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Investigation and Decontamination of an Urban Monkeypox Occurrence

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Abstract

Before the described monkeypox virus (MPXV) case in this article, limited cases of human MPXV had occurred within the United States. Lessons learned from prior outbreaks contributed to a successful approach to decontamination and containment of an adult case of MPXV in Dallas, Texas. This case report provides an overview of the characteristics of the monkeypox virus, its effects on the human body, and a primary focus on a successful protocol for household decontamination. Additional information is provided on methods related to public relations and information management that were utilized during this incident.

Monkeypox virus (MPXV) is a member of the *Orthopoxvirus* genus consisting of 2 known phylogenetic groupings that infect humans: Congo Basin and West African clades. Of the 2, the Congo Basin monkeypox virus (CB-MPXV) has a higher mortality (11% in unvaccinated persons) and transmissibility rate.¹ West African monkeypox (WA-MPXV) possesses an estimated mortality rate of 1-6% and, according to the Centers for Disease Control and Prevention (CDC), is excluded from the Federal Select Agent Program list.²⁻⁵

West and Central African small mammals are considered the most likely reservoirs of MPXV, although this has not yet been confirmed.¹ Zoonotic transmission to humans can occur by means of exposure to infected animal tissues, bodily fluids, sloughed lesions/scabs, or consuming undercooked wild game meat.^{1,6} Person-to-person transmission has been demonstrated in prior outbreaks involving both known clades and the prevalence of severe disease has been associated with immunocompromised hosts.^{3,5,6}

Symptoms of MPXV infection begin with generalized lymphadenopathy, fever, headache, and myalgias after a 5 to 13 day incubation period.⁷ These symptoms are followed by the development of a vesicular rash, progressing through multiple stages and eventually to scabs that slough off.¹ Fibrin matting within the scabs from poxvirus lesions carry active virions incorporated in the dead skin matter which can lead to resistance to desiccation.⁸ Most reports of historical outbreaks suggest prior smallpox vaccination leads to attenuated symptoms, shortened duration of disease, and lower morbidity and mortality rates.⁶

The first documented human case of monkeypox infection occurred in a 9 year old boy in Zaire, Africa in 1970. At the time of this particular MPXV case, an estimated 8 MPXV incidents had occurred outside of Africa since 2003: 2 occurrences in the United Kingdom (2019, 2021), an isolated case in Singapore (2019), 2 cases in the United States in 2021.^{1,4,9-11}

Evidence of human-to-human transmission of MPXV among these prior outbreaks was limited. However, there are published examples of this transmission occurring in the United Kingdom in 2018 and 2021.^{4,9} Specific evidence supporting transmission of WA-MPXV between humans has been suggested by contact tracing of recorded cases in Nigeria from 2017-2018.⁵ Very little data exist to define the prevalence of MPXV surviving on contaminated surfaces or the role in which this may contribute to person-to-person transmission. Before the case described in this study, MPXV outbreaks were limited in number. The 2003 US outbreak resulted in 47 cases in 4 separate states, no deaths, and a host of new regulatory measures implemented concerning animal importation. This outbreak highlighted the need for improvement in public health interagency collaboration, information management, and public relations.^{6,12,13}

After a review of the literature describing the outbreaks within the United States before August 2021, it was determined that no monkeypox-specific decontamination protocols were used or described. This study intends to document and define the decontamination procedures within the personal residence of an individual infected with monkeypox.

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Case

On July 13, 2021, a Texas resident self-reported to a large metropolitan hospital in Dallas, Texas, with the chief complaint of fever, cough, fatigue, and a vesicular skin rash, which began on July 7. He was admitted and monitored for a rash suspicious of an undifferentiated pox virus. Appropriate contact and airborne precautions were instated within the hospital. CDC and local health authorities were notified of the case. Further investigation revealed that the patient had traveled from Lagos, Nigeria, to Dallas, Texas, by means of a connecting flight in Atlanta, Georgia, on July 8-9, 2021. Masks were required for transit due to coronavirus disease 2019 (COVID-19) restrictions, which may have limited the potential person-to-person spread of the disease while enroute. The patient's source of exposure remains unknown. This was the first known case of MPXV diagnosed in a Texas resident.^{11,14,15}

Viral Sampling

Due to limited knowledge of the persistence of monkeypox viral particles within a household, the CDC conducted a site visit to assess the patient's residence on July 28, 2021, and gathered samples for testing from high-traffic areas and surfaces of high-use objects within the home. These samples were obtained to further investigate the level of contamination within the home of an infected person. Viral sampling resulted in the confirmation of persistent viral material primarily found on soft, porous items such as clothing and bedding.¹⁶ These data were not yet available for use by the Dallas County Health and Human Services (DCHHS) before initiating decontamination efforts. CDC and local health authorities made recommendations for residential decontamination of the patient's apartment based on smallpox decontamination instructions and knowledge of prior MPXV cases in the United Kingdom.^{4,8}

Residence Decontamination

Using photographs obtained by the CDC during viral sampling and information gathered from apartment management by DCHHS, a layout of the apartment and its contents were defined and itemized to facilitate decontamination efforts.

