue to evolve and maintain itself in human populations.[9]

MPX INFECTION

Monkeypox infection is similar to smallpox but not as severe.[10] The MPX incubation period is usually 7 to 14 days,

Author Affiliations: Nurse Researcher, Center of Nursing Excellence, Premier Health–Miami Valley Hospital, Dayton, Ohio.

The author reports no conflicts of interest.

Correspondence: Patricia Anne O'Malley, PhD, APRN-CNS, Center of Nursing Excellence, Premier Health–Miami Valley Hospital, 1 Wyoming St, Dayton, OH 45409 (pomalley@premierhealth.com; pomalley5@woh.rr.com).

DOI: 10.1097/NUR.0000000000000709

Table 1. Signs and Symptoms (S/S) of Monkeypox Infection[11]

Disease expression can include all or a few S/S
S/S begin within 3 wk of exposure to the virus
Flulike S/S are followed by a rash 1-4 d later and include:
• Fever, headache, muscle aches, backache, sore throat, cough, and swollen lymph nodes
• Rash on or near genitals, hands, feet, chest, and face • Rash has pimples or blisters that are painful or itchy
Until scabs fall off, and a fresh layer of sin has formed; one is contagious.
Skin healing can take several weeks.
With diagnosis, consider informing all sexual partners over the past 21 d

with a maximum of 21 days. Infection has a prodromal phase (lasting approximately 0-2 days), with fever, fatigue, severe headache, lymphadenopathy, and muscle aches, followed by a rash phase (lasting 7-21 days). The patient is contagious when the rash appears. The usual rash presentation is the face (95%), palms and soles of the feet (75%), oral mucosa (70%), genitals (30%), and conjunctiva (20%) and can number a few or thousands.[10] Table 1 describes the presentation of human MPX infection,[10,11] and Table 2 highlights transmission routes for infection for animals and humans.[12]

In severe cases, lesions can merge resulting in loss of large patches of the skin. Lymphadenopathy is common and usually found in the groin. Patient may present with other symptoms such as bacterial infection, respiratory distress, encephalitis, corneal infection, vision loss, and dehydration due to vomiting and diarrhea. Although MPX is a self-limiting disease, expression is a function of degree of viral exposure, as well as health before exposure and complications. Severe cases are observed more often in children.

Table 2. Transmission Routes Monkeypox[a,b]—Animal/Human and Human/Human[12]

• Direct contact—rash, scabs, or body fluids during infection
• Touching clothing, bedding or towels, or other surfaces during infection
• Contact with respiratory secretions during infection
• Intimate contact—oral, anal, or vaginal sex; touching genitals during infection
• Hugging, petting, massage, kissing, or prolonged face-to-face to contact

[a]Natural hosts for monkeypox includes squirrels, Gambian rats, and other primates.
[b]Transmission from animals to humans usually via bites, direct contact with monkeypox lesions, or consuming improperly cooked infected animals.

Finally, MPX can lead to death, with a case fatality rate of 1% to 10%.[10]

Monkeypox can also spread between humans and pets. Transmission can occur through petting, cuddling, kissing, licking, sharing sleeping areas, and sharing food. Table 3 provides important self-care and pet care information for patients with MPX who live with pets.[13]

There are no definite data on the required infectious dose of MPX virus for transmission to humans. Compared with the variola virus, a significantly higher dose is assumed to be required to trigger infection. However, nosocomial transmission has been reported in the United Kingdom. Healthcare workers were infected related to inadequate personal protective equipment in provision of care to patients and changing linen with MPX infection.[14]

At this time, the viral load on inanimate surfaces needed for disease transmission remains unknown. Sufficient time and attention must be given to the careful doffing of personal protective equipment. Regular disinfection of frequent hand and skin contact points is required in addition to regular room cleaning and surface disinfection. Disinfecting products should have virucidal activity against enveloped viruses to prevent the spread of the virus outside the patient's room. Persons living with others with MPX should avoid close physical contact and should disinfect shared skin- and hand-contact surfaces.[14] Excellent

