

Monkeypox Pandemic in Africa: Human Dissection Protocols, Precautions and Recommendations for Medical Education

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Submitted to: JMIR Preprints
on: January 28, 2025

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Abstract

The management of human dissection labs and medical education are significantly impacted by the resurgence and spread of monkeypox (Mpox) as a global health issue, especially in Africa. Human dissection, a crucial part of anatomical education, requires strict procedures to protect medical students and instructors from the spread of infectious diseases. This article highlights important hazards and biohazard concerns while examining the difficulties presented by the Mpox pandemic in the context of cadaveric dissection. Through a review of literature, institutional protocols and epidemiological data, we propose improved personal protective equipment (PPE) regulations and disinfection guidelines tailored for African medical facilities. This article highlights the need for capacity-building programs to equip educators and students with skills to manage infectious disease risks effectively. By tackling these challenges, we aim to advance medical education safely while contributing to discussions on public health emergency adaptations and fostering pandemic resilience.

(JMIR Preprints 28/01/2025:71857)

DOI: <https://doi.org/10.2196/preprints.71857>

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Original Manuscript

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Running Title: Human Dissection during Monkeypox Pandemic in Africa

Abstract

The management of human dissection labs and medical education are significantly impacted by the resurgence and spread of monkeypox (Mpox) as a global health issue, especially in Africa. Human dissection, a crucial part of anatomical education, requires strict procedures to protect medical students and instructors from the spread of infectious diseases. This article highlights important hazards and biohazard concerns while examining the difficulties presented by the Mpox pandemic in the context of cadaveric dissection. Through a review of literature, institutional protocols and epidemiological data, we propose improved personal protective equipment (PPE) regulations and disinfection guidelines tailored for African medical facilities. This article highlights the need for capacity-building programs to equip educators and students with skills to manage infectious disease risks effectively. By tackling these challenges, we aim to advance medical education safely while contributing to discussions on public health emergency adaptations and fostering pandemic resilience.

Keywords: Monkeypox, human dissection, medical education, biohazard precautions, personal protective equipment, pandemic preparedness.

Introduction

Monkeypox (Mpox) is an uncommon zoonotic illness caused by a double-stranded Deoxyribonucleic acid (DNA) virus that is a member of the Orthopoxvirus genus within the Poxviridae family ³. Mpox was initially discovered in Western Africa in 1970, when it was thought to be prevalent ⁵. Mpox has been endemic in Central and West Africa before the latest epidemic in non-endemic nations ¹². The West African Clade (Clade 2) and the Central African Clade (Clade 1) are the two genetic clades in which the Mpox virus (MPXV) is found. The severity of these two clades varies, and the Central

African Clade is more severe, causing infected people to become more ill ⁵⁶.

Its transmission happens through human-to-human, animal-to-human, and contaminated environment-to-human contact and is usually favoured by climate and temperature (Figure 1) ^{30, 50}.

Over the years, several countries in sub-Saharan Africa have reported cases of Mpox with significant morbidity and mortality rates ⁷. Mpox has been a global outbreak since 1 January 2022 from 23 Africa Member States and a World Health Organization (WHO) public health emergency of worldwide concern on August 14, 2024, resulting in 14,582 laboratory confirmed cases, alongside 76 deaths as of 10 November 2024 ⁵⁴.

Since 300 BC, medical students have relied on human dissection, an age-old yet effective teaching method that gives them a better grasp of the human body's structure ^{20, 54}. For a thorough understanding of the human body, it is crucial to see the anatomical variances in individual cadavers in addition to textbooks and anatomical models. Though beneficial, this reliance on human bodies for anatomical studies is of great concern due to the risk of spreading disease. Since the first known victim, Giovanni Domenico Santorini (1681–1737), an Italian anatomist, passed away on May 9, 1737, from an illness he had acquired while doing human dissections, it has been a topic of interest. It is essential to note that body surfaces can harbour various infectious agents for extended periods ²⁴. Strict infection control protocols must be implemented to prevent the virus's spread among body handlers. This review sheds light on the Mpox pandemic and its potential implications for human dissection and highlights emerging concerns with practical solutions.