Using CDC smallpox environmental control guidelines and monkeypox decontamination publications by Public Health England, the DCHHS, in conjunction with a government-contracted professional decontamination company, formulated a plan addressing decontamination efforts of the patient's living quarters.^{4,7,17} Based on the classification of WA-MPX virus as a category "B" agent, level C personal protective equipment (PPE) was determined as sufficient protection for pox virus environmental control (Figure 1).³

A conservative multistage approach was utilized in the decontamination process to avoid excessive damage to apartment materials, electronics, and personal items of the individual. Cleaning solutions were chosen for their effectiveness against pox viruses and limited corrosive qualities and included a germicidal quaternary ammonia agent (Mediclean [EPA 70385-6]) and hypochlorite solution (bleach).^{7,18} Nonchemical methods (ultraviolet [UV] light wands) were also used to assist decontamination of items that could not have liquids or sprays applied (paper products). Hydrogen peroxide solution was considered but rejected due to its corrosive, oxidizing nature.



Figure 1. Full decontamination PPE. Stock image from CG Environmental.

The patient's residence consisted of a 553-square-foot second-floor apartment accessed only by open-air stairwells. The apartment's 5 rooms consisted of a living room, kitchen area, bedroom, bathroom, and walk-in closet.

Decontamination efforts commenced on August 2, 2021. Decontamination crewmembers initiated containment of the apartment and open-aired stairwell from other areas of the complex by hanging plastic enclosures. Eight-millimeter-thick plastic polyethylene enclosures were used to inhibit access to the apartment and to construct staging of decontamination and waste containment areas. Plastic enclosures served a secondary purpose of blocking the view of operations within the apartment from potential onlookers. Decontamination zones were assigned as follows:

1. **Hot Zone** - involved the patient's apartment and all contents.
2. **Warm Zone** - included the area immediately outside the apartment entrance and encompassed the majority of the second-floor hallway/landing and a portion of the stairwell.
3. **Cool Zone** - began outside the warm zone double plastic exit in the stairwell and extended to the first-floor landing.

