Perspective

The re-emergence of wild poliovirus type 1 in Africa and the role of environmental surveillance in interrupting poliovirus transmission

Phanuel Tawanda Gwijnji, Godfrey Musuka, Grant Murewanhema, Perseverance Moyo, Enos Moyo, Tafadzwa Dzinamaria

A B S T R A C T

Although there has been a global reduction in wild poliovirus (WPV) type 1 cases, Africa has experienced a re-emergence of the disease. This article discusses the re-emergence of WPV in Africa, the transmission and pathogenesis of WPV, and the role of environmental surveillance and other strategies used to interrupt all WPV transmission in the region permanently.

1. Introduction

Globally, there has been a reduction in the number of wild poliovirus (WPV) cases, with only six reported in 2021. However, the data could be misleading, because these cases were in war-ravaged Pakistan and Afghanistan, where reporting might be poor. Moreover, about 1 in 1000 WPV infections result in acute flaccid paralysis (AFP), meaning that most asymptomatic cases are not detected. Africa was declared free of indigenous WPV in August 2020, after Nigeria, which was formerly considered endemic for WPV type 1, achieved WPV-free status following 3 years of no reported cases. Africa is now experiencing WPV outbreaks, with confirmed WPV cases reported in the Democratic Republic of Congo, South Sudan, Ethiopia, and Somalia. WPV transmission in Africa is likely to be enabled by the continent’s weak and fragile health systems, emanating from poor health governance, inadequate health infrastructure, a shortage of healthcare workers, insufficient essential medicines, and inadequate health funding. In addition, the importation of polio infections through international travel could be substantial. Conflict and migration could also contribute to the spread of the disease, as displaced people have the potential to carry the virus from one place to another. In addition, refugees are likely to be malnourished and under extreme stress, leading to low immunity against infectious diseases. Furthermore, refugees are usually accommodated in crowded camps with a poor water supply and inadequate sanitation, making it easy for the disease to spread.

2. Re-emergence of wild poliovirus type 1 in Africa

Although Africa was certified polio-free in 2020 by the African Regional Certification Commission after 3 years without a case, two cases of WPV type 1 have been reported in Africa this year. One of these cases occurred in Malawi in February 2022, the first WPV case in 30 years, and the other in Mozambique, where an outbreak was declared following a case in Tete Province in May 2022. Both cases were linked to the WPV type 1 strain from Pakistan. WPV type 1 is highly infectious and predominantly affects children younger than 5 years of age. Although the number of cases is low, one case is too many and constitutes an outbreak because the disease is incurable and can result in lifelong disability. A rare circulating vaccine-derived poliovirus (cVDPV) is also affecting African countries with low immunization coverage, especially remote communities and those experiencing migration and conflict. WPV transmission in Africa is likely to be enabled by the continent’s weak and fragile health systems, emanating from poor health governance, inadequate health infrastructure, a shortage of healthcare workers, insufficient essential medicines, and inadequate health funding. In addition, the importation of polio infections through international travel could be substantial. Conflict and migration could also contribute to the spread of the disease, as displaced people have the potential to carry the virus from one place to another. In addition, refugees are likely to be malnourished and under extreme stress, leading to low immunity against infectious diseases. Furthermore, refugees are usually accommodated in crowded camps with a poor water supply and inadequate sanitation, making it easy for the disease to spread.

Conflict-affected areas in some African countries, such as Nigeria, the Democratic Republic of the Congo, South Sudan, Ethiopia, and Somalia, have not always achieved the desired immunization coverage. This is attributed to tense security conditions, damaged healthcare infrastructure, and depleted human resources, making it challenging to conduct immunization campaigns and provide outreach services. In places with poor sanitation and many unvaccinated children, the attenuated virus in the oral polio vaccine can genetically mutate. The mutating virus may recombine with other vaccine serotypes.
3. Transmission and pathogenesis of poliovirus

Poliovirus can spread through poor hand hygiene and contaminated food and water. The primary system for detecting poliovirus is case-based syndromic surveillance for AFP, with stool specimen confirmation (Rachlin et al., 2022). AFP surveillance comprises field surveillance and laboratory testing. In field surveillance, all cases of AFP should be notified to the health authorities, and two stool specimens should be collected from each case within 14 days of the onset of the paralysis. The stool samples should be collected 24–48 hours apart and transported on ice to reach the laboratory within 72 hours of collection. Cell culture is used in the laboratory to isolate the virus (Nsama et al., 2021).