Overview of Mpox and Its Transmission Risks

The symptoms of Mpox are similar to those of smallpox. Fever, headaches, backaches, exhaustion, lymphadenopathy, and a distinctive rash are some symptoms. The presentation of lymphadenopathy as a symptom of Mpox differentiates its symptomatology from that of smallpox. This lymphadenopathy presents as swollen lymph nodes, which may affect multiple localized areas such as the armpits or neck region ⁵⁷. Clinical symptoms of Mpox usually show up 5–21 days after

infection, making it a significant disease of a global public health concern ⁶⁹. Serious consequences may develop from early symptoms, including muscular soreness and widespread rashes ¹⁸. Pregnant women, children, and those with impaired immune systems are among the vulnerable categories that are more likely to experience pneumonia, sepsis, encephalitis, visual loss, bacterial infections, dehydration, and even death ⁹. Additionally, lasting effects such as skin scarring and pigmentation further highlight this disease's substantial burden on general well-being, demanding urgent attention to its management ⁹.

Mpox can be transmitted through different routes, including direct contact with bodily fluids, and respiratory droplets are identified in some of the described instances. Additionally, infected fomites, skin breaks, respiratory tract infections, or mucous membranes in the mouth, nose, and eyes can all spread the disease ^{21, 65}. Human cadavers are considered potent vectors of MPXV infection in dissection labs, given the resilient nature of viruses to survive even after the death of their host. In medical dissection settings, handling cadavers infected with MPXV poses a danger since contact with body fluids, lesions, or contaminated dissection equipment can result in transmission ¹⁵. Although respiratory transmission of MPXV is generally considered lower risk, aerosolization during dissection could potentially introduce contaminated airborne particles, which pose a significant risk for everyone in the laboratory ²². One of the critical challenges in dissection labs is that infected cadavers may not always be quickly identified, especially when a virus is undetected before death, which is usually the case in some African medical institutions that depend on unclaimed and felons for body sourcing ⁵¹. This may inadvertently cause the laboratory personnel to neglect taking sufficient precautions ⁴⁴. Furthermore, exposure to MPXV is heightened when laboratory personnel are undertrained, particularly if they lack awareness of Mpox transmission pathways and necessary control measures and protocols to implement ²².

Standard Human Dissection Protocols in Africa

Around the world, especially in Africa, human dissection is essential to anatomical instruction in

medical institutions⁴³. It offers medical and allied health professions unique and valuable hands-on experience to conceptualize knowledge of the structures of the human body and its variation through a three-dimensional approach and develop skills in visual-spatial abilities⁴². Moreover, human dissection promotes professionalism, ethical behaviour, and empathy as students learn to handle human remains with respect^{17, 1, 52}.

Human dissection is an important component of anatomy instruction in Africa, particularly for undergraduate medical students³⁶. Challenges facing anatomy education in the African region, like shortage of educators, high student ratio, and poor facilities, among others¹⁶, also impact the practice of human dissection. The practice of human dissection varies significantly among institutions, even within the same country or region. This could stem from variations in the curriculum³⁸ and the dynamics of the cadaver populations³⁷. Thus, African medical schools currently adopt no documented universal standard for human dissection protocol. A careful assessment of various institutions would reveal individualized protocols.

