Global Scientific JOURNALS

GSJ: Volume 12, Issue 12, December 2024, Online: ISSN 2320-9186
www.globalscientificjournal.com

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Research and clinical aspect of the Virus

Abstract

Even though several scientists and public health officials have investigated the origins of the Ebola Virus, there is still no consensus as to the actual reason for the virus appearing in Africa. The Ebola Virus Disease, known within the scientific community as Orthoebolavirus, causes severe hemorrhagic fever in both humans and non-humans, which, without proper treatment, leads to death. The main purpose of researching the medical part of the disease is to acquire deep knowledge of the Ebola Virus and seek reasons for the slow treatment, and why, despite the fact that this is a slow spreading disease, there have been so many outbreaks in the last 50 years. Although medication is crucial for treating illnesses, if taken improperly, it can also be quite dangerous. This article explains the scientific controversies that surround the disease and the management of it. It includes vaccine trials, the quarantine measures and the overall research into Ebola.

1.1. Healthcare

It is known that most Ebola-affected countries have poor health infrastructures, low numbers of medical workers and underdeveloped healthcare systems. Every aspect of healthcare in the countries depends on the rapid expansion of science and technology and medical education. The relationship between scientific

representatives and citizens of a country is extremely important, as events during the COVID-19 pandemic have demonstrated.

1.1.1 DRC

According to USAID, 70% of Congolese people have limited or no access to healthcare.[1] In order to improve the health of Congolese citizens, the country's healthcare system must be strengthened, all the more so since Ebola outbreaks are not the only recurrent epidemics in the DRC. The nation's health system is experiencing extreme strain as a result of concurrent COVID-19, measles, polio, and mpox outbreaks. According to the WHO, cholera, malaria, and yellow fever are on the rise as a result of frequent natural catastrophes and the inaccessibility of clean water and sanitary facilities. Therefore, science and technology is not well developed in the country. However, recently, Gilbert Kabanda Kurhenga, Minister of Scientific Research and Technological Innovation, signed a DRC's Country Programme Framework (CPF) for 2023-2028. A CPF specifies priority areas where the transfer of nuclear technology and resources for technical cooperation will be directed to meet national development goals. It serves as the framework for the medium-term planning of technical cooperation.[2] One of the top priorities of the CPF is healthcare.

Medical education and training in the DRC is weak. For instance, in 2021, the government revoked the licenses of about 70 colleges to provide medical education because they lacked the necessary staff and equipment to effectively train students.[3]

[1] USAID, "Democratic Republic of Congo: Health Fact Sheet", https://2012-2017.usaid.gov/democratic-republic-congo/fact-sheets/usaiddrc-fact-sheet-health#:~:text=In%20the%20past%20three%20decades,no%20access%20to%20health%20care
[2] International Atomic Energy Agency, "Democratic Republic of Congo Signs its Fourth Country Programme Framework (CPF) for 2023–2028", 27 September 2023, *https://www.iaea.org/newscenter/news/democratic-republic-of-congo-signs-its-fourth-country-programme-framework-cpf-for-2023-2028*
[3] Sadiki, A., "Democratic Republic of Congo: Dozens of universities have to stop their medical training", 30 September 2021, https://www.universityworldnews.com/post.php?story=20210929154645979

Challenges such as economic decline, wars, and political instability led to an educational crisis in DRC. The crisis worsened after the Ebola and COVID-19 outbreaks. In general, the education system is weak due to different causes, therefore there is no relationship between science and society as there are a few professional medical workers.[4]

On the other hand, research into the Ebola virus in the DRC is going well. Congolese Professor Hypolite Muhindo-Mavoko and his colleagues at the University of Kinshasa carried out important research in Boende, in equatorial Congo.[5] "Having constructed a clinical trial site for an Ebola vaccine trial called EBL2007 (conducted by the EBOVAC3 Consortium) in 2019, the facilities are now used for several ongoing projects."[6] In addition to producing much-needed clinical trial data, funding (from the EU) for these initiatives helps regional health services and infrastructure and increases the capacity for clinical research by giving local employees jobs and training opportunities. Though many members of the local community still harbor negative memories of the 2014 Ebola crisis, the EBOVAC3 experiment was positively received.[7] Colleagues conducting an assessment of the community's opinion on trials visited locations, including the village where the 2014 outbreak's initial cases took place. Some began to cry and express their wish to never hear about Ebola again when they were questioned about it.[8]

[4] UNICEF, "Education - DRC", https://www.unicef.org/drcongo/en/what-we-do/education
[5] CEPI, "Clinical trials in remote rainforests: how vital Ebola research in DRC enhances local expertise and infrastructure", 30 August 2023, https://www.gavi.org/vaccineswork/clinical-trials-remote-rainforests-how-vital-ebola-research-drc-enhances-local
[6] Ibid.
[7] Ibid.
[8] Ibid.