The virus is transmitted mainly through fecal matter or less frequently through contaminated water or food. It then multiplies in the intestines (Rachlin et al., 2022). The poliovirus has an incubation period of between 2 and 35 days. The virus has a particular affinity for the cellular receptor CD135, which helps in its attachment and entry into cells, central nervous system. The cytopathic nature of the virus results in extensive damage to the anterior horn cells of the spinal cord, causing limb paralysis. The poliovirus may also spread to the posterior horn cells, the motor neurons of the thalamus, and the hypothalamus. Infected cells are phagocytosed by macrophages causing the degeneration of axons. This leads to widespread muscular atrophy, which causes flaccid paralysis. In extreme cases, respiratory paralysis may occur, leading to death. The poliovirus can cause paralysis within a few hours, especially in children under 5 years of age (Topley & Wilson, 2005). Vaccination remains the only means of preventing polio, and this can be achieved through the oral poliovirus vaccine (OPV) and inactivated poliovirus vaccine (IPV) (Global Polio Eradication Initiative, 2015).

Quality AFP surveillance, laboratory, immunization, and geospatial data are crucial for monitoring the spread of WPV in communities. However, in Africa, the availability of quality data is hampered by poor collection and documentation and the inability to integrate these data sources for decision-making (Nsama et al., 2021). AFP surveillance can be affected by pandemics such as COVID-19 and conflicts, resulting in the samples not being collected, or failing to reach the laboratory in time (Manyanga et al., 2021). The accuracy of stool specimen analysis depends on whether an accurate paralysis date was elicited, which may be challenging in cases where people delay seeking health services. Furthermore, some acute AFP cases may go undetected, especially in hard-to-access populations (Wilkinson et al., 2022). With such challenges, Africa may benefit from ES in its efforts to interrupt WPV transmission.

4. Role of environmental surveillance in interrupting poliovirus transmission

Poliovirus is shed in the stool for about 6 weeks during asymptomatic infection and may be detected in sewage or wastewater. Depending on the immediate conditions of the sewage or wastewater, excreted poliovirus particles remain infectious in the environment for different periods. Stool samples from AFP patients have been used to monitor the wild and mutated polioviruses (Asghar et al., 2014). ES is an additional method used to monitor the transmission of poliovirus and is more sensitive than AFP surveillance. ES permits a focused investigation of polio cases and forms a basis for further studies of the risk of poliovirus transmission in the community. However, the sensitivity of ES to detect polioviruses circulating in a specific population will depend on the nature of the sewage network, the appropriateness of the sampling site, and the quality of sample handling and laboratory processing. High sensitivity is crucial for the timely detection of outbreaks. ES involves testing sewage or wastewater samples that may contain polioviruses in human feces. ES relies on sewage collection using different methods such as bag-mediated filtration, composite sampling, virus concentration, and virus detection, usually through cell culture growth (Hamisu et al., 2022). ES can assist in identifying residual WPV transmission in endemic areas, primarily where WPV circulates among infected but asymptomatic individuals (O’Reilly et al., 2018).

ES is also valuable in providing an early indication of new poliovirus importations into polio-free areas, as well as vaccine-derived poliovirus transmission, and for confirming the presence of vaccine-related viruses following vaccination campaigns involving OPV administration. ES helps link poliovirus isolates from unknown individuals to populations served by a standard wastewater collection system (Ndaiye et al., 2014). Despite the importance of ES in controlling and monitoring polioviruses, it only began in 2011 in Africa. Nigeria started ES in July 2011, followed by Kenya in May 2013. Other African countries that began ES in Africa in 2014 include Angola, Madagascar, Cameroon, Chad, Senegal, Niger, Burkina Faso, and Guinea. There are ongoing efforts to strengthen ES in Africa by initiating new sites, expanding old ones, and reviewing existing sites (Gumede et al., 2018). As of April 2022, all of the countries in the World Health Organization Africa Region except two have implemented ES. The number of samples from African countries with cVPDV detected by ES between January 2020 and April 2022 was about 14 500 (Rachlin et al., 2022).