Human dissection is influenced by ethical and logistical concerns, with acquisition and handling being key to these factors. Due to the lack of formalized corpse donation programs, the majority of African medical schools—aside from those in South Africa and Libya—heavily rely on unclaimed bodies²⁵. In Kenya, for example, all the cadavers used in medical training are obtained from unclaimed bodies, thus also raising a need for precise regulation on cadaver acquisition⁶⁰. Clear regional, national, or institutional rules for human dissection must be established for training and research purposes. The Japanese Association of Anatomists, the Japan Surgical Society, and the International Federation of Associations of Anatomists (IFAA) have all offered suggestions that might be followed in this regard^{62, 59}. Additionally, when creating standardized procedures, the psychological effects of dealing with cadavers on students must be carefully taken into account^{6, 49}. While the lack of unified human dissection protocols in African medical schools has not been reported to pose any significant challenge to medical training, institutional or national guidelines in

line with international best practices must be established and implemented.

Precautionary Measures for Human Dissection During Infectious Disease Outbreaks

Human dissection during infectious disease outbreaks predisposes significant health risks to the people involved due to the high rates of morbidity or death associated with outbreaks of new, emerging, or re-emerging infectious illnesses^{24, 54, 68}. Some preventive measures that can be taken include:

Personal Protective Equipment (PPE)

Proper PPE use builds a sense of security among participants, allowing them to focus on the academic motive of human dissection without compromising their health³⁵. Important PPE includes gloves, masks, face shields, and gowns⁶⁷. A glove protects the hands from potentially harmful biological agents, minimizing the risk of infection from cuts and abrasions¹⁴. Masks help protect the respiratory tract, while laboratory gowns and aprons provide full-body coverage, preventing the skin and clothing from infection and enabling effective anatomical education⁶⁷.

Body Preparation and Storage

Cadavers must be prepared and stored correctly to reduce the spread of pathogens during dissection⁶⁴. Bodies diagnosed or suspected of having infectious diseases, including HIV and hepatitis, must be labelled⁶³. Increased disinfection, regular surface cleaning, and more potent chemical preservatives, such as formaldehyde and alcohol-based treatments, should be employed (Kim et al., 2021). Multiple high-efficiency particulate air (HEPA) filters and well-ventilated storage with negative pressure can also contain airborne infections³⁵. Combining these procedures with good hygiene can effectively decrease contamination risks, ensuring a safer anatomy laboratory.

Ventilation and Laboratory Setup

During disease outbreaks, adequate ventilation and strategic laboratory setups ensure a safe dissecting environment. To lower the risk of airborne diseases, the anatomy lab should use a negative pressure system of air conditioning and HEPA filters³⁵. For instance, air purifiers may be installed in

dissection laboratories to enhance air circulation and reduce the risk of aerosol transmission. Also, crowding can be avoided by modifying the entry and exit points, with PPE placed at designated stations ³⁵.

Hand Hygiene and Surface Cleaning

Proper hand hygiene and consistent surface cleaning can minimize contamination risks during human dissection ⁵⁴. Alcohol-based hand sanitizers should be used before and after sessions, and dissection tools and work surfaces must always be routinely cleaned with potent disinfectants ²⁸. This regular disinfection procedure would decrease the risk of pathogen contamination and maintain a high standard of hygiene in the laboratory.

Safe Disposal Methods

Several ethical, public health, and societal repercussions can result from improper handling of biological waste ⁸. Safe disposal of biological waste is crucial to decrease the risk of infection (World Health Organization, 2024). The students' and the institutions' obligation is to properly care for and dispose of these human remains ⁸. All used PPE and disposable instruments are treated as bio-hazardous waste and discarded in designated biohazard bins. Incineration of biological waste ensures the destruction of pathogens and maintains a sterile environment in the anatomy laboratory ^{8, 28}.

Case Studies: Protocol Adjustments in Response to COVID-19 and Applicability to Mpox

Considered the worst pandemic in recent history, the coronavirus disease 2019 (COVID-19) had a significant impact on the terrain and culture of anatomy dissection in some ways ^{53, 23}. Due to the disease's inception and global dissemination, the conventional hands-on, face-to-face approach to human dissection had to undergo specific important changes ^{39, 51}. To contain the disastrous spread of the virus, many educational campuses went into total lockdown, leading to the cancellation of physical classes, including human dissection ^{55, 11}. However, others who continued face-to-face cadaveric dissections during the disruptive period of the pandemic changed their dissection procedures and adopted new strategies to minimize the risks of infections ⁷¹.

