Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Correspondence

Deadly endemic zoonotic disease Ebola re-emerges in the democratic Republic of Congo amid the ongoing COVID-19: are we prepared from lessons learnt? – Correspondence

Dear Editor

West African nations are experiencing outbreaks of infectious ailments like Lassa fever, monkeypox, yellow fever, Ebola, and Marburg virus disease over the past couple of decades [1,2]. As such countries are often the zoonotic disease and epidemic outbreak epicentres, the global health system needs to prioritise the Grand Magal [3]. Touba, a city near Senegal's capital Dakar gears up to hold one of the world's largest mass gatherings of religious pilgrims, the 'Grand Magal of Touba' during 14 and September 15, 2022 [4], wherein nearly four million pilgrims from across West Africa, Europe, Middle East and the US are expected. They shall live and perform rituals together and visits to the mausoleum of the founder of Mouride brotherhood Sheikh Amadou Bamba [3]. The Grand Magal of Touba has a low global profile despite its large size, compared to similar events like the Kumbh Mela (India) and the Hajj (Saudi Arabia), and remains neglected in global dialogue about mass religious gatherings [5–7]. People attending such mass gatherings and coming in close, prolonged and frequent contacts, and unsafe sexual practices would encourage pandemic spread in religious pilgrimages that should be factored into surveillance, especially in countries where MSM (men who have sex with men) sex is illegal [3].

The Democratic Republic of the Congo (DRC) reported a laboratory-confirmed Ebola Virus Disease (EVD) case recently on August 21, 2022 [8]. Along with unexplained haemorrhaging and bleeding, EVD symptoms include fever, severe headache, sore throat, muscle and joint pain, weakness, fatigue, loss of appetite, abdominal pain, diarrhoea and vomiting. Red eyes, skin rash and hiccups are other late-stage symptoms. Most symptoms are similar to influenza (flu), malaria or typhoid thereby complicating and confusing its initial diagnosis. Ebola survivors experience tiredness, muscle aches, vision problem and stomach pain as side-effects. EVD transmission majorly occurs among healthcare workers and their family members, as per earlier data. Close contact with infected blood, reuse of contaminated needles and syringes, and improper nursing techniques were great source of human-to-human transmission during early Ebola outbreaks [9].

A 46-year old woman with unconfirmed Ebola vaccination status and comorbidities died of Ebola on August 15, 2022 after 23-day hospitalisation [8]. Reverse transcription polymerase chain reaction (RT-PCR) of the post-mortem test of oropharyngeal samples was EVD positive [8]. Her symptoms like cough, headache, joint pain and general fatigue were assumedly related to comorbidities. Investigations into her hospital and community contacts to mitigate the risk of spread among health workers and copatients confirmed a total of 134 hospital contacts (60 healthcare personnel and 74 copatients) and nine family contacts [8]. Sequencing confirmed that the case was of Ebola Zaire strain, genetically linked to the 2018–2020 DRC outbreak and not a one-off event [8]. Earlier, on July 4, 2022, EVD outbreak in the DRC was declared over [10]. However, as it experienced, it has reemerged.

EVD is endemic to DRC as animals in the region harbour the virus. The virus, making occasional outbreaks mostly in the African continent, is primarily found in sub-Saharan Africa. As documented, the virus may persist in body fluids of EVD survivors that further lead to secondary transmission from exposure to their body fluids including semen. Disease relapse in EVD survivors has also been reported. The recent frequent outbreak of EVD is a major public health concern in the DRC while the country still struggles hard with a yawning gap in outbreak preparedness. The Beni region particularly, where the current EVD case was identified, is additionally affected by frequent protests that block progress in installing proper outbreak control measures [8]. Recurring outbreaks of cholera, measles, polio, yellow fever, COVID-19 and monkeypox coupled with frequent protests have put tremendous pressure on the country's healthcare system. The national level risk of EVD is assessed to be high while at the global level is assessed to be low. Close monitoring of the situation and risk assessment with real-time updated information are recommended.

EVD is a rare viral hemorrhagic fever which is often fatal in humans if untreated. Supportive care like oral or intravenous rehydration and symptom-specific treatment can improve survival. Ebola transmits to humans through close contact with infected animals like fruit bats (thought as natural hosts), their blood, secretions or other body fluids. Its human-to-human transmission is through direct contact with blood or body fluids of a sick or dead Ebola infected person, or their contaminated objects. Its incubation period ranges from 2 to 21 days and case fatality ratio (CFR) varies from 25 to 90% with around 50% as average [8].

EVD is as deadly in nonhuman primates like monkey, gorilla and chimpanzee [11]. Ebolavirus causing EVD has numerous strains like Zaire ebolavirus, Sudan ebolavirus, Bundibugyo ebolavirus, Taï Forest ebolavirus, Reston ebolavirus and Bombali ebolavirus [11]. Of these, Zaire, Sudan, Taï Forest and Bundibugyo strains are pathogenic in humans. The Bombali strain has recently been reported in bats in Sierra Leone [12]. Although whether Bombali virus in bats can cause disease in either animals or humans is yet unknown, Reston virus is disease-causing in nonhuman primates and pigs. The former was discovered in imported Philippine monkeys in 1989, wherein through aerosolised transmission it spreads through the monkey population. Such airborne transmission however is insignificant in human outbreaks [11]. The discovery of Reston ebolavirus in imported Philippine monkeys revealed that Ebola was no longer confined to Africa, but was present in Asia too. There have also been four EVD diagnosed cases in the USA till today.