Table 3. Monkeypox Prevention and Illness Care for Pets[13]

Instruct patients to avoid contact with pets, domestic animals, or wildlife if infected
• Isolate exposed animals—animals should not be cared for by the infected person
• Consider moving a pet to another home if no close contact with an infected person
• Disinfect the home before bringing the animal home
For exposed pets, do not abandon or euthanize; seek veterinary care. If animal is infected:
• Do not mask the pet
• Avoid close contact and wash hands frequently
• Do not wipe the pet with chemical products, alcohol, wipes
• Use protective glasses and N95 masks during contact
• Wear clothing to cover all skin during contact
• Launder bedding or enclosure after contact with the animal
• Use alcohol-based hand rub
• Use dedicated lined trash can for all waste and disposable bedding
• Keep waste in sealed bags to avoid spread to other animals/wildlife
• Persons who are immunosuppressed, pregnant women, children < 8 y, and those with history of atopic dermatitis or eczema should not provide care for infected pets because of risk of severe disease

educational materials for patients are available at the World Health Organization website for safely recovering at home from MPX.[15]

Patient education should also provide information regarding the elevated risk of MPX infection in the sexually active population.[16] Multiple sexual partners, male sex with males, condomless sex, seropositivity HIV positivity, and history of previous sexually transmitted infections including syphilis have been identified as significant contributing clinical factors in the current MPX epidemic.[16,17]

VACCINE OPTIONS

Until 1971, children received an *Orthopoxvirus* vaccination to prevent smallpox. Routine vaccinations ended in 1980 worldwide with the eradication of smallpox caused by the variola virus. In 2015, the Advisory Committee on Immunization Practices recommended pre-exposure prophylaxis with ACAM2000 (smallpox vaccine [Sanofi Pasteur Biologics, Lyon, France]). a replication-competent live virus vaccinia virus vaccine, for certain US persons at risk of occupational exposure to orthopoxviruses.[8] At this time, there are no specific vaccines for MPX infection. However, the smallpox vaccination affords 85% protection against MPX infection.[10]

In 2019, JYNNEOS (smallpox vaccine [Bavarian Nordic A/S, Kvistgaard, Denmark]) is a replication-deficient live vaccinia virus vaccine licensed in the United States. JYNNEOS (also known as Imvamune or Imvanex) and formulated from a modified form of the vaccinia virus called modified vaccinia Ankara, closely related to variola or MPX viruses and nonreplicating. Therefore, the vaccine does not cause disease and provides protection against MPX and smallpox. JYNNEOS is administered in 2 doses given 4 weeks apart. JYNNEOS is the only US Food and Drug Administration–approved vaccine for adults 18 years or older determined to be at high risk of smallpox or MPX disease.[18]

On November 3, 2021, the Committee on Immunization Practices voted to recommend JYNNEOS pre-exposure prophylaxis as an alternative to ACAM2000 for certain persons at risk of exposure to orthopoxviruses.[8] While naturally occurring smallpox disease is no longer a global threat, the release of JYNNEOS was timely because an intentional release of smallpox would be a catastrophe considering the case fatality rate. This vaccine is also now part of the Strategic National Stockpile, the nation's largest supply of potentially lifesaving pharmaceuticals and medical supplies for use in a public health emergency.[18,19]

Table 4. Clinical Considerations for JYNNEOS Vaccine[23]