Due to its pandemic-related modifications, the anatomy department at Korea University's College of Medicine in Seoul had to modify its schedule to shorten the number of days students had to visit the dissection lab ³⁵. Before the pandemic, 110 students would be divided into 20 groups for 3-4 hours of dissection lessons. However, the number of days that students had to come on campus for dissection was reduced under COVID-19, and they had to complete the material for two to three dissection sessions every day for six to twelve hours ³⁵. Secondly, every student attending the classes was made to follow a stringent infection management protocol. This involved checking their body temperatures and respiratory symptoms of COVID-19. Additionally, the students were urged to enter through the Korea University Anam Hospital's admission system and screened daily for potential infection exposure. Additionally, each participant in the dissection class had to turn in a checklist asking them whether they had visited a highly contaminated area or had come into contact with a proven infected individual. Students with questionable signs of the illness during Anatomy Lab 8 had a COVID-19 test promptly performed at the hospital infection control office ³⁵.

Furthermore, PPE such as nitrile gloves, dental masks (for respiratory protection), aprons, wristlets, and full-body lab coats (Figure 2) were made available to each student. While certain PPEs, such as face shields and lab coats, were cleaned and reused, most were thrown away after their initial usage in each lab session. Lastly, to minimize the risk of infection, the lab was equipped with a negative pressure system, air conditioning, and six air purifiers with extremely effective particle air filters running at maximum efficiency.

According to Muñoz-Leija et al. (2020), the Human Anatomy Department at the School of Medicine of the Universidad Autónoma de Nuevo León, Mexico, used both synchronous and asynchronous online modalities for the anatomy practical sessions during the COVID-19 pandemic. The asynchronous modality involved using "Anatoboard," an institution's online anatomy platform, to which recorded practical anatomy classes were uploaded. The platform had features that enabled discussion forums with students, viewing of protected cadavers, identification of anatomical

structures, and the applications of video-controlled questionnaires and lecture-based quizzes. The online synchronous sessions were live-streamed using Microsoft's TEAMS (Microsoft Corporation, Redmond, USA) to ensure real-time interaction.

According to Kathleen (2021), during the epidemic, the Warren Alpert Medical School at Brown University in Rhode Island, USA, had to change its anatomy from dissection to prosecution. Prior to the pandemic, students would dissect cadavers alone for three hours per week in groups of five or six. This brought many students together for lengthy hours in a confined laboratory. However, to reduce the possibility of spreading the disease and ensure social distancing requirements, the cadavers were dissected beforehand for the students to view and study later. Also, only two students were allowed into the lab for one hour per week.

The COVID-19 pandemic required quick and significant protocol changes to reduce infection risks, transforming medical education and training, especially in human body dissection ⁴⁰. These modifications provide insights that can be applied to control newly emerging infectious illnesses such as the MPXV. Because of the parallels in infection control standards and transmission paths, these lessons can assist medical facilities in maintaining safe and efficient dissection procedures during epidemics ⁴⁶.

Dissection labs implemented strict risk assessment procedures and improved infection prevention controls during the COVID-19 pandemic. Strict disinfection procedures were implemented, as well as improved ventilation systems and espoused PPE ⁵³. These precautions are just as important in the case of Mpox, a zoonotic virus contracted by direct contact with lesions, bodily fluids, or infected surfaces. Strict handling procedures would be necessary for bodies with suspected or confirmed Mpox infections to reduce hazards. These procedures include gloves, disposable gowns, and virucidal chemicals effective against orthopoxviruses ¹⁹.

