

The Ongoing Ebola Epidemic in the Democratic Republic of the Congo: Contributing Factors that have Influenced Disease Control

by

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Abstract

Ebolavirus outbreaks and epidemics have affected regions of Africa since its discovery in 1976. Presently, the Democratic Republic of the Congo (DRC) is experiencing its tenth and largest outbreak of Ebolavirus, infecting nearly 3,432 individuals and causing 2,253 deaths. First declared an official outbreak on August 1, 2018, the DRC Ministry of Health (MOH) and other global health institutions are having difficulties in controlling the spread of infection due to community resistance and mistrust, poor healthcare infrastructures, political conflict, civil unrest, and porous geographic boundaries. A literature review and analysis were performed to evaluate contributing factors to the ongoing outbreak in the DRC. In this essay, I outline the contributing factors that have led to the continuity of the ebolavirus epidemic in the DRC and predict long-term effects it may have on the country. By analyzing up-to-date World Health Organization (WHO) situation reports, journal articles, and newspaper reports, I have found that in order to sufficiently control the outbreak, continued surveillance and contact tracing is required in combination with building community trust and transparency. It is important to understand outbreak and infection control measures in historically underdeveloped areas, especially those with poor healthcare infrastructure and politically unstable environments. By gaining insight on the successes and shortcomings of specific public health control measures, health ministries and global health organizations can improve upon their actions and distribution of resources in times of dangerous outbreaks.

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Preface

First, I would like to thank my committee members for their guidance and feedback throughout this entire process. This semester proved to be more challenging than expected due to current global health events, and I appreciate the flexibility both Dr. Martinson and Professor Russell had during the semester. I want to extend gratitude to my “Pittsburgh Family” for supporting me these past two years with their kindness, friendship, and endless support. Finally, this project is a result of unconditional love and support from my mother. She has always encouraged me to be tenacious and passionate about my academic and professional pursuits. I am the person I am today because of her guidance, encouragement, and unequivocal love.

List of Abbreviations

ADF	Armed Democratic Forces
CFR	Case Fatality Rate
DRC	Democratic Republic of the Congo
ETC	Ebola Treatment Center
INRB	The Institut National de la Recherche Biomédicale
MOH	Ministry of Health
MSF	Médecins Sans Frontières
MVYLL	Monetary Value of Years of Life Lost
PHEIC	Public Health Emergency of International Concern
POE	Points of Entry
SDB	Safe and Dignified Burials
UN	United Nations
WHO	World Health Organization

1.0 Introduction

The Democratic Republic of the Congo (DRC) is currently facing its largest ebolavirus outbreak ever to be recorded, infecting nearly 3,444 individuals and killing 2,264. Presently, the DRC's Ministry of Health (MOH), along with partnering agencies, such as the World Health Organization (WHO), the United Nations (UN), and other international health agencies have focused their response efforts on surveillance, contact tracing, vaccination and community mobilization to stop the spread of disease. Although response efforts have prevented cases from spreading to other parts of Africa, health authorities are still having difficulty controlling the spread of disease because of the country's poor healthcare infrastructure, community resistance and distrust, presence of armed conflict groups, and high mobility of the population. This essay describes the characteristics of the main contributing factors that have led to difficulties in controlling the outbreak and suggests how response methods should be improved to stop the spread of disease.

1.1 History of Ebola

Ebolavirus outbreaks and epidemics have affected regions of Africa since 1976 when it was discovered during two simultaneous outbreaks in Nzara, South Sudan and Yambuku, Democratic Republic of Congo, the latter of which occurred near the Ebola River, where the virus received its namesake (World Health Organization, 2018). Ebolavirus is one of three members of the Filoviridae family and comprises of five distinct species, *Budibugyo ebolavirus*,

Zaire ebolavirus, Sudan ebolavirus, Reston ebolavirus, and Tai ebolavirus (Bah et al., 2015). *Zaire ebolavirus* has historically resulted in the highest case fatality rate (CFR) of up to 90%, while Zaire, Sudan, and Budibugyo Ebolavirus have been associated with the largest outbreaks in Africa (World Health Organization, 2018). Recent outbreaks of ebolavirus in West Africa during 2014-2016 and presently in the Democratic Republic of Congo have been a result of *Zaire ebolavirus* (2018 Eastern Democratic Republic of the Congo: Ebola, 2019).

Ebolavirus is a type of filovirus, first discovered in 1967 as a causative agent of a hemorrhagic fever outbreak among lab workers in Europe. Filoviruses are filamentous viruses that contain negative-sense single-stranded RNA and possess single glycoprotein spikes on the virion surface (Feldmann & Klenk, 1996). The structure of ebolavirus includes a nucleocapsid, matrix space, and envelope, while the genome consists of seven genes encoding for eight proteins (Falasca et al., 2015). Of these genes, the most notable is the GP gene which encodes for two separate glycoproteins, GP and sGP. The GP glycoprotein is responsible for forming spikes on the envelope of the virion, which is required for viral cellular entry, while the sGP glycoprotein is secreted from the host cell and helps with modulation of host immunity (Falasca et al., 2015). The ebolavirus glycoproteins are important for virus function, but also serve as important targets for therapeutic medicines and vaccine development