Patient Characteristics	Considerations
Atopic dermatitis, eczema, or other exfoliative skin conditions	Persons with atopic dermatitis have demonstrated a neutralizing antibody response; however, patient may still be at risk of severe disease.
Immunocompromising conditions	Persons with immunocompromising conditions may be less likely to mount an effective response; risk-to-benefit ratio should be considered; is it imperative to vaccinate with risk of severe disease even with vaccination?
Pregnant women	Human data on JYNNEOS administered to pregnant women are insufficient to determine vaccine-associated risks in pregnancy.
Breastfeeding women	Safety and efficacy of JYNNEOS have not been studied, unknown whether excreted in human milk or the safety in breastfed infants. Because JYNNEOS vaccine is replication-deficient, it likely does not present a risk of transmission to breastfed infants and can be administered to women who are breastfeeding if vaccination is critical.
Children and adolescents aged < 18 y	JYNNEOS is not licensed for persons aged < 18 y; has not been rigorously evaluated in this population. Public health authorities should be consulted First if JYNNEOS is considered for children and adolescents aged < 18 y.
Patients with multiple cardiac risk factors: hypertension, diabetes, hypercholesterolemia, heart disease at age ≤50 y in a first-degree relative, and smoking	Patient should be counseled about possible risk of myopericarditis after vaccination with JYNNEOS; related the uncertain etiology of myopericarditis associated with replication-competent smallpox vaccines such as ACAM2000.
Time to maximal antibody titers	Fully immunized[a] 2 wk after administration of the second dose of the 2-dose JYNNEOS vaccination series

ACAM2000: smallpox vaccine (Sanofi Pasteur Biologics, Lyon, France); JYNNEOS: smallpox vaccine (Bavarian Nordic A/S, Kvistgaard, Denmark).

[a]*Persons with immunocompromising conditions may be able to mount an effective response.*

CONSIDERATIONS FOR JYNNEOS VERSUS ACAM2000 FOR PRIMARY VACCINATION

JYNNEOS uses a replication-deficient virus and has fewer contraindications and serious adverse effects compared with ACAM2000. Administration route of JYNNEOS is subcutaneous compared with multiple puncture (scarification) route used for ACAM2000, which requires 15 jabs with a bifurcated stainless-steel needle that has been dipped into the reconstituted vaccine. JYNNEOS requires 2 vaccine doses 28 days apart with vaccine protection 2 weeks after the second dose. ACAM2000 requires 1 dose with peak vaccine protection within 28 days. For those working with more virulent orthopoxviruses, booster frequency differs: ACAM2000 boosters are recommended every 3 years, whereas JYNNEOS boosters are recommended every 2 years. ACAM2000 vaccination produces a take containing infectious vaccinia virus capable of transmission through autoinoculation and inadvertent inoculation in close contacts with the patient. JYNNEOS does not produce a take.[8,20–22]

Because of the documented risk of myocarditis after receipt of both ACAM2000 and mRNA COVID-19 vaccines and a possible risk of myocarditis after JYNNEOS, persons might consider waiting 4 weeks after *Orthopoxvirus* vaccination (either JYNNEOS or ACAM2000) before receiving an mRNA COVID-19 vaccine, particularly adolescent or young adult males. However, if an *Orthopoxvirus* vaccine is recommended for prophylaxis during an outbreak, vaccine administration should not be delayed related to recent mRNA COVID-19 vaccination. There is no minimum interval between mRNA COVID-19 vaccination and *Orthopoxvirus* vaccination.[8]

Table 4 describes important clinical considerations for pre-exposure vaccination with JYNNEOS.[22] Consider that the information provided in this table will be modified with further research. Table 5 provides important information regarding prevention and postexposure prophylaxis for MPX.[23]

Table 5. Prevention and PEP for MPX[23]

• CDC recommends that the vaccine be given within 4 d from the date of exposure for the best chance to prevent disease onset.
• If given between 4 and 14 d after the date of exposure, vaccination may reduce the symptoms of disease, but may not prevent disease.
• PEP when coupled with self-isolation is important for controlling outbreaks and preventing further transmission of MPX
JYNNEOS vaccine is being allocated to jurisdictions for use for the following individuals:
• Known contacts who are identified by public health via case investigation, contact tracing, and risk exposure assessments
• Presumed contacts who may meet the following criteria:
○ Know that a sexual partner in the past 14 d was diagnosed with MPX
○ Had multiple sexual partners in the past 14 d in a jurisdiction with known MPX
• Adverse reactions include injection site reactions such as pain, swelling, and redness.
• People with a severe allergy to any component of the vaccine (gentamicin, ciprofloxacin, egg protein) should not receive this vaccine.
• Vaccine is safe for administration to people with HIV and atopic dermatitis.
• Although there are no data in people who are pregnant or breastfeeding, animal data do not show evidence of reproductive harm; pregnancy and breastfeeding are not contraindications.
• People who receive JYNNEOS are considered to reach maximum immunity 14 d after their second dose (~ 6 wk from first dose). They should continue to take precautions against MPX during this time.
• There are currently no data on effectiveness of JYNNEOS from the current outbreak.

