

HUMAN EBOLA VIRUS DISEASE OUTBREAK IN SUB SAHARAN AFRICA: IMPLICATION FOR BORDER TOWNS ACROSS THE GLOBE

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ABSTRACT

Introduction: Ebola virus disease (EVD) is a zoonotic disease that has affected humans especially in sub Saharan Africa (SSA) for the past four decades with case fatality rate up to about 90%. As at September 2015, the recent EVD in West Africa has led to 11 306 deaths out of 28 200 cases reported from 10 countries.

Objective: Firstly, to provide the EVD epidemic profile in SSA. Secondly, is to identify the location and spread of EVD outbreaks in SSA from 1976 to 2014. Thirdly, is to examine the implication of the spread for border towns across the globe.

Methods: A systematic review of research on Ebola virus disease in sub-Saharan Africa. Search focused on nine databases: EBSCO host (Discovery), Academic Search Complete, AJOL, Google Scholar, Pub Med, Medline, Health Source, CINAHL Complete and Bio Medical Central. An additional search of reference lists of relevant papers was also conducted.

Results: The review highlighted the increasing frequency of EVD outbreaks, mobility and mortality with the geographical niche of EVD expanding from east to west of SSA, and border regions being high risk area. Border towns have double risk of Ebola epidemic. More especially border towns that lie within the geographical niche of EVD SSA across the globe.

Conclusions: The changing patterns in the spread of EVD calls for holistic preparedness which comes from well informed individuals, communities, regions, countries and the international community as a whole to combat Ebola outbreaks in the future. This paper therefore suggests that border towns across the globe need to prepare for any contingency through capacity building and Ebola awareness creation and education.

KEYWORDS: Epidemiology of Outbreak, Epidemic, Ebola Disease, Haemorrhagic Fever, Location, Spread, Sub-Saharan Africa

INTRODUCTION

Ebola virus disease (EVD), formerly known as the Ebola haemorrhagic fever is caused by Ebola virus, which was first identified about four decades ago is a zoonotic disease, with high fatality rates of up to 90% in humans (Bausch et al., 2014; Bellizzi, 2014; Dhama et al., 2015; Heymann et al., 1980; Okware et al., 2002; PAHO/WHO, 2014; Yamin et al., 2015). In Sub-Saharan Africa (SSA), EVD first appeared in 1976 in two simultaneous outbreaks in Sudan (Nzara) and in Yambuku of the Democratic Republic of Congo (DRC). The latter occurred in a village near the Ebola River, from which

the disease takes its name. The Ebola virus belongs to the Filoviridae virus family which includes three genera: Cuevavirus, Marburg virus and Ebola virus (Cenciarelli et al., 2015; Dixon et al., 2014; Hayman et al., 2015; Mirazimi, 2015)

The Ebola virus can be classified into five distinct virus which are the Zaire Ebola virus (EBOV), Sudan Ebola virus (SUDV), Bundibugyo Ebola virus (BDBV), Tai Forest Ebola virus (TAFV) and Reston Ebola virus (RDV) (Baştuğ et al., 2015). The most lethal is the Zaire Ebola virus, Reston Ebola virus is not known to cause disease in human and Tai Forest Ebola virus has only been reported in one human case (Van Kerkhove et al., 2015 :1). Ebola virus is introduced into the human population through close contact with body fluid of an infected person from an animal host (Roddy, 2014). Symptoms of EVD range from, firstly, fever and fatigue before descending into headaches, vomiting, violent diarrhoea, then multiple organ failure and massive internal bleeding (Tambo et al., 2014). Currently, there are no proven cures or vaccine or even specific treatment available to prevent this infection, so supportive care for severely ill patients focuses on alleviating the symptoms. (Amandu, et al., 2015; Getz et al., 2015; Ndambi et al., 1999; Zhang et al., 2014). EVD begins in remote places and can be distributed through healthcare centres or within the community as it takes several infections before the disease is ascertained.

