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The reemergence of the human monkeypox: strengthening Africa's epidemic preparedness and response system

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Abstract

The reemergence of the monkeypox (MPX) virus poses a serious threat to global health security. While the first human case was reported in Democratic Republic of Congo in 1970, a recent outbreak of this disease in May 2022 has gone 'viral,' spreading to most continents and occurring in nonendemic countries. Outside Africa, there have been reports of cases of MPX in countries such as Singapore in May 2019, Israel in September 2018, UK in September 2018, among others which have been traced back to importation of infected wild rodents from Africa. The Centers for Disease Control and Prevention (CDC) recommends that the standard laboratory facility to carry out MPX tests is Biosafety Containment Level (BSL)-2 working standards if the laboratory staff has taken smallpox vaccine within the last 3 years and BSL-3 working standards if the laboratory staff has not taken the smallpox vaccine. However, African countries have a shortage of BSL laboratories. Hence, there is a need to improve the integrated surveillance of the MPX virus, strengthen diagnostic capacity, capacity building of health workforce, public education programs, fund research, and development, among others. Leveraging a 'One Health' approach will offer fresh insight into the human–animal–environment interface and boost the understanding on the possibility and mechanisms of spillback and reverse zoonosis as well as disease severity and risk factors for severe disease as well as its epidemiology in various subpopulations. Not leaving Africa behind in the prevention, diagnosis, and management of MPX is important to stopping the spread and reemergence of this virus.

Keywords: Africa, epidemic, monkeypox, preparedness, response

Epidemiology of monkeypox virus

The reemergence of the MPXV poses a serious threat to global health security. While the first human case was reported in the Democratic Republic of Congo (DRC) in 1970, a recent outbreak of this disease in May 2022 has gone 'viral,' spreading to most continents and occurring in nonendemic countries and as at 26 August 2022, reports from Centers for Disease Control and Prevention (CDC) states that MPX has sporadically spread to 99 countries with a total of 47 652 cases globally. A total of 47 209 cases among countries that have not historically reported MPX and 443 cases in endemic African countries[1]. This recent outbreak has called the world's attention to the neglected disease, thereby prompting the WHO to declare it a Public Health Emergency of International Concern (which is the highest level of international alert under the International Health Regulations) on 23 July 2022.

MPX is a re-emerging disease in West and Central Africa. It was first discovered in 1958 among a troop of monkeys kept for a research purpose in a laboratory in Denmark and in 1970[2], the first human case was reported in a 9-month-old baby in the DRC[3]. Since then, MPX became endemic in some African countries. These countries include Cameroon, Benin, the Central African Republic, Gabon, the Republic of the Congo, Nigeria, the

HIGHLIGHTS

- The reemergence of the monkeypox virus (MPXV) poses a serious threat to global health security.
- Most African countries have a shortage of Biosafety Containment Level (BSL) laboratories for the diagnosis of monkeypox (MPX).
- Surveillance and diagnostics systems in Africa need to be strengthened to stop the spread of MPXV.
- Leveraging a 'One Health' approach will be beneficial in strengthening health systems capacity to stop the spread of MPX.

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Democratic Republic of the Congo, Côte d'Ivoire, Sierra Leone, South Sudan, and Liberia[4]. Some of these countries only had a few cases and others have had recurrent outbreaks. Between 1970 and 1979, there was a sporadic spread of the disease, and about 54 cases were reported by the WHO[5]. Between 1981 and 1986, 404 cases were reported in Central and West Africa though the increase was attributed to intensive surveillance and case identification[6]. Outside Africa, there have been reports of cases of MPX in countries such as Singapore in May 2019, Israel in September 2018, UK in September 2018, USA in July and November 2018 which have been traced back to importation of infected wild rodents from Africa[7–10].