Abbreviations: CDC, Centers for Disease Control and Prevention; MPX, monkeypox; PEP, postexposure prophylaxis.

JYNNEOS: smallpox vaccine [Bavarian Nordic A/S, Kvistgaard, Denmark].

THE FUTURE

Biomedical Advanced Research and Development Authority (BARDA) supported the development of JYNNEOS. An existing 10-year contract with the (BARDA), within the US Department of Health and Human Services Office of the Assistant Secretary for Preparedness and Response, has provided a foundation for BARDA collaboration with Bavarian Nordic enabling vaccine access. Recently, the United States ordered an additional 2.5 million doses of Bavarian Nordic's JYNNEOS for use in current and future MPX outbreaks. This vaccine order will add 4 million doses to the Strategic National Stockpile from late 2022 continuing through early 2023.[19]

This vaccine purchase appears timely in light of the increasing concerns that Poxviridae appear to have a high potential of zoonotic spillover and pandemic. Clinical nurse specialists will play an important role in prevention, recognition, treatment, and care for persons at risk and with MPX disease.[24]

References

1. Mathieu E, Dattani S, Ritchie H, Roser M. Monkeypox. OurWorldInData.org. https://ourworldindata.org/monkeypox. Accessed August 1, 2022.
2. US Department of Health & Human Services Centers for Disease Control and Prevention. Monkeypox—2022 U.S. map & case count. Updated July 29, 2022. https://www.cdc.gov/poxvirus/monkeypox/response/2022/us-map.html. Accessed July 29, 2022.
3. Levine J. World Health Organization declares monkeypox a 'global health emergency'. New York Post. 2022. https://nypost.com/2022/07/23/world-health-organization-declares-monkeypox-a-global-health-emergency/. Accessed July 29, 2022.
4. World Health Organization. WHO director-general declares the ongoing monkeypox outbreak a public health emergency of international concern. 2022. https://www.who.int/europe/news/item/23-07-2022-who-director-general-declares-the-ongoing-monkeypox-outbreak-a-public-health-event-of-international-concern. Accessed August 1, 2022.

