Lethal disease in less-developed areas: case study of Ebola in Guinea

Tianjian Mu[1, *, †], Jiarui Sun[2, *, †], Yutong Tang[3, *, †]

[1]Qingdao No.9 High School, G11, Qingdao, China

[2]Lakefield, Canada

[3]Rongqiao Sedbergh School, G12, Fuzhou, China

*Corresponding author: tianjiandavid@gmail.com, rsun@lcs.on.ca, yutong.tang 23@outlook.com

†These authors contributed equally to this paper

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Abstract: When the world's largest outbreak of Ebola virus disease first occurred in 2014, most cases were concentrated in West African. Countries as Guinea, Liberia, and Sierra Leone suffered mostly from this lethal pandemic. Poverty and less-developed society environment made the issue more serious and the situation against Ebola still requires much attention not limited to comprehensive healthcare and volunteer work. In this paper, we review the pandemic of Ebola in Guinea, virus transmissions and current prevention measurements. We further discuss the improvements about future applied interventions for the less-developed area such as Guinea. This paper provides a thorough understanding for lethal pandemics in less developed countries and sets a good example for future work.

1. Introduction

On February 14, 2021, the first cases of Ebola virus disease (EVD) had been confirmed in Guinea after the 2014-2016 West Africa outbreak. The cause of this recent outbreak is still unclear, though scientists had compared the samples of the recent outbreak and 2014-2016 outbreak. The reported number of deaths and percentage of fatal cases with a value of 52.2% has redrawn people's attention to this fatal disease [1].

In this report, we give a brief overview of the recent outbreak of Ebola, its transmissions and how does Ebola virus work. We then discuss the existing interventions and other interventions that should take for Ebola in Guinea.

2. Background And Rationals

2.1 What is Ebola Virus Disease?

Ebola virus disease (EVD) is a deadly disease with occasional outbreaks that occur mostly on the African continent [2]. Human beings and nonhuman primates such as monkeys and chimpanzees are often the infected objects by a group of viruses within the genus Ebolavirus [3]. Ebola virus is also not an airborne virus. The phenomenon of transmitting through inhalation of an infectious dose of virus from a suspended cloud of small dried droplets has not been observed yet. Early symptoms are fever, aches and pains, weakness and fatigue sore throat, loss of appetite, gastrointestinal symptoms, unexplained hemorrhaging, bleeding or bruising.

2.2 Transmission Ebola Virus Disease

The Ebola virus is transmitted among humans through close and direct physical contact with infected bodily fluids, the most infectious being blood, feces and vomit. People who have direct contact to bodily fluids like urine, saliva and breast milk from a person who is sick with EVD or died from that will get infected by EVD. Objects that contain bodily fluids from infected people would also

transmit the virus to other people once others have contact with it. However, no evidence having sex with people who recovered from EVD would transmit the viruses yet. As mentioned above, the transmission does not occur from inhalation.

2.3 Rationales

The Ebola virus has caused outbreaks of fatal infection since it firstly appear in 1976. This new outbreak of Ebola in Guinea after 2014-2016 outbreak has been taken seriously for scientists and researchers all over the world to find the reasons for its occurrence. All sorts of Medias has public these in several of ways, sometimes the information given out is even untrue. We aim to search the authentic information and organized it into a report. Limitation of regional conditions in Guinea such as medical institutions, health care workers and medical devices have exacerbated the virus situation in Guinea, this will be discussed in detail later. Several of ways of controlling Ebola disease can be used as referential use to control other diseases.

3. infection mechanism

Since Ebola is a virus, it can only survive and proliferate by infecting cells instead of replicating through any kind of cell division. The way that Ebola infects cells is using a combination of host and virally encoded enzymes, producing multiple copies of viruses by attaching to the host cell. These then self-assemble into viral macromolecular structures in the host cell. The virus completes a set of steps when infecting each cell [4].

To avoid the infection, the immune system will stand up to against the viruses. Dendritic cells can initiate the adaptive immune response [5]. Generally, support cells and anti-body factories will be activated by dendritic cells to work together with the guard cells, against anti-virus. The virus is often wiped away by a few days in this case.

However, the Ebola virus is different from other viruses, it attacks the immune system directly. Dendritic cells which are regarded as the brain of the immune system will be attacked by the Ebola virus first. The Ebola virus enters the dendritic cells by binding into the receptor that is used for cell transport. Once it is inside, it will dissolve its outer hull and releases its genetic material, nucleoproteins and enzymes. The cells' protective mechanisms are disabled and reprogramed in this case, becoming a virus production machine. The sources will be used to generate more viruses.