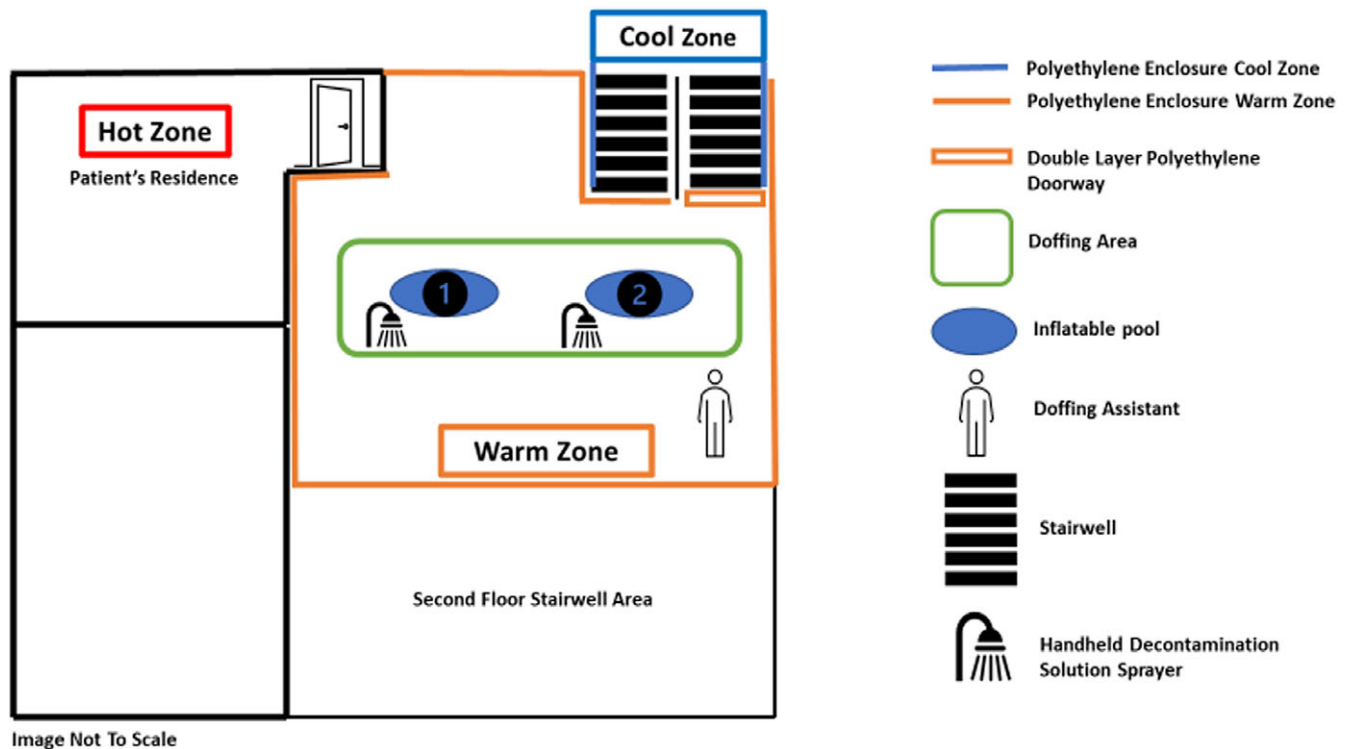


Figure 2. Decontamination zones. Image produced by S. Hockaday.

Figure 2 provides a schematic representation of the zones of decontamination. Hot and warm zone entrance/exit traffic was highly regulated, and only decontamination crew with appropriate PPE were allowed to enter or leave. Crew members donned Level C PPE in the cool zone with the assistance of donning personnel to check suit integrity and apply critical taping at all junction areas: gloves to suit, boots to suit, suit to full face respirator. Cleaning personnel proceeded to atomize Mediclean solution throughout the areas designated as transit zones (warm and cool zones) to decontaminate these areas.

Atomization of full-strength Mediclean within the residence and warm/cool zones was accomplished with Hudson® 110 V handheld sprayers. Atomized Mediclean was also circulated through the apartment by means of the air-conditioning system which assisted in the application of virucidal agent to air ducts and all cubic air space/ventilated spaces and surfaces. This atomization process was conducted 3 times during the decontamination process. Before the initiation of decontamination efforts, it was verified that each apartment in this complex was equipped with a separate HVAC system, and therefore, atomized solutions were only circulated through the apartment of interest. Care was taken by the professional decontamination team to wear individual respirators with 3M filters that were approved for ammonia and chlorine-based products.

After a timed break to allow drying of atomized solutions, a bleach solution was applied to all hard surfaces, furniture, appliances, box springs, and suitcases using cloth rags to prevent spillage. Within the apartment, a small plastic pool was filled with a bleach solution and used to submerge and clean small items that were not susceptible to water damage.

Items identified as potentially soiled with direct skin contact by the patient were soaked with atomized Mediclean and placed in plastic bags and labeled for disposal. These items included:

used medical waste, worn or soiled clothing, bedding, open food items, over the counter medications. Clean laundry hanging in closets or folded in drawers was not destroyed but treated with atomized Mediclean. Soft furniture items, including a couch, loveseat, and mattress, were saturated with atomized Mediclean, deconstructed within the apartment, and bagged for disposal. Carpets were steam-cleaned using commercial water-based cleaning solutions at a temperature of 198°F, which ensured the neutralization of viral particles without damage to the structure of the flooring or carpet. Industrial-grade, truck-based vacuums were used with HEPA filters to remove the cleaning solution and wastewater completely from the flooring at a pressure of 25-28 negative gravitational pull on the Mercury scale. Wastewater was treated with bleach and Mediclean and then collected into barrels for proper removal.

As personnel exited the Hot Zone, they immediately entered the warm zone decontamination area. They stepped into an empty plastic inflatable pool (labeled #1 in Figure 2) and proceeded to spray the exterior of their PPE with handheld pumps containing bleach solution. The exterior of the PPE was also sprayed with atomized Mediclean and then scrubbed with a soft brush connected to an extension pole. Afterward, personnel stepped into rinse pool #2 and had the exterior of PPE rinsed with soapy water by handheld pump sprayers operated by a doffing assistant. Here, they doffed their protective suits, rolling them outward so as not to contaminate the interior portions. Once the suits were rolled down below the knee, the team members sat on a clean chair and withdrew their feet from the suit, stepping onto the area outside the doffing zone. Doffing assistants were present to ensure proper technique and reduce possible contamination. Personal respirators were removed by doffing assistants. Contaminated PPE and doffing cleaning solution were collected along with apartment waste for appropriate disposal.