The necessity of pre-screening bodies to weed out those with recent or ongoing diseases was further

highlighted by the pandemic. Mpox screening can be added to this procedure, guaranteeing that donors' medical histories are carefully examined. Post-mortem diagnostic testing, if required, can assist in verifying the virus's absence, lowering the possibility of exposure for medical professionals and students. The widespread use of online anatomy platforms and virtual dissection tools during COVID-19 was a noteworthy advancement²³. Few in-person sessions were available, so these resources ensured that anatomy instruction continued. A similar dependence on digital tools may prove crucial if physical attendance in dissection labs is disturbed during an Mpox outbreak. Virtual tools can enhance experiential learning while putting staff and student safety first.

Biological waste handling and disposal were also closely monitored throughout the epidemic, and procedures were revised to handle the biohazard threats posed by SARS-CoV-2. For infectious agents like Mpox, these procedures—such as double-bagging garbage and autoclaving before disposal—remain essential. Because the virus can survive on surfaces, careful waste management is necessary to avoid contaminating the environment^{33, 47}. Lastly, the ethical and psychological issues raised during COVID-19 apply just as much to Mpox. Students and employees' mental health and willingness to engage in dissection activities may be impacted by their fear of infection. These worries can be avoided, and a supportive learning environment can be guaranteed with open communication, strong safety protocols, and access to mental health assistance. The COVID-19 pandemic offered a model for modifying cadaveric dissection procedures to accommodate newly discovered infectious illnesses like Mpox. Medical schools may continue to provide top-notch anatomy instruction while ensuring everyone's health and safety by building on these experiences. These actions improve readiness for upcoming outbreaks and address current issues^{34, 47}.

Recommendations for Enhanced Protocols in African Medical Institutions

The potential danger of contracting Mpox illness via contact with cadavers associated with the disease cannot be ruled out, even in the absence of evidence of infection⁶⁶. Following safety precautions before, during, and after dissection is essential to avoiding unintentional disease

transmission from cadavers. To guarantee that handling personnel have thorough access to extensive technical knowledge before handling such remains, it was advised during COVID-19 that the proper medical records of bodies given to educational institutes be obtained⁵³. The same recommendation should be espoused for Mpox disease in African medical institutions. Medical students who participated in the study showed little understanding of Mpox, particularly the disease's epidemiology, symptoms, and treatments^{29, 61}. Therefore, it is essential to have education and training in identifying the disease among staff and students in African medical institutions. Promoting Mpox vaccination and physical distancing measures between populations and areas with high transmission rates should be encouraged in African medical institutions³¹.

Screening and Monitoring

As adopted during COVID-19, each student at Korea University underwent a strict infection control program that evaluates respiratory symptoms, body temperature, and possible infection³⁵. The most common Mpox symptoms before the rash are fever, restlessness, and lymphadenopathy. It is recommended that students, employees, and dissection technicians undergo health examinations or symptom screening for the symptoms mentioned above, even though they are asymptomatic²⁶.

Preparing Dissection Labs for Potential Future Infectious Disease Outbreaks

According to Kim et al. (2021), in order to lower the danger of probable contagion during COVID-19—which may also be espoused during Mpox—a negative pressure system, air conditioning, and six air purifiers with high-efficiency particle air filters were operated as effectively as possible in the lab³⁵. Additionally, the dissection laboratory's air handling systems should be built so air is expelled outdoors, away from crowded areas or gathering places (like the roof), and other air intake systems rather than being brought back into the facility. This strategy can also be used for Mpox as there seems to be little chance of MPXV respiratory transfer from person to person¹⁰.

Policy Recommendations

According to the World Health Organization's (WHO) interim recommendation for infection

prevention and control for the safe handling of dead bodies dated March 24, 2020, embalming suspected or confirmed deceased remains is not advised in the context of COVID-19⁵⁸. Furthermore, an integrated multilayer body bag is advised for handling and storing deceased corpses to minimize the "body handlers" exposure to contaminated bodily fluids⁵⁸. These blueprints should be employed for Mpox disease and monitored in African medical institutions. Due to cultural customs, a lack of resources, and a lack of public health knowledge, the African continent is a hotspot for vector-borne and zoonotic viral diseases that have the potential to spread globally⁴⁰. This highlights how crucial it is for the government and health ministries to include the epidemiology of re-emerging diseases like Mpox in the medical curriculum to improve disease prevention and control.