Once the cell is saturated, it dissolves in the cell membrane. Then viruses will be released into tissues. The Ebola virus can not only prevent the dendritic cells from activating the specialized and anti-virus forces. It manipulates them into sending signal proteins that strike lymphocytes into ending their own lives prematurely. So the immune system is disrupted significantly and unable to react.

There do have one type of cell, natural killer cells, that can kill Ebola virus. However, it will get infected very soon after it kills the Ebola virus, die before it can prevent it. In the meantime, Ebola virus also infects the guard cells of human bodies - macrophages and monocytes. Ebola virus then disables the macrophage and monocytes, and even sends signals to release the fluid into human bodies.

This will make the system even more confusing. All the neutrophils are activated. Neutrophils are now doing the tasks they should not do, sending signals for releasing more fluids. This will end up in internal bleeding.

The liver is often the start place for Ebola virus infection. This organ is easiest for Ebola virus to enter and causing organ failure and more internal bleeding.

All of these things happen at the same time. One of these explosions would be problematic enough to solve. These would act as the explosion everywhere in the human bodies. All the immune systems even become harmful to humans.

As the virus continues to replicate and enter cells, the immune system launched the last weapon – cytokine storm. More and more fluids are released from the blood vessels to against the viruses, this will dehydrate people ending up with not enough oxygen supply for organs. Hence, cells begin to die. Patients at this stage have a very rare chance to recover [6].

4. Existing Interventions

During the 2014 Ebola outbreak in West Africa, the world gained 9000 cases in around 2 months after it was declared by WHO (World Health Organization) as a PHEIC (Public Health Emergency of International Concern). Because of the rapid spread of the virus, the government of the country in West Africa has to keep finding new interventions to slow down and eliminate the spread of the virus. Lots of intervention has been done to control the spread of the virus, but depending on how the intervention was executed during the outbreak, some of the results didn't come out as expected.

4.1 Isolation

The spread of Ebola can be prevented if body fluid contact is avoided; exchanging needles, exchanging saliva (kissing or coughing), and blood transfusion between humans must be avoided. To do so, the healthcare worker needs to wear PPE (Personal Protective Equipment) to contact the patient to prevent getting the virus, the patient also needs to stay isolated to prevent spreading the virus to more people. But in 2014, the health care in West Africa wasn't perfect, and the lack of equipment and healthcare workers caused the virus to spread through the whole hospital. The health care condition in West Africa is designated that this won't be a successful intervention.

4.2 Safe Burial

Safe Burial is another intervention that's important to the West Africa outbreak. Because of the body fluid, the body that died from Ebola needs to be completely sterilized and sealed in the bag before it gets buried, without letting it contact anyone. Yet the dead body is a really common thing in West Africa, the family contact with the dead body and prepare for the funeral all the time, which causes the virus to spread easily through the dead body and human interaction. In October 2014, the Sierra Leone Ministry of Health and Sanitation (MOH) collaborated with CDC, conducted an assessment by observing the management of cemeteries in three high-incidence districts. They end up finding lots of existing problems with the cemeteries, for example, lack of space and staff members, lack of lab reports of the body, the lab doesn't approve by the family member of the deceased, etc.

4.3 Rapid Diagnose Test

The purpose of a rapid diagnostic test is to provide a quick diagnostic result of the patient, and it suits for a preliminary test of the disease. Since patients with Ebola don't usually present with specific symptoms, they usually present with fever, headache, vomiting, which it's hard to specify apart from other diseases. The health workers can't identify Ebola by their symptoms, and the RT-PCR (polymerase chain reaction) test can take several days to get the result, and that's why people need the rapid diagnosis test. In 2014, because of the lack of rapid tests, health workers sorted the patient based on general symptoms, placing patients without Ebola at high risk of being hospitalized along with those who were infected, which caused another spread of the virus. In 2015, the WHO approved a rapid test called Corgenix ReEBOV, which is the only Rapid Diagnose Test identified by WHO and appropriate to use for Ebola at that time. The method for Corgenix ReEBOV is to collect the blood sample from the patient from finger or venepuncture. This rapid test doesn't require experience or training, which is very accessible to people of any skill level.

4.4 Contact Tracing

The definition of contact tracing with infectious disease is the process of identifying the recent contact of the patient who has been diagnosed positive for the disease to quarantine and treat them. Specifically for Ebola is identification and follow-up over 21 days of individuals who have been in contact with a person confirmed to have been infected. One of the main ways to help control the spread of Ebola during the outbreak is Contact Tracing. However, during the outbreak in 2014, the health worker used paper-based systems by recording down the phone calls of the patient's recent contact and connecting them with messages, which is inefficient compared to the technology system. Not just the efficient side, the paper-based system also includes problems like missing contact lists, late responses and communication, and lack of data.