Additionally, there are developments of new technologies in the DRC that help with detection of the Ebola Virus. GeneXpert is one of the technologies in question.[9] Originally designed to identify tuberculosis cases, it has been modified to facilitate quick testing for a variety of infections, including HIV, malaria, STIs, and Ebola. Technicians at the INRB laboratory in Kinshasa may utilize GeneXpert to test for the Zaire strain of Ebola with help from the USA, WHO, Canada, the Global Outbreak Alert and Response Network (GOARN), and the Emerging and Dangerous Pathogens Laboratory Network (EDPLN). Subsequent testing is conducted on negative samples to look for other viral hemorrhagic fevers, Ebola strains, or other illnesses.[10]

1.1.2 Sudan

Sudan has not had an Ebola outbreak for a long time, hence there are limited sources on the state of research into Ebola in the country.

Only 2% of South Sudan's medical needs are met as Shashwat Saraf, the East Africa regional emergency director for the International Rescue Committeehas declared, which transfers essential duties relating to medicine, training, and services to donors.[11] As mentioned earlier, sanitation, safe water and basic health care are inaccessible to the majority of South Sudanese. At present, the US CDC and the WHO are actively helping to improve local healthcare conditions by funding and providing healthcare services. There are two licensed vaccines against the Ebola

[9] WHO-DRC, “New technology allows for rapid diagnosis of Ebola in Democratic Republic of the Congo”, 12 June 2017, https://www.afro.who.int/news/new-technology-allows-rapid-diagnosis-ebola-democratic-republic-congo
[10] Ibid.
[11] Tanis, F., “Attacks on Sudan's hospitals, clinics put millions at risk”, 11 July 2024, https://www.npr.org/sections/goats-and-soda/2024/07/11/nx-s1-5006126/sudan-civil-war-hospitals-clinics-attacks

virus in Zaire, but none against the Sudan ebolavirus[12] which raised another issue during Ebola outbreaks in Sudan and Uganda.

Medical education in Sudan is stagnant because of ongoing political conflicts. A few researchers and scientists produced a study of the consequences of war on medical schools in Sudan. A nation's infrastructure, medical facilities, and educational institutions are all severely damaged during a war. The study covered all medical schools in conflict zones. Attacks occurred at more than half (58.6%) of these medical schools. Attacks on private schools, which made up the bulk of the study sample, were the most common (70.6%). 52.9% of these were found in the city of Khartoum. In 64.7% of the impacted institutions, reports of multiple assault types were received. Of the assaulted facilities, 73.5% were looted, and 67.6% were turned into military installations. Using online instruction and cooperation with other organizations, 60.3% of the schools in the conflict zone were able to resume instruction in spite of these obstacles.[13]

To conclude, Sudan faces many political challenges and many infectious diseases other than Ebola. For this reason, medical experts do not prioritize it in the country, however, the Sudan Ebolavirus affects nearby countries, e.g. Uganda.

1.1.3 Uganda

With just one doctor for every 25,000 people, Uganda has one of the lowest doctor-to-patient ratios in the world.[14] Normally, the WHO recommends one doctor for every

[12] WHO, “Sudan Ebolavirus Candidate Vaccines”, 12 January 2023, https://www.who.int/news-room/events/detail/2023/01/12/default-calendar/save-the-date---sudan-ebolavirus-candidate-vaccines---what-additional-research-should-be-conducted-to-advance-the-evaluation-of-these-vaccines
[13] Mahgoub E.A.A., et al. “War and education: the attacks on medical schools amidst ongoing armed conflict” *Conflict and Health* 18, 23 (2024)
[14] Ajari, E. E. and D. Ojilong, “Assessment of the preparedness of the Ugandan health care system to tackle more COVID-19 cases”, *Journal of Global Health*, 10, 2 (2020)

1,000 people, which makes Uganda's ratio critically low. Additionally, because so few people can afford the expense of drugs in Uganda, the country lacks affordable healthcare. While private health insurance offered by insurance companies exists, there is no government health insurance program.[15] The estimated percentage of the GDP that is covered by health insurance is low.[16]

Medical workers' demands for better working conditions are not always met, which results in migration or the stagnation of medicine in the country.. The country does not have enough trained doctors, and students are often requested to fulfill the roles of medical professionals before completing their education.[17] Government promised an increase in salaries, because medical workers do a tremendous amount of work, but do not always pay in time, which made medical interns go on a strike. Frequent strikes worsen the situation of healthcare in Uganda, as they result in fewer workers assisting in critical times.[18]