Poor diagnosis and surveillance systems for monkeypox in Africa

CDC recommends that the standard laboratory facility to carry out MPX tests is BSL-2 working standards if the laboratory staff has taken smallpox vaccine within the last 3 years and BSL-3 working standards if the laboratory staff has not taken smallpox vaccine[11]. While high-income countries have 'sufficient' necessary and effective biosafety laboratory and equipment needed for the diagnosis of MPX, this is not the case in African countries (and many low-and-middle-income countries) as there has been long-term reports of an insufficiency of biosafety laboratory and measures coupled with inadequacy of personal protective equipment and shortage of skilled staff. For instance, the USA, UK, Canada, and Australia has 4 BSL-4 (USA), 600 BSL-3 and 10 BSL-4 (UK), and 1 BSL-4 (Canada) of BSL laboratories, respectively, while there are just 10 BSL-3 laboratories located in Nigeria, 1 BSL-3 laboratories in DRC, 1 BSL-4 in Gabon, and 1 BSL-3 in Cameroon (Table 1). Another report shows that Europe has 25 BSL-4 laboratories, Asia has 15, North America has 14, Australia has 4, and Africa 3[17]. In addition, research shows that high-income countries have significantly higher number of BSL-3 laboratories than low-and-middle-income countries[18]. For instance, the UK, USA, and Canada have 600, 200, 12 BSL-3 laboratories, respectively, while African countries like Ghana, Kenya, Morocco, Nigeria, Uganda, and Zimbabwe have 3, 9, 6, 10, 6, 1 BSL-3 laboratories, respectively.

Table 1

BSL-3 and BSL-4 laboratories across different regions of the world [12–16]

Country/region	BSL-3 laboratory	BSL-4 laboratory
Brazil	20	1
USA	> 200	4
UK	600	10
Canada	12	1
Australia	—	4
Nigeria	10	—
Democratic Republic of Congo	1	—
Gabon	—	1
Cameroon	1	—
South Africa	—	1

BSL, Biosafety Containment Level.

Strengthening diagnosis and surveillance systems of monkeypox in Africa

Boosting surveillance mechanisms in Africa should be prioritized. Integrated surveillance in hotspots such as LGBTQ + communities as well as the clinics and centers that serve these key population in Africa is essential as more than 95% of the recent cases of MPX has been among this group[19]. Strengthening national disease notification systems especially in primary and secondary healthcare centers in Africa as well as in rural areas, hard-to-reach communities and conflicting regions are vital to the controlling spread of the virus. Providing diagnostic capacity for the MPXV infection is vital by building more laboratory centers (NS-2 and NS-3) and provision of diagnostic kits such as the nucleic acid amplification testing, real-time or conventional PCR. It is necessary to strengthen genomic sequencing capacities as well as international specimen referral capacities to identify circulating virus clades and their evolution. Furthermore, sharing the genetic sequence data through freely accessible databases is crucial.

Figure 1 shows the number of BSL-4 laboratories in Europe, Asia, North America, Australia, and Africa. There was no information found on the laboratories in the South America and Antarctica regions.

Conduct contact tracing among people who have come into contact with anyone who may be a suspected, probable, or confirmed case of MPX. This involves contact identification (protected by confidentiality), management, and follow-up for 21 days through health monitoring, which may be self-directed or assisted by public health officers. Health, psychological, material, and other necessities for a decent standard of living should be covered by policies relating to the management of contacts. Take into account the targeted use of vaccines for preexposure prophylaxis in people at risk of exposure. This may include health workers at high risk of exposure, laboratory workers who work with orthopoxviruses, clinical laboratory workers who perform MPX diagnostic testing, and communities at high risk of exposure or with high-risk behaviors, such as people who have multiple sexual partner.

Furthermore, the recommended antiviral drugs that have been approved for use as treatment of MPX, especially for those at risk for severe disease, or those with complications such as tecovirimat, brincidofovir, cidofovir, and NIOCH-14 has been limited in Africa[20]. While other antiviral/other classes of drugs are

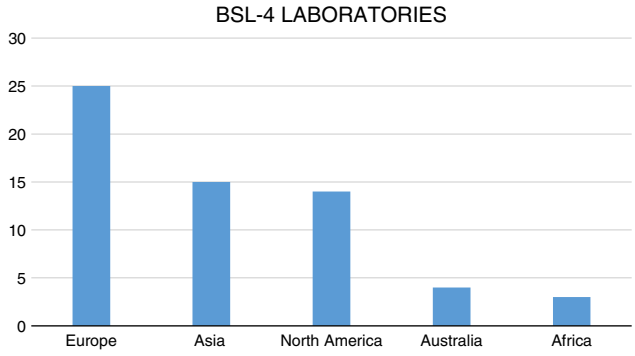

Figure 1. Number of BSL-4 laboratories across five continents. BSL, Biosafety Containment Level.

currently undergoing clinical trials in several other countries, many African countries are taking a passive approach and outlook to drug and treatment discovery. Furthermore, while there are smallpox and MPX vaccines in Europe and the USA, there are no vaccines available in Nigeria or Central African Republic[21].