Ebola virus was identified in 1976 with two consecutive fatal hemorrhagic fever outbreaks. The first outbreak was in a DRC (formerly,

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Zaire) village close to the Ebola River while the second occurred in South Sudan. The virus was named after the Ebola River [11]. As documented, two genetically distinct strains, Zaire ebolavirus and Sudan ebolavirus caused the outbreaks. Although the origin of Ebola virus is uncertain, it has been infecting people from time to time and the majority of EVD outbreaks have occurred in African countries since its discovery in 1976. Data suggested that the virus existed long before the two recorded outbreaks. It is believed that EVD is animal-borne and bats or nonhuman primates are the most likely source. Direct wildlife contact, including consumption of bushmeat, could be responsible for the spread of the virus. African fruit bats may be the reservoir host and are likely to be involved in the spread of the virus. Researchers continue to look for conclusive evidence of the bat's role in transmitting Ebola [13].

The virus spreads through any direct contact (through broken skin or mucous membranes in nose, eyes or mouth), body fluids (saliva, urine, faeces, sweat, breast milk, vomit, amniotic fluid or semen) or blood of a sick or dead EVD-infected individual. The person's contaminated objects like clothings, bedding, needles and other medical equipments are also significant sources of transmission. However, there is little evidence that Ebola spreads through contact with vaginal fluids of an infected EVD woman. The virus may **p**ersist in the interior of eyes, cerebrospinal fluid, placenta and testes after recovery. The duration of the virus staying in these body fluids of Ebola survivors is to be ascertained. At room temperature, Ebola virus can survive on dry surfaces for several hours. Surface disinfection using hospital-grade disinfectants is therefore recommended. A person having had a possible exposure and showing EVD symptoms should be isolated. Blood samples from the patient should be collected after onset of symptoms and RT-PCR tested for confirmation. In instances of early infection where the virus population in a patient's blood can be low, RT-PCR may not be effective. Antibody detection technique can then be employed as an alternative to confirm [11].

Single dose Ebola vaccine rVSV-ZEBOV (Ervebo®) is approved by the US Food and Drug Administration (USFDA) as a preventive to protect against *Zaire ebolavirus* [11]. Moreover, the USFDA also recommends pre-exposure rVSV-ZEBOV prophylactic in the US for adults more than 18 years of age who are potentially at occupational risk of exposure to Zaire ebolavirus. A two-dose vaccine regimen (with a booster dose after 56 days) of two other vaccines (Ad26.ZEBOV and MVA-BN-Filo) is designed to protect the DRC population against *Zaire ebolavirus* [11], which are yet to be USFDA approved. Currently, there are two approved treatments (Inmazeb™ and Ebanga™) for EVD caused by Zaire ebolavirus. Inmazeb™ is a combination of three monoclonal antibodies whereas Ebanga™ is a single monoclonal antibody. However, their efficacy against strains other than Zaire ebolavirus is yet to be evaluated [11].

The size as well as the duration of contained outbreaks are highly variable due to their inherent stochastic nature. Ring vaccination (vaccinating close contacts of confirmed cases) strategy was used to eradicate EVD earlier, and prompt diagnosis of infectious cases could ensure successful ring vaccination [14]. However, precautions ought to be ensured. Rigorous testing and contact tracing, which this approach relies on, is challenging as the disease can potentially spread through sex (MSM), and it can be difficult to infiltrate the societies where stigma exists [14].

Identifying the source of contamination, contacts, contacts of contacts, defining the risks of exposure and strengthening infection prevention and control measures are critical. The outbreak control interventions need to be organised with case investigation, contact tracing, strengthening of surveillance system, isolation of suspected cases and providing care, laboratory confirmation and healthcare facilities. Training of healthcare workers on IPC measures implementation needs to be improved. Ring vaccination using the licensed vaccine may be carried out among risk groups. WHO recommends risk mitigation measures to reduce transmission in humans as an effective way. In this context, to reduce wildlife-to-human transmission risk, it also recommends avoid contacting infected fruit-bats or monkeys/great apes, and consumption of raw meat. Animals should be handled with gloves wearing and their meat should be cooked thoroughly before consumption. The recommended effective way to reduce the risk of human-to-human transmission is to use, proper personal protective equipment while caring sick or symptomatic persons. Regular hand washing after visiting hospitalised patients is suggested. Providing access to Ebola specific monoclonal antibodies (mAbs) to treat confirmed EVD cases is also suggested. To reduce possible sexual transmission, male EVD survivors should practice safe-sex for at least 12 months after recovery, or until their semen tests become negative twice for Ebola virus [8]. The WHO also suggests Ervebo vaccination of healthcare workers, contacts and contacts-of-contacts, and revaccination of those who have been vaccinated before six months.

Proper coordinated and planned surveillance, testing and epidemiological research are highly recommended before, during, and after all the religious mass events. Diagnostics, vaccines and other resources required for proper surveillance and prevention in countries that can ill-afford should be made available by the international community. Research priorities of zoonosis should be set, and drug and vaccine development should be strengthened. The need to understand the root cause, including the natural reservoir, primary and intermediate hosts, host range, and virus spillover events with spillover time and frequency, is a step forward toward future preparedness to stop reemergence of zoonotic diseases [15]. To understand the lethal genes better from genomic evolution, whole-genome sequencing, phylogenetics, changing epidemiology patterns and genomic diagnostics of the virus are necessary. Chakraborty et al. (2022) proposed a global-scale multidisciplinary teamwork to act against zoonotic viral diseases [15]. They also sought the attention of policymakers in the fight against zoonotic diseases. In light of this, the 'One Health' approach, which believes in one-world-one-family, seems befitting.

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