The joint Africa Centres for Disease Control and Prevention (CDC) and WHO African leaders must implement the Mpox Continental Preparedness and Response Plan for Africa since political power is the foundation for any policy's actualization. By uniting all member states, local civil societies, industries, public and private sector players, and foreign partners, they must work together across borders and sectors². Additionally, ministerial-level health executives should prioritize clear communication, well-coordinated resource allocation, and a consistent message emphasizing the importance of cooperation².

Discussion

An essential component of the history and contemporary storyline of Mpox is the African continent. Despite having been on the African continent for more than 50 years, Mpox only came to the attention of the world when it started to spread to wealthy nations in North America and Europe (Mercy et al., 2024). The 2017 outbreak in Nigeria, which included 122 confirmed cases and 7 fatalities (a case fatality rate of 5.7%), was one of numerous Mpox epidemics in Africa prior to the Public Health Emergency of International Concern (PHEIC) being announced.⁴⁵

Since most Mpox virus transmission occurs through contact with an infected person's scabs, sores, or

respiratory droplets, non-pharmacological measures to control the virus's spread, such as social dissociation, hand washing practices, and the use of face masks, are crucial in preventing Mpox outbreaks.^{3, 27} In order to ensure that students, teaching staffs, and non-teaching staffs working in the dissection hall are better prepared to manage future pandemics, it is also crucial to use the knowledge and experience gathered during the epidemic to inform their training and growth.^{3, 27, 41} Since university medical students are susceptible to infectious illness exposure due to their academic activities such as cadaver dissection. By teaching medical students at universities about the dangers of Mpox and how to avoid it, they can take the necessary precautions to keep the illness from spreading.²⁷ University medical students may serve as advocates and ambassadors for disease awareness and prevention by educating themselves about Mpox, fostering safer and healthier communities.²⁷

The importance of stopping an epidemic before it spreads widely was also highlighted by a previous Mpox outbreak, and this should always be the first priority when symptoms are approaching. Declaring several Mpox cases in multiple nations without any apparent cause should serve as a warning to policymakers and the government, and effective measures must be taken to combat the spread.³

Conclusion

The necessity to review safety procedures in medical education, especially in human dissection labs, has been highlighted by the development of the Mpox pandemic. The disease's main problems, such as its ways of spreading and the increased risks it poses in anatomy labs, have been discussed in this article. Additionally, it highlighted crucial safety precautions such as improved PPE, strict hygienic procedures, and technological advancements like virtual learning platforms to support conventional teaching strategies. These steps are essential to guarantee instructors and students a secure and productive learning environment.

Maintaining the integrity of anatomical education while protecting the health of medical students and

instructors requires proactive safety precautions. Strict measures designed to address the dangers of Mpox, such as required health examinations and enhanced ventilation systems, will reduce the chance of infection while boosting instructors' and students' trust. Furthermore, promoting awareness and following these recommendations will guarantee long-term resistance to possible future epidemics of comparable zoonotic illnesses.

Finding a balance between the need for comprehensive medical education and health safety during human dissection is still tricky but essential. Institutions can maintain educational quality while adjusting to new public health issues by putting the welfare of all stakeholders first. Ultimately, implementing these recommendations will pave the way for a more creative, adaptable, and robust approach to medical education, ensuring that future medical professionals are equipped to support their communities during emergencies.