With outbreaks of WPV type 1 in Southern African countries such as Malawi and Mozambique, there is a need to strengthen polio surveillance systems in individual countries and the region. To detect potential future outbreaks in Africa, AFP surveillance and ES should be expanded. Following the case of WPV reported in Malawi in February 2022, the country managed to set up an ES system for poliovirus in 11 cities, including Lilongwe where the case was detected, by mid-April 2022 (Santos, 2022). While AFP surveillance is used to detect the physical symptoms of polio, including paralysis, ES is used to detect polioviruses in samples of wastewater and sewage. Suitable wastewater locations that will serve as ES sites should be identified, and responders at both the local and national level should be trained on collecting and packaging samples for transportation and analysis (Hamisu et al., 2022). The current Global Polio Eradication Initiative (GPEI) guidelines recommend establishing ES sites where there is a convergent sewage network and a catchment population of between 100 and 300 000 people. However, these guidelines may be challenging in African countries where some areas have informal drainage and poorly documented sewerage arrangements. Furthermore, the data on the size of the population in some catchment areas are either not readily available or unreliable (Global Polio Eradication Initiative, 2015). Since maintaining ES may be expensive, neighboring countries may need joint facilities. To increase ES sensitivity, the frequency of sampling will need to be increased. For ES to be more beneficial in polio eradication strategies, there should be an improvement in the timeliness and efficiency of detecting polioviruses in sewage samples. Laboratory and field-training curricula should be developed to ease and speed ES implementation in new areas. The effectiveness of ES should also be monitored and evaluated frequently (Wilkinson et al., 2022).
The COVID-19 pandemic has reduced the sensitivity of AFP surveillance and ES. Therefore, strengthening AFP surveillance and ES is important in tracking progress in eradicating polio and documenting the absence of transmission. In addition, using both AFP and ES would improve the sensitivity of detecting WPV (Bigouette et al., 2021). Furthermore, using ES to monitor WPV circulation would also be beneficial, since it identifies isolates before they undergo a lot of genetic change and gain neurovirulence (Wilkinson et al., 2022).

5. Conclusions

Although there has been a reduction in the number of WPV cases globally, Africa has experienced a re-emergence of the disease. Malawi and Mozambique reported cases of WPV in early 2022. Conflict, migration, and low immunization coverage have been associated with cVPDV in the continent. Poliovirus invades the nervous system and may result in paralysis, other disabilities, or even death. Vaccination remains the only way of preventing polio. As poliovirus is shed in the stools during asymptomatic infection, ES can be used to investigate the risk of poliovirus transmission in communities. Although ES is more sensitive than AFP surveillance, its sensitivity depends on several factors.

Declarations

Funding

This study was not funded.

Ethical approval

Not applicable.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Phanuel Tawanda Gwinji: Writing – original draft. Godfrey Musuka: Writing – original draft. Grant Murewanhema: Writing – review & editing. Perseverance Moyor: Writing – review & editing. Enos Moyor: Writing – review & editing. Tafadza Dzinamarira: Writing – review & editing. Supervision.

References

Aki L, Ahmad HA. The recent outbreaks and re-emergence of poliovirus in war and conflict-affected areas. Int J Infect Dis 2016;49:40-6.
Asghar H, Diop OM, Weldegebriel G, Malik F, Shetty S, El Bassioni L, et al. Environmental Surveillance for Polioviruses in the Global Polio Eradication Initiative. J Infect Dis 2014;210:S294–303.

Bigouette JP, Wilkinson AL, Tallis G, Burns CC, Wassilak SG, Vertefeuille JF. Progress Toward Polio Eradication — Worldwide, January 2019–June 2021. Morb Mortal Wkly Rep 2021;70(34):1129–35.

Centers for Diseases Control and Prevention. Poliovirus Disease & Polioviruses. 2020. Available from: https://www.cdc.gov/polio/poliocontaminant/diseasedevelopment.htm, Ekwebelem OC, Nnorom-Dike OV, Aborode AT, Ekwebelem NC, Aleke JC, Ofiebi ES. Eradication of wild poliovirus in Nigeria: Lessons learnt. Public Health in Practice 2021/2.