Ebolavirus is thought to be zoonotic, with the natural host of the virus being fruit bats of the Pteropodid family; however, this has not been officially confirmed. Non-human primates have also been a source of human infection; however, because the primates develop severe and fatal illness when infected, it was confirmed not to be a natural reservoir (United Kingdom Government, 2018). Ebolavirus is introduced to humans through close contact of blood, secretions, organs or other bodily fluids of infected animals. The virus spreads via human-to-

human transmission through direct contact, whether it be through broken skin or mucous membranes. It can also be spread through coming into contact with surfaces and material contaminated with infected fluids (Feldmann & Klenk, 1996). Symptomology of the disease begins with sudden onset of fever or fatigue, along with muscle pain, headache, and sore throat. It is then followed by vomiting, diarrhea, internal and external bleeding, impaired kidney and liver function, and low platelet and low white blood cell counts. It causes severe fluid distribution problems due to changes in vascular permeability. The mortality rate for ebolavirus is approximately 30-90% with no proven treatment therapy available. Patients infected with the virus are given medication and therapies to assist with symptom and pain management (Vine et al., 2017). In 2015, an experimental vaccine was developed and proven highly protective against the virus in a major trial in Guinea; however, there is still no commercially licensed and available vaccine for ebolavirus (Sridhar, 2015).

1.2 Timeline of Outbreak in the Democratic Republic of the Congo

The DRC has an involved history with ebolavirus outbreaks. Over the past forty years, the country has been home to nine previous outbreaks all of which have been located in rural, secluded areas of the country. The current ebolavirus outbreak in the DRC is the largest to date, and is the second largest ebolavirus epidemic ever recorded, behind the West African epidemic in 2014. It has largely affected urban populations that border the countries of Uganda and South Sudan (Sikakulya et al., 2020).

The epidemic began in late July of 2018, when North Kivu Provincial Health Authorities reported clusters of cases of hemorrhagic fever in the village of Mangina in the

Malabako rural health zone. These cases were epidemiologically different from cases during an outbreak in the Equateur province earlier in May 2018 (*Timeline of the Ebola outbreak response in Democratic Republic of the Congo 2018, 2020*). Representatives from the MOH and WHO began an investigation of multiple suspected cases and found that these individuals tested positive for hemorrhagic fever. On August 1st, the MOH made an official declaration of an outbreak of ebolavirus disease in the North Kivu province, and by August 7th the DRC's National Institute of Biomedical Research (INRB), confirmed that the outbreak was *Zaire ebolavirus*, the same strain that had affected West Africa in 2014 (*Timeline of the Ebola outbreak response in Democratic Republic of the Congo 2018, 2020*).

Over the course of the next few months the epicenter of the outbreak progressively moved south towards the larger cities of Beni, Butembo, and Katwa (Médecins Sans Frontières (MSF) International, 2019). By November 2018, the outbreak had become the second largest recorded ebolavirus outbreak in history. Control efforts, such as vaccination, contact tracing, Ebola Treatment Centers (ETCs), community education, and Point of Entry (POE) screenings, were put in place by the MOH and WHO in order to limit the spread of the disease to large cities and other bordering countries (Inungu et al., 2019).