An article on the global healthcare workforce states that in 2020, the global workforce stock totaled 65.1 million health workers, including 29.1 million nurses, 12.7 million medical doctors, 3.7 million pharmacists, 2.5 million dentists, 2.2 million midwives, and 14.9 million other occupations[22]. Furthermore, there is inadequate virologists in Africa region. This global workforce shortage is made even worse by imbalances not only between but also within countries as most of the few available healthcare staff in Africa work in tertiary and secondary facilities which are often located in urban areas. Capacity-building programs and retaining the existing workforce are important.

Using innovative methods to expand health worker education, such as training HRH managers, planners, and economists, among others. Transformative tactics should prioritize investment in instructors to serve a range of populations, including children, migrants, elderly, and other vulnerable groups. Trainees should be adequately equipped with information on public health issues and social determinants of health. Preparedness for epidemics is one of the health concerns. State members should increase participation of the public and private sectors which will strengthen the private education industry educational institutions' capacity and quality.

A study done in Portugal shotgun metagenomics allowed the rapid reconstruction and phylogenomic characterization of the first MPXV outbreak genome sequences, showing that this MPXV belongs to clade 3 and that the outbreak most likely has a single origin[23]. Although 2022 MPXV (lineage B.1) clustered with 2018–2019 cases linked to an endemic country, it segregates in a divergent phylogenetic branch, likely reflecting continuous accelerated evolution[23]. An in-depth mutational analysis suggests the action of host APOBEC3 in viral evolution as well as signs of potential MPXV human adaptation in ongoing microevolution[23]. This strongly suggests that genome sequencing of circulating clade in Africa and other continents may provide resolution to track the spread and transmission of this presumably slow-evolving double-stranded DNA virus. Furthermore, the world will benefit from cross-country collaboration and research to compare the genomic sequencing findings among others.

In the area of research, there is a need to understand the routes for human-to-human transmission, including research on viral dynamics and trajectories, correlate the presence of viruses in different bodily fluids and the effects on transmission, infectious times, by disease manifestation and severity. Integrating a 'One Health' surveillance and emergency response into the persistent menace of emerging zoonotic threats across Africa is crucial[24,25]. There is need for animal surveillance to understand the origin, ecology, emergence, and epidemiology of the MPXV as well as environmental 'surveillance' on the origin. Leveraging a 'One Health' approach will offer fresh insight into the human–animal–environment interface and boost the understanding on the possibility and mechanisms of spillback and reverse zoonosis as well as disease severity and risk factors for severe disease as well as its epidemiology in various subpopulations (neonates, children and teenagers, immune-compromised individuals, expectant women, and the elderly). It will also be helpful to specifically know whether co-infections (with other viruses and parasitic infections) also affect disease severity and transmission, and the best treatment for mild, moderate, and severe cases as well as complications.

Furthermore, there is need for community engagement not only to explore people's perception and knowledge about the MPXV but also understand their willingness and acceptance of future vaccine uptake. Communication and educational strategies can easily be co-created and co-developed to drown any stigma, shame, and silence that might want to be associated with the MPXV and infected people. Also, ensuring the MPXV is not labeled as a 'key population disease' is also important as there have been several documented cases of stigmatization, discrimination and even violence against this group in Africa.

Strengthening Africa's and other regional health networks are also important. A better-funded and independent Africa Centers for Disease Control as well as the regional and national infectious disease centers will help bolster health security in Africa. Perhaps an establishment of an African Epidemic Intelligence Unit (such as the World's Pandemic Surveillance and Intelligence Unit in Germany[26]) as most epidemics that has emerged or re-emerged such as Ebola, MPX, Lassa Fever, in the last 10 years have been from Africa.

As the world recovers gradually from the COVID-19 pandemic, our global health security is once again threatened by the MPXV. There is a need to improve the integrated surveillance of the MPXV, strengthen diagnostic capacity, capacity building of health workforce, public education programs, fund research and development, among others. The world needs to understand that MPX anywhere is a threat to MPX everywhere. Not leaving Africa behind in the prevention, diagnosis and management of MPX is important to stopping the spread and reemergence of this virus.

Ethical approval

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Authors' contribution

T.A.A., I.I.O., M.A.A., and R.I.O. conceptualized the study and wrote the first draft of the study. T.A. and O.A. wrote the second draft. M.J.O. edited the second draft and wrote the third draft. All authors edited and contributed to the final version of the manuscript.

Conflicts of interest disclosure

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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References

[1] Centers for Disease Control and Prevention (CDC). Monkeypox, 2022 Global Map and Case Count. 2022. Accessed August 15, 2022. https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html.

[2] Magnus PV, Andersen EK, Petersen KB, *et al*. A pox-like disease in cynomolgus monkeys. Acta Pathol Microbiol Scand 1959;46:156–76.