4.5 Vaccination

In response to the Ebola outbreak, efforts were put into creating the Ebola vaccine. However, the vaccine was created three years later after the outbreak ended. In 2019, the first FDA- approved vaccine named Everbo was released to the market, it is an Ebola vaccine for 18 years and older. The Ebola vaccine is really important to humans because of how fatal and severe Ebola is, an effective vaccine would be really helpful for humans to eradicate this deadly virus.

Even though lots of interventions didn't work well during the outbreak, the government eventually found a way to solve the problem. Safety Burial as an example, after the assessment, has been conducted and the problem has been found, which leads them to develop an SOP (national standard operating procedure) for safety burial; the government didn't have a rapid diagnostic test for ebola at the beginning of the outbreak. After one year, a rapid diagnostic test has been put out and used in the outbreak to help control the spread of the virus; there isn't any vaccine during the epidemic, yet three years after, a legible Ebola vaccine has been released. On May 3, 2021, North Kivu Province has just been announced by WHO and the Ministry of Health (MOH) in the Democratic Republic of the Congo that the case of Ebola disease has been declared in this area, which Congo is one of the countries with the most severe situation during the 2014 outbreak. The people is another step close to the final goal: eradication.

5. Current Situation In Guinea

An old disease in a new context. Ebola, an unfamiliar and unexpected disease, attacked Western African countries fiercely. However, those countries were poorly prepared, from early detection of infected cases to providing a quick and effective response. Doctors were trained poorly, and laboratories even had no experience to analyze patients' specimens. At the beginning of the epidemic, no governments paid attention to the social and economic chaos that accompanied the outbreak, and it was like a mess. Ebola was thus an old disease in a new context that behaved rapid change and initially invisible spread. As a result, the Ebola virus has challenged some previous assumptions. In past outbreaks, the amplification of infections in health care facilities was the principal cause of initial explosive spread. Transmission within communities played a lesser role, with the notable exception of unsafe burials. In West Africa, entire villages have been abandoned after a community-wide spread killed or infected many residents and fear caused others to flee. Furthermore, in past outbreaks, Ebola was largely confined to remote rural areas, with just a few scattered cases detected in cities. In West Africa, cities – including the capitals of all three countries – have been centers of intense virus transmission. The West African outbreaks demonstrated how swiftly the virus could move once it reached urban settings and densely populated slums. Today, with so many people infected, the primary aim must also include aggressive supportive care, especially the correction of electrolyte imbalances, which improves the chances of survival. Life-saving supportive care is difficult to provide in a typical West African health care setting but is improving as more treatment facilities are built by MSF, the UK and US governments, WHO, and other partners.

5.1 Damaged Public Health Facilities

Guinea, Liberia, and Sierra Leone, which are among the poorest countries in the world, have basic health infrastructures that are severely damaged or destroyed. The workers there are young adults with little or no education. What's more, roads, transportation services, and communication devices are also underdeveloped in all three countries, especially in rural settings. These weaknesses greatly slow down the transportation of patients to treatment centers and also of specimens to laboratories, the communication of alerts, reports, and calls for help. Thus, well-developed countries need to focus more on building these necessary health facilities in these countries, which is beneficial for their long-run development.

5.2 High population mobility across country borders

One of the famous characteristics of West Africa is its high degree of population movement across country borders. Recent studies estimate that these countries' population mobility is seven times higher than elsewhere around the world. Many extended West African families have relatives living in different countries. To such a large extent, it is a natural route of transmission for Ebola virus. Population mobility produced two significant hidden dangers to control. First, as mentioned in the early paragraph, moving across country borders' contact is tremendously difficult to trace. Populations readily cross porous borders but outbreak responders do not. Second, as the situation in one country began to improve, this condition attracted patients from nearby countries seeking available treatment beds, which extends transmission chains. In other words, as long as one country experienced intense transmission other countries were also remained at risk, no matter how strong their own response measures had been. The traditional custom of returning over long distances to a native village to die and be buried near ancestors is another dimension of population movement that carries an especially high transmission risk.