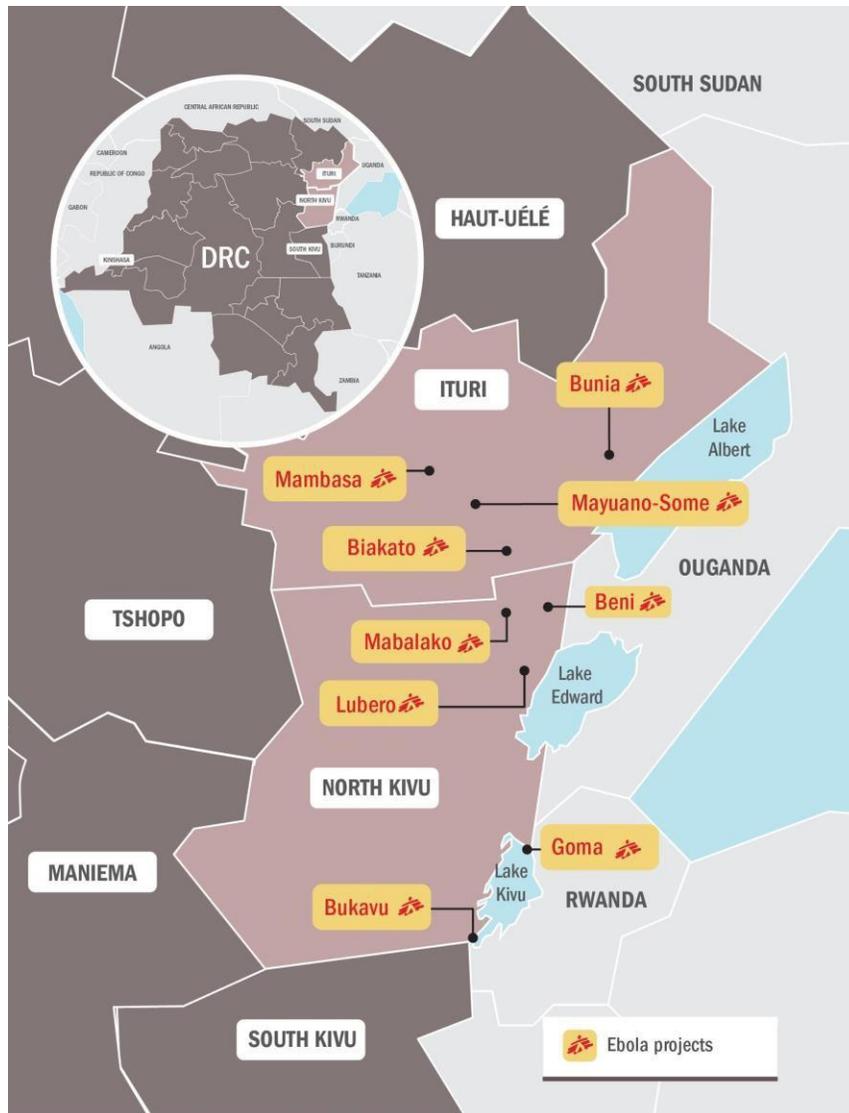


Figure 1. Map of Ituri and Kivu provinces where ongoing MSF projects are located (Médecins Sans Frontières (MSF) International, 2019).

With nearly 1,000 people dying from the disease by May 2019, WHO had yet to declare the epidemic a Public Health Emergency of International Concern (PHEIC) (Médecins Sans Frontières (MSF) International, 2019). On June 11, 2019 the Ugandan MOH confirmed their first case of ebolavirus from the DRC, making this the first cross-border case in the timeline of the outbreak. This event, along with cases being reported in the highly populated capital city of

Goma, prompted WHO to officially declare the outbreak a PHEIC on July 17th, 2019 (Alexandra M. Medley et al., 2020). The declaration of a PHEIC authorizes the distribution of additional funding and resources to countries highly affected by the disease. Throughout the entirety of 2019, hotspots of cases would die down only to flare up again weeks or months later, with little indication of the chain of transmission, further signifying that surveillance and contact tracing had become a significant challenge for health workers (Médecins Sans Frontières (MSF) International, 2019). Attacks on ETCs in the beginning of 2019, along with resurgence of community violence towards the end of 2019, have also contributed to challenges in controlling the epidemic.

1.3 Present Updates on the Outbreak

To date, the outbreak has affected 29 Health Zones in the provinces of South Kivu, North Kivu, and Ituri, with a majority of the cases located in North-Kivu. A total of 3,444 people have been infected by the virus, leading to 2,264 total deaths since the start of the outbreak. The overall CFR is reported to be 66%, with 56% (1,916) of cases being female, and 28% (963) of cases being children under the age of 18. Only 5% (172) of cases have been healthcare workers. It is important to note that these numbers do not reflect the likely high number of unreported and unconfirmed cases and deaths occurring in DRC provinces.

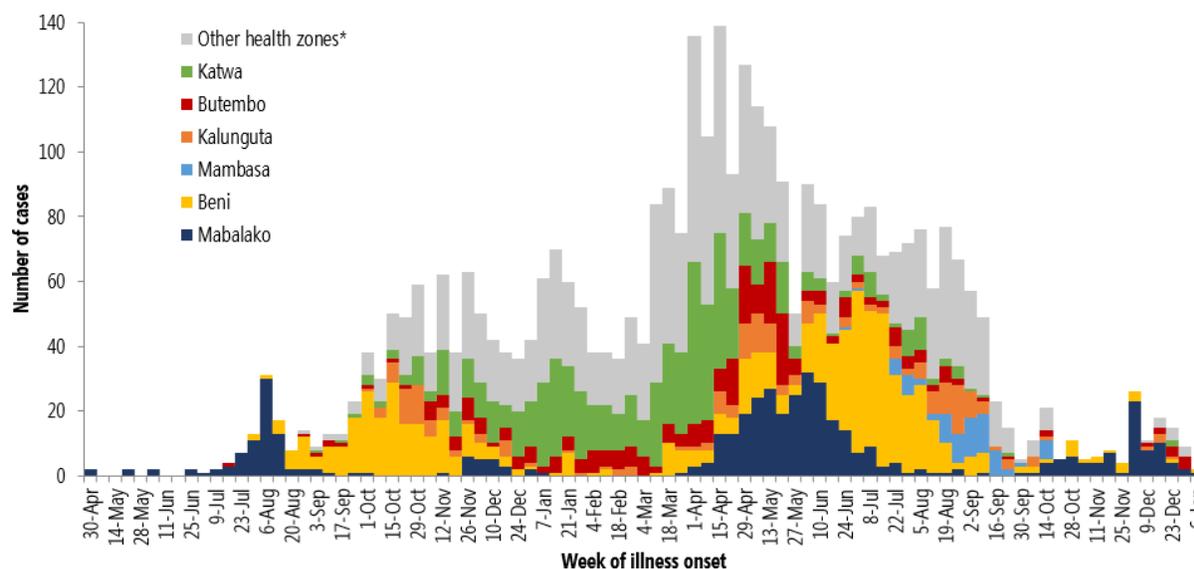


Figure 2. An epidemiological curve of cases in DRC, starting in April of 2018 and ending in January of 2020 (Ebola virus disease – Democratic Republic of the Congo, 2020).