Source of funding: No funding was received for this study

Conflict of Interest: The authors declare no conflict of interest in this study

Authors' contributions: Conceptualization, Methodology, Project Management and Supervision: AOA and IAO; Data curation, Writing- Original draft preparation: All authors; Visualization: ASW. Software, Validation, Writing (Reviewing and Editing): All authors

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Figures

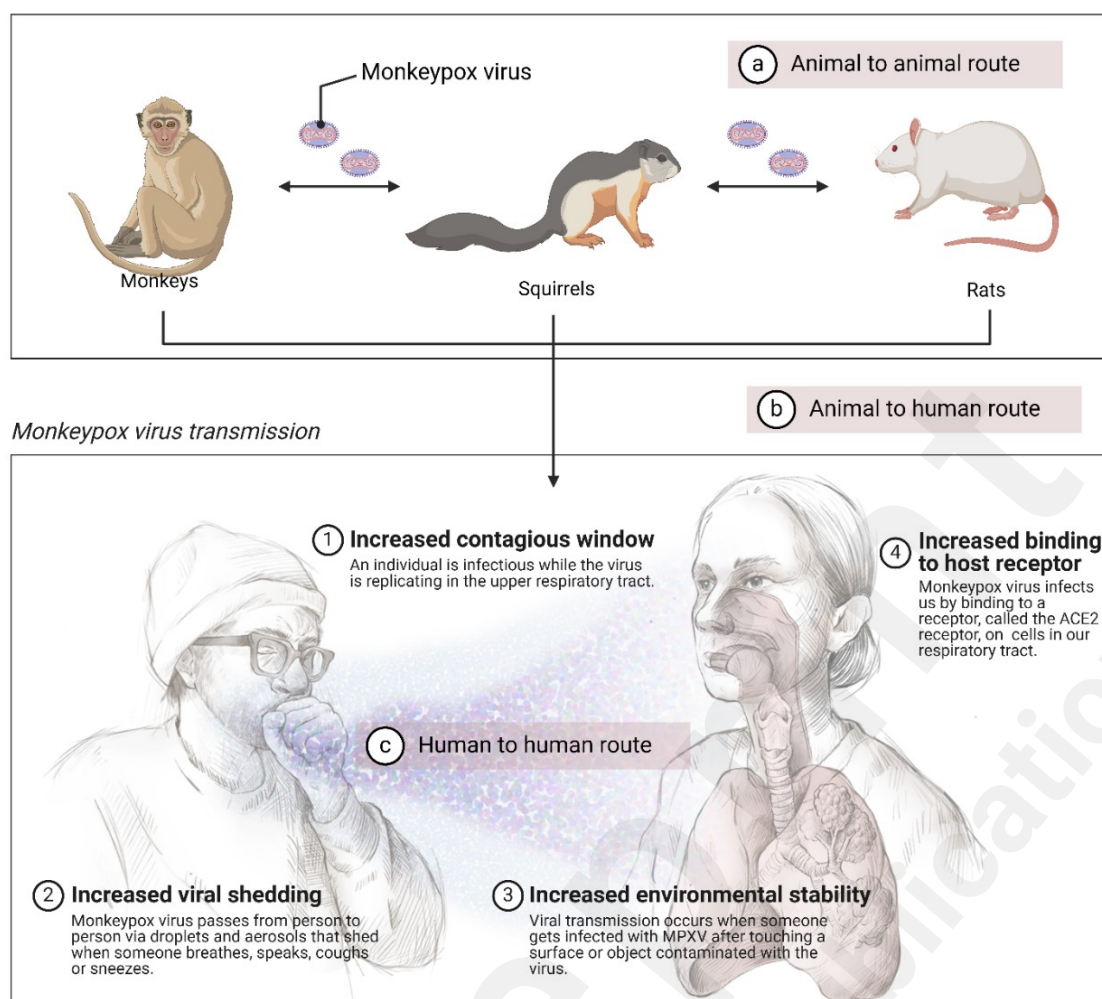


Figure 1: Transmission routes of the Mpox virus.