5. US Department of Health & Human Services-Centers for Disease Control and Prevention. Monkeypox—past US cases & outbreaks. Last reviewed June 6, 2022. https://www.cdc.gov/poxvirus/monkeypox/outbreak/us-outbreaks.html. Accessed July 28, 2022.
6. Moore M, Zahra F. *Monkeypox. StatPearls*. Treasure Island, FL: StatPearls Publishing; 2022. https://pubmed.ncbi.nlm.nih.gov. Accessed July 18, 2022.
7. US Department of Health & Human Services Centers for Disease Control and Prevention. Poxvirus disease. Last reviewed January 24, 2020. https://www.cdc.gov/poxvirus/index.html. Accessed July 28, 2022.
8. Rao AK, Petersen BW, Whitehill F, et al. Use of JYNNEOS (smallpox rand monkeypox vaccine, live, nonreplicating) for preexposure vaccination of persons at risk for occupational exposure to orthopoxviruses: recommendations of the advisory committee on immunization practices—United States, 2022. *MMWR Morb Mortal Wkly Rep*. 2022;71:734–742.
9. Parker S, Nuara A, Buller RM, Schultz DA. Human monkeypox: an emerging zoonotic disease. *Future Microbiol*. 2007;2(1):17–34. doi:10.2217/17460913.2.1.17.
10. Gong Q, Wang C, Chuai X, Chiu S. Monkeypox virus: a re-emergent threat to human [published online July 9, 2022]. *Virol Sin*. https://www.sciencedirect.com/science/article/pii/S1995820X22001201?via%3Dihub. Accessed July 28, 2022.
11. US Department of Health & Human Services Centers for Disease Control and Prevention. Monkeypox—social gatherings, safer sex, and monkeypox. Updated July 12, 2022. https://www.cdc.gov/poxvirus/monkeypox/specific-settings/social-gatherings.html. Accessed July 28, 2022.
12. US Department of Health & Human Services Centers for Disease Control and Prevention. Monkeypox- How it Spreads. Updated July 29, 2022. Available at: https://www.cdc.gov/poxvirus/monkeypox/if-sick/transmission.html. Accessed August 29, 2022.
13. US Department of Health & Human Services Centers for Disease Control and Prevention. Monkeypox—pets in the home. Updated June 24, 2022. https://www.cdc.gov/poxvirus/monkeypox/specific-settings/pets-in-homes.html. Accessed July 28, 2022.
14. Nörz D, Pfefferle S, Brehm TT, et al. Evidence of surface contamination in hospital rooms occupied by patients infected with monkeypox, Germany, June 2022. *Euro Surveill*. 2022;27(26). pii = 2200477. doi:10.2807/1560-7917.ES.2022.27.26.2200477.
15. World Health Organization. Recovering from monkeypox at home. 2022. https://www.who.int/multi-media/details/recovering-from-monkeypox-at-home. Accessed August 1, 2022.
16. Rodriguez-Morales AJ, Lopardo G. Monkeypox: another sexually transmitted infection? *Pathogens*. 2022;11(7):713. doi:10.3390/pathogens11070713.
17. Bragazzi NL, Kong JD, Mahroum N, et al. Epidemiological trends and clinical features of the ongoing monkeypox epidemic: a preliminary pooled data analysis and literature review. *J Med Virol*. 2022;1–8. doi:10.1002/jmv.27931.
18. US Food and Drug Administration. FDA approves first live, non-replicating vaccine to prevent smallpox and monkeypox. 2019. https://www.fda.gov/news-events/press-announcements/fda-approves-first-live-non-replicating-vaccine-prevent-smallpox-and-monkeypox. Accessed August 1, 2022.
19. US Department of Health and Human Services. HHS orders 2.5 million more doses of JYNNEOS vaccine for monkeypox preparedness. Content created by the Assistant Secretary for Public Affairs (ASPA). Content last reviewed July 1, 2022. https://www.hhs.gov/about/news/2022/07/01/hhs-orders-2-point-5-million-more-doses-jynneos-vaccine-for-monkeypox-preparedness.html. Accessed July 29, 2022.
20. JYNNEOS (smallpox and monkeypox vaccine, live, nonreplicating) suspension for subcutaneous injection [package insert]. Initial US approval: 2019. Revised June 2021. https://www.fda.gov/media/131078/download. Accessed July 29, 2022.
21. ACAM2000 [product insert]. https://www.fda.gov/media/75792/download. Accessed August 2, 2022.
22. Rao AK, Petersen BW, Whitehill F, et al. Use of JYNNEOS (smallpox and monkeypox vaccine, live, nonreplicating) for preexposure vaccination of persons at risk for occupational exposure to orthopoxviruses: recommendations of the Advisory Committee on Immunization Practices—United States. *MMWR Morb Mortal Wkly Rep*. 2022;71(22):734–742. https://www.cdc.gov/mmwr/volumes/71/wr/mm7122e1.htm. Accessed August 2, 2022.
23. US Department of Health & Human Services-Centers for Disease Control and Prevention. Considerations for monkeypox vaccination. Updated June 30, 2022. https://www.cdc.gov/poxvirus/monkeypox/considerations-for-monkeypox-vaccination.html. Accessed July 29, 2022.
24. Bryer JS, Freeman EE, Rosenbach M. Monkeypox emerges on a global scale: a historical review and dermatological primer. *J Am Acad Dermatol*. 2022. doi:10.1016/j.jaad.2022.07.007. Accessed August 2, 2022.