The MOH, along with other national authorities in the DRC, WHO, and contributing partners, have collaborated in implementing various outbreak control measures to reduce and stop the outbreak. Over 249,000 contacts have been registered to date, and presently 1900 are under surveillance. Since August 8, 2018, 276,520 people have been vaccinated with the rVSV-ZEBOV-GP ebolavirus vaccine, while vaccination with the Ad26.ZEBOV/MVA-BN-Filo vaccine continues in two health areas near Goma, with 7,611 people vaccinated since its introduction on November 14, 2019. The DRC currently has 11 operational ETCs and 25 ebolavirus transit centers located in North Kivu, South Kivu, and Ituri. POE screenings are still in effect, with a total of 155 million screenings having occurred since the beginning of the outbreak. The outbreak has received funding from WHO, partnering organizations, and foreign governments to assist with response efforts. As of August 1, 2019, approximately \$148 million

has been received to combat the outbreak (*Ebola response funding: Democratic Republic of the Congo 2018-2020, 2020*).

Presently, the outbreak has been controlled to a relatively small geographic area, with only five new confirmed cases being reported from two health areas as of February 23, 2020. Health officials are cautiously optimistic as the overall trend in geographic spread of disease has declined; however, “the risk of resurgence within the DRC and neighboring countries remains high, and continued containment of the outbreak is contingent on maintaining access and security in affected communities” (*Ebola Virus Disease: Democratic Republic of the Congo, 2020*). WHO has requested further funding in order to maintain current levels of operations to prevent a re-emergence of the outbreak. A total of \$40 million USD is currently needed “to ensure continuity of response and preparedness activities to bring the case incidence to zero, and [to] continue building strong, resilient health systems” (*Ebola Virus Disease: Democratic Republic of the Congo, 2020*).

1.4 Intervention and Response Efforts

WHO and the DRC MOH have implemented response plans that have included the following interventions: screening of suspect cases at POE, contact tracing and surveillance, laboratory testing, case management and infection prevention and control, safe and dignified burials (SDB), vaccination, therapeutics, community mobilization, and free access to healthcare (Sikakulya et al., 2020). Since the start of the outbreak, over 155 million screenings have been performed at approximately 115 POE, along with over 249,000 contacts being registered in a national database (*Ebola Virus Disease: Democratic Republic of the Congo,*

2020). Nine ETCs and fourteen ebolavirus transit centers are presently active in the provinces of North Kivu, South Kivu, and Ituri. Health officials have continued efforts in SDB through the Red Cross SDB database, and educational discussions, mass awareness-awareness raising, and community dialogues are ongoing. “Support [has been] provided to teams in all response intervention areas and activities are jointly planned to ensure respect and engagement of all affected families and communities” (*Ebola Virus Disease: Democratic Republic of the Congo*, 2020). Partnerships between the DRC MOH, WHO and other international health organizations, continue to support public health operations and regional preparedness activities that have been outlined in strategic response plans.

One of the most important methods of prevention and control that have been deployed to stop the ebolavirus outbreak in the DRC has been the use of vaccinations and ring vaccination techniques. Ring vaccination consists of identifying contacts and contacts of contacts and vaccinating them to control disease spread (Wells et al., 2019). Contrasting to the West African ebolavirus outbreak in 2014, the DRC is presently using two different vaccines, both in clinical study phases. The Merck rVSV-ZEBOV vaccine was previously deployed in a phase III trial in Guinea during the 2014 West African outbreak. The vaccine was found to be highly protective in single doses, and final analyses of the trial revealed that it had high protective efficacy and effectiveness to prevent ebolavirus disease (Henao-Restrepo et al., 2017).

In mid-November of 2019, a second Ebola vaccine was deployed, in addition to the rVSV-ZEBOV vaccine, to consenting individuals in the North Kivu and Ituri provinces. The Ad26.ZEBOV/MVA-BN-Filo vaccine, produced by Johnson & Johnson, is a multivalent vaccine designed to provide protection against ebolavirus, but also to Marburg viruses, Sudan

viruses, and Tai Forest viruses (*Ad26.ZEBOV/MVA-BN-Filo Ebola Vaccine*, 2020). As of February 23, 2020, approximately 16,140 people have been vaccinated with the Ad26.ZEBOV/MVA-BN-Filo vaccine (*Ebola Virus Disease: Democratic Republic of the Congo*, 2020).

The use of vaccines has been tremendously useful in controlling the epidemic; however, it does pose challenges when being deployed to communities. The DRC is home to numerous politically volatile areas plagued with violence. This puts healthcare workers at risk and prevents more rural communities from receiving necessary vaccinations. The rVSV-ZEBOV vaccine requires transportation in temperatures of around -60°C to areas that are remote and often lack adequate roads and infrastructure. The Ad26.ZEBOV/MVA-BN-Filo vaccine needs to be given in 2 doses, 56 days apart, thus requiring follow-up appointments. Multi-dose vaccines are notoriously difficult because compliance for secondary boosters is significantly lower than the initial dose. Populations in this area are also very mobile due to unemployment and violence; therefore, follow up appointment 56 days later may prove to be difficult (Médecins Sans Frontières (MSF) International, 2019). Identifying contacts of contacts for ring vaccination is also challenging because of population mobility and displacement.