A student from Brown University, Kyoko Saito, visited Uganda's capital city of Kampala to research the local healthcare system. She observed lack of medical workers, weak medical education, and unaffordable medical aid. However, she also pointed out that Uganda is trying to eradicate communicable diseases by giving necessary medical implements, e.g. free condoms for preventing HIV/AIDS.[19]

[15] International Trade Administration, US, "Uganda – Country Commercial Guide", 13 October 2023, https://www.trade.gov/country-commercial-guides/uganda-healthcare
[16] Ibid.
[17] Ogei, E., & Lewis, C., "Medical Training in Uganda: A Critical but Neglected Part of the Healthcare System", *Cureus*, 15, 6 (2023)
[18] Saito, K., "Beyond Borders: A Glimpse into Uganda's Healthcare Challenges and Solutions", *Brown Undergraduate Journal of Public Health*, 2024, https://sites.brown.edu/publichealthjournal/2024/03/29/beyond-borders-a-glimpse-into-ugandas-healthcare-challenges-and-solutions/
[19] Ibid.

Moreover, she noticed that progresses were being made, as attested by quick responses both to the Ebola outbreak and the COVID-19 pandemic.[20]

To conclude, Uganda has many disadvantages when it comes to healthcare and medicine, which is why the probability of a reoccurrence of Ebola is high. However, the government in Uganda is trying to improve the system, as well as decreasing poverty which is an important factor. Because of that, it is likely that any future EVD outbreak will be contained quickly.

1.1.4. West Africa

Recurrent epidemics of measles, cholera, meningitis, Lassa fever, yellow fever and, since 2014, Ebola have plagued the West African region, leaving national health institutions ill-equipped to respond appropriately. According to Heymann and Sylvain Aldighieri, of the Pan American Health Organization, the high transmission among healthcare workers in West Africa was caused by a lack of personal protective equipment (PPE) or improper use of it.[21]

Liberia, Sierra Leone, and Guinea improved maternal health before the pandemic, but such progresses virtually vanished with the start of the Ebola outbreak. The few clinics and hospitals that did exist in these countries were mostly, or perhaps entirely, converted into Ebola treatment centers (ETCs). This had grave consequences: between October 2014 and October 2015, when the epidemic peaked, 800,000 women were expected to give birth in Liberia, Sierra Leone, and Guinea; up to 120,000 mothers could die if they were denied access to emergency

[20] Baxter, D. “5 Improvements to Healthcare in Uganda”, 8 July 2020, https://borgenproject.org/healthcare-in-uganda/
[21] National Library of Medicine, *The Ebola Epidemic in West Africa: Proceedings of a Workshop* (Washington, DC: National Academies Press, 2016)

obstetric care. The United Nations Population Fund (UNFPA) calculated at the time that the rates of maternal deaths in these three nations might treble, returning to the levels observed during the civil conflicts of the 1990s. In Guinea, Liberia, and Sierra Leone, this rise would translate into a maternal mortality ratio of almost 200 per 1000 people.[22]

Studies indicate that the Ebola virus is far more lethal to pregnant women and their unborn children than it is to the general public, yet there is no proof that pregnant women are physiologically more vulnerable to contracting the infection after exposure. Depending on the characteristics of the group under review, the case fatality rate (CFR) for the Ebola virus pandemic in West Africa ranged from 60 to 70% for individuals of all ages and genders.[23] According to data from the Centers for Disease Control and Prevention, there were 28,616 confirmed cases of EVD in Guinea, Sierra Leone, and Liberia, and 11,310 deaths overall which is approximately 39% mortality rate. However, there is evidence to show that the mortality rates are higher among pregnant women and their infants. For instance, out of 108 pregnant West African women infected by Ebola, there were 91 maternal deaths, an 84.3% case fatality rate, and only one surviving fetus.

One significant issue is the lack of access to health care services. Access to basic primary health care services was a key barrier to good health in the impacted African countries even before the Ebola outbreak.[24] Having access to early supportive treatment is essential for anyone who may have Ebola. The number of Ebola

[22] Strong, A. E., “Effects of the West African Ebola Epidemic on Health Care of Pregnant Women: Stigmatization With and Without Infection”, in D.A. Schwartz et al (eds), *Pregnant in the Time of Ebola* (Cham, Springer, 2019)
[23] Buseh, A. G., et al., “The Ebola epidemic in West Africa: challenges, opportunities, and policy priority areas”, *Nursing outlook*, 63, 1 (2015)
[24] Ibid.

treatment facilities in Liberia has expanded as a result of interventions by the US military and other international organizations. Unfortunately, people in certain affected locations could not have access to the necessary supportive care - care that would boost their chances of survival - due to a lack of transportation and limited ambulance services.[25]

In summary, several healthcare shortcomings led three West African countries towards the inevitable Ebola outbreak. From a medical point of view, the scale of the 2014 epidemics was not entirely surprising, considering the lack of basic necessities and material for treating primary symptoms and preventing death. However, this situation helped other countries to anticipate upcoming viruses and made Guinea, Liberia and Sierra-Leone more prepared for future outbreaks.