5.3 The severe shortage of health workers

Prior to the outbreaks, these three countries had a ratio of only one to two doctors per nearly 100,000 population. Unluckily, that has now been further decreased by the tremendous number of health care workers who were infected during the outbreaks. Nearly 700 were infected by year-end and more than 50% of them had died. Although at the beginning of the outbreaks the number of infected health care workers was the highest, infections in doctors and nurses began to go to the peak again at the end of that year. In Liberia, as cases start to decrease and the risk was observed to be lower, some additional evidence suggests that strict measures for personal protection are lacking. Protective measures in the community, such as frequent hand hygiene and keeping a safe distance from others, visibly declined. In Sierra Leone, which has five times as many new cases per week when compared with Liberia, exhaustion among staff may help explain this increase. As experience has shown, when a city experiences intense and widespread transmission the distinctions between "hot" and "low-risk" zones become blurred. Infections in some health care workers, who rigorously followed safe procedures while caring for Ebola patients in a hospital or clinic, are known to have acquired their infection in the community.

5.4 Cultural traditions

High-risk behaviors in three countries have been similar to what has been observed during Ebola outbreaks in equatorial Africa, with adherence to ancestral funeral and burial rites singled out as fueling large explosions of new cases. Medical anthropologists have, however, noted that funeral and burial practices in West Africa are exceptionally high-risk. Data available, as reported by Guinea's Ministry of Health, indicated that 60% of cases in that country could be linked to traditional burial and funeral practices. In November, WHO staff in Sierra Leone counted that 80% of cases in that country were linked to these practices. In Liberia and Sierra Leone, where burial rites are reinforced by a number of secret societies, some mourners bathe in or anoint others with rinse water from the washing of corpses. Understudies of socially prominent members of these secret societies have been known to sleep near a highly infectious corpse for several nights, believing that doing so allows the transfer of powers. Ebola has preyed on another deep-seated cultural trait: compassion. In West Africa, the virus spread through the networks that bind societies together in a culture that stresses compassionate care for the ill and ceremonial care for their bodies if they die. Some doctors are thought to have become infected when they rushed, unprotected, to aid patients who collapsed in waiting rooms or on the grounds outside a hospital. As several experts have noted, when technical interventions cross purposes with entrenched cultural practices, culture always wins. Control efforts must work within the culture, not against it.

5.5 A virus with different clinical and epidemiological features

Recent analyses have determined that the virus circulating in West Africa is genetically distinct from Zaire viruses seen in past outbreaks and the 2014 outbreak in the Democratic Republic of Congo. As scientists have noted, the virus in West Africa takes a different clinical course with different epidemiological consequences, although these differences do not affect the infectious period, case fatality rate, or modes of transmission. As noted in a major study and commentary published in Science Magazine on 29 August, the virus' genome – its genetic "identity card" – is changing "fairly quickly" in fixed ways. As the authors of the report concluded, "continued progression of this epidemic could afford an opportunity for viral adaptation, underscoring the need for rapid containment."

5.6 The long duration of the outbreaks — International support

The Ebola outbreak demonstrated the lack of international capacity to respond to a severe, sustained, and geographically dispersed public health crisis. Governments and their partners, including WHO, were overwhelmed by unprecedented demands driven by culture and geography as well as logistical challenges. Together, these and other factors, including the behavior of the virus, created a volatile situation that evaded conventional control measures and constantly delivered surprises. Faced with so much suffering and so many unmet needs, many partners in the outbreak response courageously took on responsibilities that went beyond their traditional areas of work and expertise. Some, including MSF, the US CDC, the International Federation of Red Cross and Red Crescent Societies (IFRC), and UNICEF built upon their well-established roles during health and humanitarian crises to expand their areas of engagement. MSF, which provided the bulk of clinical care since the beginning of the outbreaks, used its treatment centers to collaborate in clinical trials of experimental therapies and also provided funding. Its helicopters were used to get rapid response teams to remote rural areas. Its engineering teams supported the rapid construction of treatment facilities by WHO and others and the clearing of ground for cemeteries. Hundreds of CDC staff, including epidemiologists with extensive experience in outbreak containment, were deployed to support surveillance, contact tracing, data management, laboratory testing, and health education. UNICEF worked to promote child health and safe childbirth in addition to taking the lead on social mobilization. IFRC used its vast network of volunteers to take on primary responsibility for safe and dignified burials. As WHO field staff observed, some operations encountered less community resistance when local staff was part of the response team, as is often the case with IFRC volunteers. However, given the cultural and religious sensitivities surrounding burials, the work of several teams was disrupted by violent community resistance, resulting in serious injuries to some team members. The International Medical Corps, International Rescue Committee, and International Organization for Migration played major roles in staffing and managing treatment facilities, in Liberia and Sierra Leone, designed to meet all isolation, care, safety, and waste management needs. Staff provided by the International Medical Corps included mental health and specialists.

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