Along with vaccination, throughout the outbreak, WHO has fast-tracked the use of antibody-based therapies for ebolavirus, mAv114, ZMapp, REGN-EB3, along with the antiviral-agent, Remdesvir (Alexandra M. Medley et al., 2020). In a study conducted in November 2018, 681 confirmed ebolavirus patients from the provinces of Ituri and North Kivu were enrolled in a randomized controlled trial to test the efficacy of the four different therapeutics (Mulangu et al., 2019). An initial analysis during the trial revealed that REGN-EB3 and Mab114 showed superior efficacy in preventing death, and efficacy in these drugs

were highest for patients who were diagnosed after early onset of symptoms (Levine, 2019).

The treatments continue to be offered to patients in the DRC under compassionate use

(“Investigational monoclonal antibody to treat Ebola is safe in adults,” 2019).

2.0 Contributing Factors to the Ebolavirus Epidemic

2.1 Disease Burden and Poor Healthcare Infrastructure

The DRC has been home to one of the world's longest running humanitarian crises. In January 2020, it was ranked as the second top-most humanitarian crisis to be watched by the International Rescue Committee (*The top 10 crises the world should be watching in 2020*, 2020). At just over 5 million people, the DRC has the largest internally displaced population in Africa. Nearly 15.9 million people require humanitarian assistance and 15.6 million suffer from crisis levels of food insecurity. In 2017, the life expectancy at birth was only 60 years old, and most recent reports define the national poverty rate to be 63.9% (*Democratic Republic of the Congo*, 2019).

Historically, the DRC had a well-organized and functioning primary healthcare and referral system; however, in the last 30 years, the system has dramatically deteriorated due to political instability, social unrest, and armed conflict (Ntembwa & Van Lerberghe, 2015). The health status of the population is alarming, with the four principal causes of death being malaria, lower respiratory infection, neonatal disorders, and tuberculosis, a ranking that has not changed since 2007 (*Democratic Republic of the Congo*, 2017). Non-communicable diseases associated with epidemiological transitions account for 21% of the national burden of disease (Ntembwa & Van Lerberghe, 2015). In 2018, \$19 USD were spent per person on healthcare in the DRC, which ranks below WHO's recommended \$60 per person in order to deliver essential healthcare functions (Jowett *et al.*, 2016).

The structure of the health system in the DRC is organized into three levels. The first level, implementation, involves 516 health districts, each managed by a district team that oversees a network of health centers and a district hospital. Each district typically covers a population of 100,000 to 200,000 individuals. The second level, intermediate, is responsible for technical and logistical support and is managed by provincial health departments, which have increased from 11 to 26 in recent years. The final level, central, generally plays a normative role (Ntembwa & Van Lerberghe, 2015).

The health system is further organized by the complexity of the care facilities. Patient care starts with local health centers where providers range from non-licensed individuals with no training to nurses who have graduated from government-certified programs. The next level are primary care clinics, which are staffed by licensed nurses and are linked to secondary health centers. Secondary health centers are hospitals and clinics that house licensed medical doctors, and can provide definitive treatment, along with powers to refer patients to regional or provincial hospitals. Regional and provincial hospitals can then report and refer patients to the national hospital in Kinshasa (Jowett et al., 2016).

The process of revitalizing the health sector in the DRC began in 2005 with the adoption of the Health Systems Strengthening Strategy (HSSS), a joint project involving the DRC's MOH and WHO's Department for Health Systems Governance in Financing. The goals of this project were to provide "a framework for reforms to overcome inefficiencies in the DRC and the marginalization of national policy-making in a context of dependency on external aid" (Ntembwa & Van Lerberghe, 2015).

The DRC's healthcare system, leading up to revitalization processes, was characterized by inefficient use of international and domestic resources. Specific downfalls

of the system included: disproportionate management costs, waste and duplication because of fragmented services and programs, organizational and managerial inefficiencies, unproductive deployment of workforce, along with duplication of supply chains for medicines and health products (Ntembwa & Van Lerberghe, 2015).

Duplication and multiplicity of projects and programs within the DRC's healthcare system has led to ineffective and mismanaged deployment of resources necessary for regular health services. For example, health districts in the DRC are intended to be led by district management teams of five individuals. These positions are responsible for the development and operation of all district health services, along with supervising projects and providing follow-up and support to their respective health facilities. As externally funded disease programs started to increase within the districts, more individuals were brought on to the district management teams. Eventually, some districts had up to 18 individuals managing overlapping projects but receiving separate resources from separate funders, thus leading to excess amounts of resources that could be shared amongst multiple programs. An example of this could be that a health district team may have received a set of motorcycles to supervise immunizations activities, another set for an HIV program, and others for TB or malaria surveillance (Ntembwa & Van Lerberghe, 2015).

When the ebolavirus epidemic began in July, though healthcare centers were widespread, many were basic, and as one doctor described "often just one room and some of them [were used] for traditional medicine". ETCs and ebolavirus transit centers were built in key locations to provide care, where proper PPE could be used by healthcare workers, and nosocomial transmission could be limited (Beaumont, 2019).

It is important to note that access to health facilities and ETCs poses a barrier to suspected and probable ebolavirus patients. Road infrastructure and transportation to necessary facilities can be challenging to individuals with limited resources (Emmanuel, 2016). Other barriers that exist for patients include geographically violent areas, geographic proximity to health facilities, and obligations as the main household caregiver.