[3] WHO. Monkeypox. 2022. Accessed August 15, 2022. https://www.who.int/news-room/fact-sheets/detail/monkeypox.

[4] World Health Organization. Clinical management and infection prevention and control for monkeypox. Interim Rapid Response Guidance. 2022: 76.

[5] Breman JG. Monkeypox: an emerging infection for humans? Emerg Infect 2000;4:45–67.

[6] Jezek Z, Marennikova SS, Mutumbo M, *et al*. Human monkeypox: a study of 2510 contacts of 214 patients. J Infect Dis 1986;154:551–5.

[7] Vaughan A, Aarons E, Astbury J, *et al*. Two cases of monkeypox imported to the United Kingdom. Euro Surveill 2018;23:1800509.

[8] World Health Organisation. Monkeypox – Singapore. WHO Disease Outbreak News. 2019.

[9] Erez N, Achdout H, Milrot E, *et al*. Diagnosis of imported monkeypox, Israel, 2018. Emerg Infect Dis 2019;25:980–3.

[10] Simpson K, Heymann D, Brown CS, *et al*. Human monkeypox—after 40 years, an unintended consequence of smallpox eradication. Vaccine 2020;38:5077–82.

[11] Centers for Disease Control and Prevention (CDC). Laboratory Procedures and Biosafety Guidelines. 2022. Accessed August 15, 2022. https://www.cdc.gov/poxvirus/monkeypox/lab-personnel/lab-procedures.html.

[12] Vounba P, Loul S, Tamadea LF, *et al*. Microbiology laboratories involved in disease and antimicrobial resistance surveillance: strengths and challenges of the central African states. Afr J Lab Med 2022;11:1570.

[13] National Institute of Allergy and Infectious Diseases (NIAID). The Need for Biosafety Labs. 2018. Accessed August 18, 2022. https://www.niaid.nih.gov/research/biosafety-labs-needed#:~:text=There%20are%20currently%20only%20four,Southwest%20Foundation%20for%20Biomedical%20Research.

[14] National Research Council (NRC). Biosecurity Challenges of the Global Expansion of High-Containment Biological Laboratories: Summary of a Workshop. The National Academies Press; 2012.

[15] Richards SL, Pompei VC, Anderson A. BSL-3 laboratory practices in the United States: comparison of select agent and non–select agent facilities. Biosecur Bioterror 2014;12:1–7.

[16] Famousfix. BSL3 laboratories in Canada. 2022. Accessed August 19, 2022. https://m.famousfix.com/list/bsl3-laboratories-in-canada.

[17] The Conversation. Fifty-nine labs around world handle the deadliest pathogens – only a quarter score high on safety. 2021. Accessed August 19, 2022. https://www.google.com/amp/s/theconversation.com/amp/fifty-nine-labs-around-world-handle-the-deadliest-pathogens-only-a-quarter-score-high-on-safety-161777.

[18] National Academies of Sciences, Engineering, and Medicine. Developing Norms for the Provision of Biological Laboratories in Low-Resource Contexts: Proceedings of a Workshop. National Academies Press; 2019.

[19] Cohen Jon, Monkeypox outbreak questions intensify as cases soar. 2022. Accessed August 20, 2022. https://www.science.org/ content/article/monkeypox-outbreak-questions-intensify-cases-soar.

[20] National Institute of Allergy and Infectious Diseases (NIAID). Monkeypox treatment. 2022. Accessed August 20, 2022. https://www.niaid.nih.gov/diseases-conditions/monkeypox-treatment.

[21] Kozlov M. Monkeypox in Africa: the science the world ignored. Nature 2022;607:17–8.

[22] Boniol M, Kunjumen T, Nair TS, *et al*. The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage? BMJ Glob Health 2022;7:e009316.

[23] Isidro J, Borges V, Pinto M, *et al*. Phylogenomic characterization and signs of microevolution in the 2022 multi-country outbreak of monkeypox virus. Nat Med 2022;28:1569–72.

[24] Oladoye MJ. Monkeypox: a neglected viral zoonotic disease. Electron J Med Educ Technol 2021;14:em2108.

[25] Errecaborde KM, Macy KW, Pekol A, *et al*. Factors that enable effective one health collaborations-a scoping review of the literature. PLoS ONE 2019;14:e0224660.

[26] World Health Organization. WHO, Germany open Hub for Pandemic and Epidemic Intelligence in Berlin. 2021. Accessed August 25, 2022. https://www.who.int/news/item/01-09-2021-who-germany-open-hub-for-pandemic-and-epidemic-intelligence-in-berlin.