2. Scientific controversies

EVD outbreaks and the virus itself sparked many discussions all over the world concerning treatments of the disease. There are controversies about vaccines use, the usefulness of quarantine, as well as controversies surrounding the ethical dimension of research into the EVD.

2.1. Vaccine

The first vaccine, Ervebo, to be declared safe by the WHO was used in Guinea, and was administered to a large number of people. However, it is not yet commercialized in the US and not used often in the EU. Despite the proof of its usefulness, the way of confirming that the vaccine works is questionable.[26] First of all, the first people who get it are medical workers. If the vaccine does not work, they are left with a

[25] Ibid.
[26] WHO, “Ebola Virus Disease Vaccines”

weak immune system, and they can contract the disease, which is precisely the opposite effect of what was intended. Vaccine uses another disease, this is why it is highly dangerous and objectionable to test it on humans. Because of the live virus that is legally injected into the person, they might experience side effects. CDC reports that following an Ebola vaccination, some patients experience pain, swelling, and redness in the injection site. Following an Ebola vaccination, symptoms may include headache, fever, muscle soreness, exhaustion or weariness, nausea, skin rash (including blisters), and unusual perspiration.[27] Moreover, after an Ebola immunization, joint discomfort or edema may develop. The joint pain or swelling can be rather severe and persistent, even though it is uncommon.[28] There is a possibility of arthritis or worsening arthritis occurring; these cases are especially common in women and those with a medical history of arthritis.[29] After receiving an Ebola vaccination, some white blood cell counts may drop below normal; however, these drops are not linked to sickness and eventually return to normal.[30] Vaccine trials always spark many conversations, but the Ebola vaccine made scientists question when exactly to decide that a vaccine is completely safe and how to minimize adverse reactions that might get people worse than the actual disease.

In the DRC, the issue also touches on the relationship between science and society, and has created feelings of mistrust from people. The difficulties involved in combining two vaccinations have been raised by the DRC government, which stated

[27] European Medicines Agency. “Ervebo - Ebola Zaire Vaccine (rVSVΔG-ZEBOV-GP, live)”. https://www.ema.europa.eu/en/medicines/human/EPAR/ervebo#:~:text=The%20most%20common%20side%20effects%20with%20Ervebo%20in%20adults%20include,than%201%20in%2010%20adults.
[28] Ibid.
[29] Ibid.
[30] Ibid.

that there was a chance of causing misunderstandings and worsening mistrust among the impacted populations.[31]

However, the results show a different picture and demonstrate the utility of vaccines. The same Ervebo, for instance, its side effects notwithstanding, provided 84% of protection in DRC during the outbreaks of 2018-2020 to people who had been vaccinated 10 days before the epidemics.[32] The vaccine, then, is not only successful, but also produces rapid results.

There is another vaccine that uses the RNA that is similar to the Ebola Virus. According to scientists, this should assist in the same way as the COVID-19 vaccine did, because it builds the immune system response to possible Ebola Virus.[33] There are hardships in launching the vaccine since people are extremely opposed to the idea of using this treatment, and are scared it would bring back COVID-19 or just not work with Ebola.

2.2. The Ebola Quarantine

Quarantine, maybe the most severe public health measure, restricts the freedom of asymptomatic people and can have serious consequences. In an effort to contain multiple Ebola outbreaks during the 2014 West African Ebola pandemic, quarantine

[31] BBC News, “Ebola vaccine: Why is a new jab so controversial?”, 4 August 2019, https://www.bbc.com/news/world-africa-49164066

[32] CDC, “Expanded Access Investigational New Drug (IND) Protocol: Ervebo® (Ebola Zaire Vaccine, Live) Booster Dose for Domestic Preexposure Prophylaxis (PrEP) Vaccination of Adults (≥ 18 years of age) at Potential Occupational Risk for Exposure to Zaire ebolavirus”, 2022, https://www.cdc.gov/ebola/media/pdfs/2024/05/Ebola-Vaccine-Protocol_508.pdf