2.2 Internal Conflict and Armed Militant Groups

Conflict and civil unrest have engulfed the DRC for decades. In the wake of the ebolavirus epidemic, in the provinces of Ituri and North Kivu, violent attacks and armed groups have made it nearly impossible to maintain control measures to stop the spread of disease. Dozens of armed groups reside in the region as remnants of regional wars sparked by the Rwandan genocide. These groups compete for control of illegal taxation, territory, and trade of resources, such as gold, timber, charcoal, fuel and illegal drugs (Ilunga Kalenga et al., 2019). Changes in lead government officials and postponements of national elections have further contributed to the hostile sociopolitical atmosphere in the DRC (*The World Bank in DRC: Overview*, 2019).

North Kivu has been characterized as the epicenter of displacement and casualties caused by internal violence (Ilunga Kalenga et al., 2019). Of the 8.3 million individuals residing in North Kivu, 2.5 million of the people are identified as displaced or refugees (Ilunga Kalenga et al., 2019). Conflict between Congolese security forces and armed militant groups have resulted in eruptions of violence targeting civilians. The violent atmosphere has displaced tens of thousands of residents into neighboring provinces and countries, such as

Rwanda and Uganda, thus making control efforts for disease spread more difficult (*Ebola Virus Disease Outbreak—Democratic Republic of the Congo, August 2018–November 2019*, 2019). The region hosts a disproportionate share of violent events and in 2018, 51% of the DRC’s total violent events and protests took place in North Kivu. The region also experienced an uptick in violent events from January 2017 to October 2018, in which a total of 800 violent events and protests occurred, resulting in 1,596 fatalities (Matfess, 2018).

Surges and increases in battles, along with civilian targeting, has been a result of continuous conflict between the Congolese government and armed military groups, including the Armed Democratic Forces (ADF). The ADF was created in 1995 and was originally founded in opposition to Ugandan government leadership. The group presently resides in the mountainous region of the DRC-Ugandan border area, a hotspot region for ebolavirus cases (Matfess, 2018). In 2013, it was estimated that the ADF had a strength of approximately 1,200 to 1,500 armed fighters located in north-east Beni in the North Kivu province (*Allied Democratic Forces (ADF)*, 2016). Violent events involving the ADF in North Kivu surged more than 140% from 2017 to 2018, with greater amounts of attacks targeting civilian populations (Matfess, 2018).

Violence has increasingly targeted ETCs, healthcare facilities, and Ebola response teams in the North Kivu region. For example, one of the first attacks on an ETC occurred in the city of Butembo on February 27, 2019. The facility was being run by Swiss MSF workers and in the early evening, assailants attempted to force entry with two cars and armed fire. Once inside, the attackers did not enter “red zone” areas, where confirmed cases resided, but went straight to the power supply and shot at it. They repeatedly demanded for a specific ICU specialist, and eventually, loss of power led to two patients dying from lack of oxygen (Wells

et al., 2019). Other attacks on ETC's have focused on destroying resources and facilities, kidnapping or killing essential healthcare personnel, and overall disruption of care for the critically infected. Between January and November 2019, 43 arson attacks on health facilities in the DRC were reported, occurring in areas where armed groups operate, and community levels of distrust were high. Motives of these attacks remain unclear to authorities, along with the specific identities of perpetrator groups (*Attacks on health care in the context of the Ebola emergency response in the Democratic Republic of the Congo*, 2019).

When treatment centers are targeted, Ebola response efforts, such as contact tracing, investigation of suspected cases, and ring vaccination are stalled, thus resulting in increases in new Ebola cases. Attacks on public spaces and resources also prevent response teams from contact tracing and case investigations (McClellan, 2017). It is important to note that contact tracing is essential for the control of infection because it allows proper deployment of ring vaccination techniques. For example, in May 2018, the DRC experienced an ebolavirus outbreak; however, it was controlled in two and a half months because of continuous contact tracing and correct distribution of the rVSV-ZEBOV vaccine (Wells et al., 2019).

Insecurity and violence in this region have put healthcare workers at risk. The DRC's MOH and other international organizations, such as Medecins Sans Frontieres (MSF), have been forced to leave certain areas of the DRC at different points during the outbreak because the safety of frontline healthcare workers took precedent over response efforts. Other efforts were stalled because of violent episodes, characterized by kidnappings and killings, prohibited healthcare professionals from operating around the major road connecting the North Kivu and Ituri provinces (Wells et al., 2019). These gaps in

surveillance, vaccination, and contact tracing lead to upticks in cases and prevents the outbreak from being controlled (Krenn, 2019).

2.3 Community Mistrust

Lack of confidence in ebolavirus responses are driven by perceptions of inadequate patient care, callous adherence to protocol, disrespectful handling of corpses (Masumbuko Claude et al., 2019), financial motivations of large health institutions, and ingrained distrust of state and militant organizations (Ilunga Kalenga et al., 2019). Misinformation and lack of understanding of the disease amplifies mistrust within communities, and further discourages people from seeking treatment at an ETC or receiving a vaccination (Krenn, 2019).

Community reluctance towards ebolavirus prevention strategies were initially interpreted as a misunderstanding of public health practices. Further investigations revealed that these practices had interfered with important cultural and social values of the communities, such as requiring total separation from loved ones, denial of human touch at the point of death, and the substitution of safe burials for traditional burial rites (Ilunga Kalenga et al., 2019). A secondary source of animosity towards foreign response teams revolves around the idea of “disaster capitalism”. Some communities believed that foreign response teams were motivated by profit from the continued response efforts, as evidenced by delays in responding to potentially infected patients and corpses and perceived sluggish roll out of interventions (Masumbuko Claude et al., 2019).