Used PPE and poly sheeting were bagged and added to waste materials. Based on supportive information provided by the CDC, the US Department of Transportation reviewed the data and determined that special permits were not necessary for the transport of the category B waste from the residence.³

Press Releases and Information Control

On July 16, 3 days following the patient's presentation to a local health-care facility, the DCHHS published a press release describing the confirmed case of monkeypox in a Dallas resident. This release described the local and federal response to this case and quantified the risk to the public. Contact information for the CDC and DCHHS offices was included.¹⁵

On July 27, 2021, DCHHS issued a control order to the residential management/owners announcing the concern for infectious disease contamination of the patient's residence and the requirement for decontamination. The order explained the contact risk of transmission to other residents. The order specifically stated the lack of potential transmission by means of the airborne route. Care was taken to not explicitly state the specific agent of concern but to instead use broad, well-understood medical terminology, thus avoiding undue public concern or panic. The control order described the corresponding laws allowing quarantine by a public health entity as well as the necessary steps that the residence management should take to facilitate the decontamination efforts of the isolated apartment.

One week before the commencement of decontamination, the following printed statement was released to the apartment residents in both Spanish and English:

"On Monday, August 2, 2021, Dallas County Health and Human Services (DCHHS) will be performing a routine deep cleaning in one of the apartments in this building. Unfortunately, the stairs will not be available between 9 AM and 5 PM. Please plan accordingly. We apologize for any inconvenience this may cause. If you have any questions or concerns, contact the management office."

Public health emergency preparedness staff and Public Information Officers (PIOs) from DCHHS were present on-site to assist with sampling and decontamination efforts. CDC lab staff conducted residence viral sampling and received samples for transport. Law enforcement officers and fire department personnel were strategically located near areas of operation to intercept and control interactions with local residents as well as members of the media. All public information exchanges were handled by PIOs on-site.

Interagency Collaboration

Interagency collaboration and involvement took place at every step of the control and containment of this infectious disease outbreak. From the recognition of the presence of the disease to the termination of decontamination procedures, great efforts were made to establish and maintain open communications between federal, state, and local entities. Without such collaboration, possible spread of disease, incorrect information release, and public panic may have ensued. The importance of these interagency efforts cannot be overstated. Below is a list of the involved agencies for reference (Table 1).

Conclusions

Each incident of monkeypox infection is unique, depending on the circumstances of exposure, involvement of travel, and

Table 1. Local, state, and federal agency participants

Federal:
<ul style="list-style-type: none"> Centers for Disease Control and Prevention Environmental Protection Agency Department of Transportation
State:
<ul style="list-style-type: none"> Texas Department of State Health Services Texas Commission on Environmental Quality Texas Department of Emergency Management
Local:
<ul style="list-style-type: none"> Dallas County Health and Human Services Dallas Fire and Rescue Fire Marshal and HazMat Dallas County Sheriff Dallas County Homeland Defense and Emergency Management Dallas County Marshal Service Contractor: Cleaning Guys Environmental HAZ/MAT https://www.cleaningguys.com/

environment of the individuals affected. This study provides a detailed description of the interagency approach to decontamination of the communicable disease monkeypox from a residential apartment in the United States. This experience documents the cooperation between government, state, and local entities in conjoined efforts to identify, contain, and decontaminate a category B agent in an urban center, drawing from prior experience with other infectious agents (such as Ebola and Smallpox). Knowledge of recent MPXV outbreaks suggested the possibility of human-to-human transmission within a residence, which caused concern for the potential spread of disease, necessitating deliberate and careful decontamination efforts. Guidance for decontamination was a multi-disciplinary effort between National Institute of Occupational Safety and Health (NIOSH), CDC, HHS, Department of Transportation (DOT), and an experienced professional hazardous material (HAZMAT) cleaning company. We strongly suggest proper planning and construction of an infectious disease response plan on the local and regional levels to improve disaster risk resiliency. It is recommended that local health authorities formulate a list of vetted experienced teams or companies skilled in the decontamination of hazardous agents. This experience may provide a useful guide in the event of future communicable disease outbreaks.

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