[33] Daniel, A. “Ebola vaccine cuts death rates in half — even if it's given after infection”, 15 February 2024, https://www.npr.org/sections/goatsandsoda/2024/02/15/1231249465/ebola-vaccine-cuts-death-rates-in-half-even-if-its-given-after-infection

was implemented. The most wide-ranging quarantine intervention took place in Monrovia, Liberia, at West Point, a 75,000-person slum.[34]

Quarantines for Ebola are controversial. On the one hand, it was used to control Ebola outbreaks. Since Ebola is an infectious disease, there is always risk of contracting it from a close distance. It is proved that people in close spaces have more exposure to the Ebola Virus than in open spaces. On the other hand, the virus is not transmitted by airborne droplets, only by fluids and contaminated needles. This type of transmission does not necessarily require a quarantine. Isolation, the separation of infected people from the healthy ones, might be a better option.

Quarantines should not be mandatory, forced, or legal, because they are not effective in the time of the Ebola crisis. If less restrictive measures (such as education, monitoring, reducing social mixing, and increasing social distance) are not working and public health is in danger, then quarantine may be necessary. Since EVD symptoms appear in individuals prior to infection, those who exhibit them may be recognized and taken into isolation before they pose a threat to others.[35] In other words, less stringent approaches than quarantine can accomplish the same purpose of halting the spread of EVD if the right tools and protocols are in place.

The National Institute of Allergy and Infectious Diseases' director, Dr. Anthony Fauci, stated on ABC News' "This Week" on Sunday that "as a scientist and as a health person, if I were asked, I would not have recommended mandatory quarantines."[36] Doctors Without Borders released a statement on Thursday stating that "self-

[34] Moore C. B., “Ebola, quarantine, and the need for a new ethical framework”, *Journal of Medical Ethics and History of Medicine,* 13, 9 (2020)
[35] Ibid.
[36] CDC Museum, “Quarantine: a Debated Strategy”, https://cdcmuseum.org/exhibits/show/ebola/public-health/isolation-treatment/quarantine

quarantine is neither warranted nor recommended when a person is not displaying Ebola-like symptoms." "However, returned staff members are discouraged from returning to work during the 21-day period."[37] Wendy Mariner, a public health lawyer, believes that the quarantines are troublesome and may even turn into a federal issue since they will deter medical professionals from going to West Africa to contain the Ebola outbreak at its source.[38]

2.3. Research

The 2014 WHO ethics panel stated unequivocally that "properly designed clinical studies" ought to serve as the primary means of evaluating novel treatments for EVD. However, there are still disagreements among researchers, and other stakeholders regarding the way studies were conducted during the Ebola outbreak, the significance of randomised controlled clinical trials (RCTs) and what constitutes "compassionate" use. These discussions have already occurred, most notably in relation to the early HIV trials. The Ebola epidemic and its unique conditions have exacerbated them, revealing a deeper conflict between personal and societal ideals. The arguments put out by proponents of a public health viewpoint on clinical trials can be summed up as follows: they prioritize social value over individual interests.[39]

First of all, the public health imperative essentially justifies clinical research. This satisfies "the moral responsibility to distribute the benefits and burdens of research fairly across society; a fiduciary obligation to realize the social value of the research; and the duty to protect the population as a whole."[40] Second, current patients should

[37] ABC News, “Why There’s So Much Controversy Surrounding Ebola quarantine orders”, 27 October 2014, https://abcnews.go.com/Health/controversy-surrounding-ebola-quarantine-orders/story?id=26482802
[38] Ibid.
[39] Kang, S. K.,et. al., “Applications of deep learning and big data in the field of drug discovery”, *Journal of Biomedical Science*, 25, 1 (2018).
[40] Ibid.

participate in therapeutic trials largely for the purpose of expanding collective knowledge and for the benefit of future generations of patients, if the ultimate goal of clinical trials is to improve the medical care of future patients. Thus, in clinical trials, the doctor-patient relationship shouldn't get in the way of the doctor-investigator and patient-subject relationship.

This division of responsibilities is necessary to protect the investigator's professional integrity and prevent any "therapeutic misconception" on the part of the patient. Lastly, randomization of participants is necessary to improve the clinical trial's social value and scientific validity.[41]

The Ebola outbreak has highlighted the limitations of a rigid interpretation of clinical research that pits patient care against public health. Two assumptions that are inherent from a strict public health perspective of clinical trials are invalidated by the simple circumstances of such a severe outbreak: (i) patients' altruism and (ii) professionals' willingness to forgo their therapeutic commitments.[42]

[41] Ibid.
[42] ibid.