Longitudinal data reported by the Harvard Humanitarian Initiative found that the North Kivu region had declining perceptions of security and trust in the government,

security, and humanitarian workers, which further complicates response measures employed by local and foreign health authorities (Vinck et al., 2019). The study also found that a lack of understanding of the disease and a lack trust in institutions trying and failing to deploy control strategies in the past have discouraged individuals to seek out medical attention from Ebola treatment facilities (Krenn, 2019). Community mistrust is further exacerbated by historical attacks from Congolese security forces. In the past, certain members of the Congolese army have been implicated in human rights abuses, such as killings, summary executions, rapes, pillage, and trafficking of minerals. Officials say they often cannot distinguish between the Congolese army and MOH officials, who are there to treat Ebola. “The [Congolese] Government is criticized for not doing enough to make it safe. The UN is judged to be complicit in the massacres here, and for not protecting the population except for a few battalions. And NGOs, people think they are here just to make money’, says N’djoloko Tambwe, an MOH representative, summarizing research from anthropologists on his team,” (Moran, 2018).

Social mobilization and risk communication were essential features of the response to the 2014 West African Ebola epidemic. In Sierra Leone, when case reports were at its peak, individuals’ attitudes towards healthcare worker interactions, accountability in health resource management, and visitations to Ebola Treatment Units were at an all-time low (Nuriddin et al., 2018). As transmission began to wane, along with Ebola survivors leaving ETCs and reentering their communities, community trust in prevention and treatment efforts increased. In a study focusing on social resistance in communities, 77% of respondents agreed or strongly agreed that the epidemic would persist if local communities continue to not be engaged (Masumbuko Claude et al., 2019). One of the main focuses of the World Health

Organization's tactics in controlling the epidemic is employing risk communication, social mobilization, and community engagement. As of late January 2020, WHO continues to host educational discussions, mass awareness-raising, and community dialogues to increase health literacy and community trust. Topics of discussion include the importance of vaccination against ebolavirus disease, the importance of consulting health facilities and ETCs, along with prevention measures against ebolavirus (*Ebola Virus Disease: Democratic Republic of the Congo External Situation Report*, 2020).

Early reports based off these community engagement strategies have found to be successful. It is unclear as to what specific elements of the strategy drove reduction in cases; however, several indicators suggest a combination of different factors may have played a role. For instance, improved community dialogue permitted better access to health zones, reducing the number of health zones that were inaccessible due to hostile groups and reducing the number of health zones with community resistance. Improved acceptance likely allowed improvements in all aspects of intervention and surveillance (Jombart et al., 2020).

2.4 Unique Geographic Boundaries

The geographic boundaries of the current epidemic pose unique challenges for ongoing response efforts. In the past, outbreaks have occurred in remote and hard to reach areas. The current outbreak is one of the first to reach urban environments. North Kivu is a densely populated area, which shares a border with Uganda. Large portions of the population travel for trade and business between neighboring countries in the east, posing the risk of cases entering areas outside of the DRC (Sikakulya et al., 2020). The province is a hub for travel and trade, as

well as human trafficking. It also has been an area marked with armed conflict for the past 25 years (Theunis, 2018). Geographic and travel limitations pose challenges for both patients and healthcare workers due to increasing violence and political unrest. The unique geographic boundaries and political climate of the area have made it difficult to disseminate information to more rural communities, along with providing necessary response mechanisms, such as surveillance, contact tracing, and vaccination.

POE screenings have been employed to mitigate the risk of Ebola patients from exiting the country, along with establishing travel and trade health measures. Communication with governments of neighboring countries has also been employed to best reduce the risk of cross-border cases (*Ebola Virus Disease: Democratic Republic of the Congo External Situation Report*, 2020).

3.0 Looking to the Future

3.1 Long Term Impacts

While it is important to focus on response and intervention methods to stop the spread of disease in the DRC, further understanding of the long-term effects of the outbreak will be necessary for recovery efforts. We can begin to predict and understand long-term impacts of the epidemic in the DRC by looking at past ebolavirus epidemics, such as the 2014 West African epidemic. Though the DRC has a fraction of the cases compared to that of West Africa, healthcare infrastructure and resource acquirement and allocation are noticeably similar. During the 2014 West African Ebola epidemic, the countries largely affected by disease burden, Guinea, Liberia, and Sierra Leone, suffered from large socioeconomic consequences. The epidemic had caused major setbacks for treatments and control of endemic infectious diseases, such as HIV, tuberculosis, and malaria. Routine health services, such as maternity care, childhood vaccinations, and HIV testing, were interrupted, with an estimated reduction of 50% of healthcare services (Parpia et al., 2016). Agriculture accounts for 57%, 39%, and 20% of Guinea's, Liberia's, and Sierra Leone's gross domestic products (GDP) respectively, and according to the Food and Agriculture Organization of the UN, the percentage of traders decreased by 20%, leading to total economic losses of approximately \$2.8 billion (Dakar, 2016).