Global Polio Eradication Initiative. Guidelines on Environmental Surveillance for Detection of Polioviruses: Working draft-March 2015. 2015. Available from: https://polioeradication.org/wp-content/uploads/2016/07/GPEN_GuidelinesESApril2015.pdf.

Grundy J, Biggs B. The Impact of Conflict on Immunization Coverage in 16 Countries. Int J Health Policy Manag 2019;8(4):211–21.

Gumede N, Okeibunor J, Diop O, Baha M, Barnor J, Mbaye S, et al. Progress on the Implementation of Environmental Surveillance in the African Region, 2011-2016. J Immunol Sci 2018;2018:24–30.

Hamisu AW, Blake IM, Sume G, Blake F, Jimoh A, Dahiru H, et al. Characterising Environmental Surveillance Sites in Nigeria and Their Sensitivity to Detect Poliovirus and Other Enteroviruses. J Infect Dis 2022;225:1377–86.

Ming LC, Hussain Z, Yeoh SF, Lee KS. Circulating vaccine-derived poliovirus: a menace to the end game of polio eradication. Glob Health 2020;16. doi:10.1186/s12992-020-00594-z.

Ndiaye AK, Diop PM, Diop OM. Environmental surveillance of poliovirus and non-polio enterovirus in urban sewage in Dakar, Senegal (2007-2013). Pan Afr Med J 2014;19 Available from: doi:10.11604/pamj.2014.19.243.3538.

Ntsama B, Iwaka A, Katande R, Obiang RM, Oyono DR, Mkanda P, et al. Polio Data Quality Improvement in the African Region. J Immunol Sci 2021;2021/Spec Issue 21:1105.

O’Reilly KM, Verity R, Durrey E, Asghar H, Sharif S, Zaidi SZ, et al. Population sensitivity of acute flaccid paralysis and environmental surveillance for serotype 1 poliovirus in Pakistan: an observational study. BMC Infect Dis 2018;18(176). doi:10.1186/s12879-018-3070-4.

Okoroafor JA, Asamani L, Kabego A, Ahmat J, Nyonji JJ, Salvador, et al. Preparing the health workforce for future public health emergencies in Africa. BMJ Glob Health 2022:7.

Rachlin A, Patel JC, Burns CC, Jorba J, Tallis G, O’Leary A, et al. Progress toward Polio Eradication- Worldwide, January 2020- April 2022. US Department of Health and Human Services/Centers for Disease Control and Prevention. Mortb and Mortal Wkly Rep 2022;71:650-5.

Santos R. Mass Polio Vaccination Drive to Administer More Than 80 Million Doses to Southern African Children in Five Countries. Health Policy Watch; 2022 Available from: https://healthpolicywatch.news/polio-vaccination-80-million-doses-africa/.

Topley WW, Wilson GS. Topley & Wilson’s Microbiology and Microbial Infections. 10th ed. New Jersey: Wiley-Blackwell; 2005.

UNICEF Zimbabwe. UNICEF and WHO call for emergency action to avert major measles and polio epidemics; 2020 Available from: https://www.unicef.org/zimbabwe/press-releases/unicef-and-who-call-emergency-action-avert-major-measles-and-polio-epidemics.

WHO Africa. Africa health ministers seek ways to bolster polio outbreak response; 2022a Available from: https://www.afro.who.int/news/african-health-ministers-seek-ways-bolster-polio-outbreak-response.

World Health Organization Africa. Ramping polio outbreak response in South- ern Africa; 2022b Available from: https://www.afro.who.int/news/ramping-polio-outbreak-response-southern-africa/.

World Health Organization. Polio-We have won a battle, but the war is still on by Professor Tomori. 2021. Available from: https://www.afro.who.int/news/polio-we-have-won-battle-war-still-professor-tomori.

Wilder-Smith A, Leong W, Lopez LF, Amaku M, Quam M, Khan K, et al. Potential for international spread of wild poliovirus via travelers. BMC Med 2015;13(133). doi:10.1186/s12916-015-0363-y.

Wilkinson AL, Diop OM, Jorda J, Gardner T, Snider CJ, Ahmed J. Surveillance to Track Progress Toward Polio Eradication — Worldwide, 2020–2021. Morb Mortal Wkly Rep 2022;71(15):538–44.