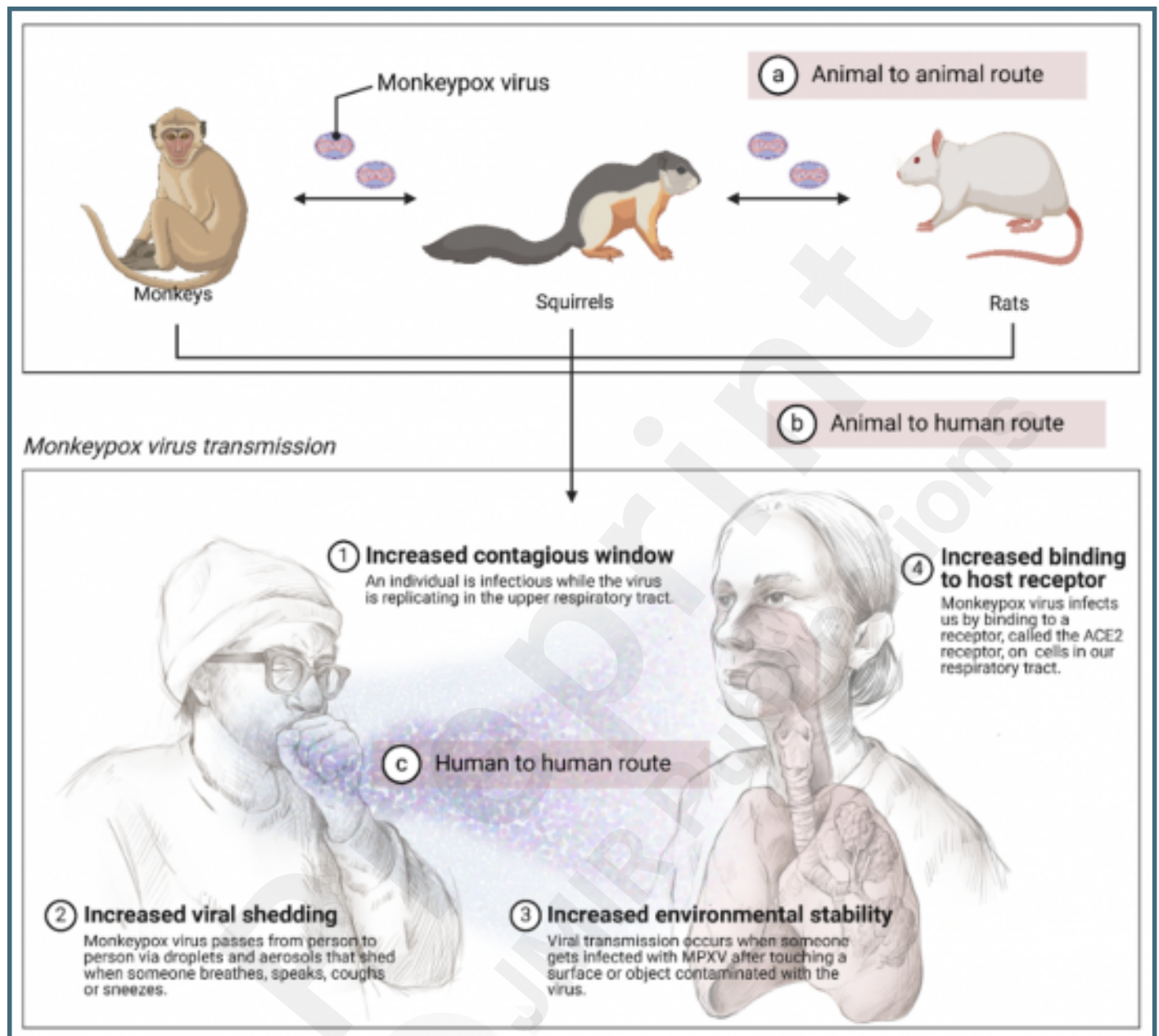


Figure 2: Protective measures to limit the spread of Mpox.

Supplementary Files

Figures

Transmission routes of the monkeypox virus.



Protective measures to limit the spread of monkeypox virus.