As the situation in the DRC continues to decline in cases and geographic spread, we are already beginning to see the losses in economic productivity and routine health practices. In a study published in September 2019, researchers looked at the economic burden the

outbreak had on the economy of the DRC. They found that the monetary value of human lives lost (MVYLL) to the ebolavirus outbreak between May 8th, 2018 and May 27th, 2019 was \$13,801 USD for each of the 1,286 lives lost. This resulted in a total MVYLL of \$17,761,539 USD for the entire country (Kirigia et al., 2019). North Kivu and Ituri have already lost significant agricultural production due to violence and conflict in the region; however, the Ebola epidemic has further exacerbated this loss. As the outbreak worsened in Ituri and North Kivu, resources for routine healthcare in the DRC were depleted and redirected towards Ebola response. This has led to disruptions in routine healthcare and childhood vaccination schedules. In 2019, the DRC reported one of the largest and most fatal outbreaks of measles across the world. It had affected 26 provinces, and as of January 7th, 2020, the DRC amassed a reported 310,000 suspected measles cases resulting in over 6,000 deaths. A majority of these cases had occurred in children under the age of five and had been a result of under vaccination (Andrada, 2020). A complete illustration of the impact of ebolavirus on the DRC cannot be fully understood in the present; however, based on past Ebola outbreaks in countries of similar economic and resource statuses, we can expect to see declines in healthcare, food security, and overall well-being of its inhabitants.

3.2 What Needs to be Done?

Since the start of 2020, the epidemic has slowly declined in spread and reported cases, with only five new reported cases in the past 21 days and cases being confined to two health areas within North Kivu (*Ebola Virus Disease: Democratic Republic of the Congo External Situation Report*, 2020). Though response partners are cautiously

optimistic with the overall trend and reduced geographic spread, the question remains: how do we end the outbreak and mitigate the risks of disease resurgence?

In an article published by NPR in January 2020, several health professionals directly involved in response efforts were asked the question: What can we do to end the outbreak? Responses to the question involved ideas of increasing levels of safety for healthcare workers and bolstering the healthcare infrastructure of the DRC.

Dr. Marie Roseline, a field coordinator with WHO, who worked in a facility that was attacked by an armed group, stated that the government and other partnering organizations needed to ensure Ebola responders' safety when traveling from one hotspot to the next. Travel time had to be cut down from treatment and response centers for daily surveillance and prevention measures to occur.

David Gressly, a U.N. emergency Ebola response coordinator, argued that providing more armed guards to protect healthcare workers would ensure healthcare worker safety, and would allow communities affected by conflict to have the proper prevention and response resources. However, Brian Moller, an emergency coordinator for Doctors Without Borders in North Kivu, says that more armed guards will likely backfire, especially if they are stationed at or near healthcare facilities. Years of abuse at the hands of the Congo's military has led to great mistrust from the local population. Combined with recent attacks from armed rebel groups, communities have protested the military and U.N. peacekeepers for failing to protect them from violence.

Others argue that bolstering the DRC's healthcare system would help end the epidemic and provide long term tools to assist in the prevention of future outbreaks. During the early phases of the outbreak, the Ebola response was largely a standalone effort, rather

than a collaboration with the DRC's existing network of healthcare centers. When the epidemic officially ends, healthcare centers need to be prepared for the likelihood of disease resurgence by having appropriate resources and tools allocated to infectious disease response (Aizenman, 2020).

WHO reports that in order to maintain a pattern of reduced spread and continued decline of cases, access and security to communities needs to be prioritized. It is critical to maintain response capacities to rapidly detect and respond to reintroduction events, and to prioritize survivor monitoring and the maintenance of cooperative relationships with the survivors' associations (*Ebola Virus Disease: Democratic Republic of the Congo External Situation Report*, 2020).

4.0 Discussion and Conclusions

Ebolavirus is a highly infectious agent that has severely affected the North Kivu and Ituri provinces of the DRC. The epidemic has led to nearly 3,444 cases within this region and caused 2,130 deaths, resulting in a CFR of 66%. The number of cases and deaths is likely much higher due to under reporting in rural and hard to reach communities. Controlling the outbreak and deploying resources to areas in need have been proven to be difficult due to poor healthcare infrastructure, presence of political conflict and armed militant groups, community mistrust, and the unique geographic characteristics of the eastern DRC. These issues have led to challenges in dissemination of correct information regarding methods of treatment and control, along with identifying and following-up with confirmed and suspected cases. The use of vaccinations and community mobilization have shown to be successful in limiting the transmission of cases and relaying patients to proper care facilities; however, armed conflict groups and attacks on healthcare workers and treatment centers have interfered with response measures. Continued surveillance and community support are vital for the continued decline of reported cases and geographic spread of the disease. The safety of frontline healthcare workers also needs to be prioritized because they play a primary role in controlling the transmission of the disease and the treatment of patients. As national and international organizations move forward in the aftermath of the epidemic, resources and assistance need to be directed towards bolstering the weakened healthcare infrastructure of the DRC. Access to routine health practices, vaccination schedules, and regular surveillance will assist in the prevention of a resurgence of Ebola. It is likely that cases of Ebola will occur in the future, however a prepared national health system will help prevent an epidemic of this severity again.

In conclusion, this essay provides a narrative of the present Ebola epidemic in the DRC and outlines the contributing factors that have led to difficulties in controlling the spread of disease. It is important to study Ebola epidemics, such as that in the DRC, because it can further advance methods of preparedness and response in areas of political instability and resource scarcity

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