Recent research has implicated fruit bats of multiple species as natural reservoirs, scientists are not certain and the possible search for a possible reservoir is ongoing (Leroy et al., 2009; Roddy, 2014). As at September 2015, the 2014 West Africa Ebola outbreak alone has claimed 11 306 deaths out of 28 200 cases reported from 10 countries (CDC, 2015) making the 2014 West Africa outbreak several times larger than all previous outbreaks combined (Alexander et al., 2015). This calls for more research on EVD in the past and now however, not much work has been done on the location and the spread of EVD.

Hence, this paper outlines (1) The EVD epidemic profile, (2) The location and the spread of the various outbreaks in SSA and (3) To examine the implication of the spread EVD for border towns. This review highlights the gaps in knowledge of the spread of human EVD in SSA so as to help various stakeholders in high-risk areas prepare for any possible EVD outbreak.

METHODS

Search Strategy

Articles were retrieved from nine electronic databases: EBSCO host (Discovery), Academic Search Complete, AJOL, Google Scholar, Pub Med, Medline, Health Source, CINAHL Complete and Bio Med Central. An additional search of reference lists of relevant papers was conducted. Search terms included were : “Epidemiology of outbreak (epidemic)”, “Ebola disease (haemorrhagic fever)”, “Sudan”, “Gabon”, “Uganda”, “West Africa”, “Congo”. The search was restricted to the period of 1976 to September, 2015. In all, a total number of twenty (20) articles were reviewed.

Study Selection

This paper included descriptive studies, Ebola reports, conference proceedings and articles published in peer reviewed journals looking at the EVD epidemic profile, the location and spread of EVD in SSA. The literature searched yielded 22 738 articles (Figure 1). Out of which, 22 635 were excluded because they are not related to human subjects, Africa and sub-Saharan Africa, Ebola virus and duplication. The remaining 103 articles were screened by title, abstract and language and 71 articles were excluded. Subsequently, 32 articles were assessed for eligibility and 12 articles were

excluded with reason leaving 20 articles to be reviewed.

Description of Studies

Overall, 20 studies were included in the systematic review (Figure 1). The studies from West Africa (n = 2), Cote d’Ivoire (n = 1), Liberia (n = 1), and Guinea (n = 1). Studies from Central Africa include Republic of Congo (n =1), Demographic Republic of Congo (n=6) and Gabon (n= 2). Studies from East Africa includes Uganda (n =3) and South Sudan (n = 3). Studies were mainly descriptive on the various outbreaks. Fifteen (15) of the studies took place in the rural setting while five (5) occurred in urban setting.

Summary of EVD Outbreak Profile in SSA

Table 1: Summary of EVD Outbreak Profile in SSA

Sub Region	Country/Year/Town	Cases (Cfr)	Transmission Route
<i>East Africa</i>	Sudan 1976 Nzara/Maridi in WES	248(53%)	Animal to human
	Sudan 1979 Nzara/Yambio in WES	34(65%)	Animal to human
	Sudan 2004 Yambio in WES	17(41%)	Animal to human
	Uganda 2000-2001 Gulu	425(53%)	Animal to Human
	Uganda 2007 Bundibugyo	116(34%)	Animal to human
	Uganda 2011 Luwero	1(100%)	Animal to human
	Uganda 2012 Kibaale	24 (67%)	Animal to human
	Uganda 2012-2013 Luwero	6 (67%)	Animal to human
<i>Central Africa</i>	DRC 1976 Yambuku	318 (88%)	Animal to human
	DRC 1977 Tandala	1 (100%)	Animal to human
	DRC 1995 Kikwit	315 (81%)	Animal to human
	DRC 2007 Occidental Kasai	246 (71%)	Animal to human
	DRC 2008 Boende	32 (43.8%)	Animal to human
	DRC 2012 Isiro	36(54.8%)	Animal to human
	DRC 2014 Boende	67 (74%)	Animal to human
	ROC 2001-2002 Cuvette Quest	57 (73.7%)	Animal to human
	ROC 2002-2003 Cuvette Quest	143 (89.5%)	Animal to human
	ROC 2003 Cuvette Quest	35 (82.9%)	Animal to human
	ROC 2005 Cuvette Quest	12 (83%)	Animal to human
	Gabon 1996 Booue in Ivindo province	52(60%)	Animal to human
	Gabon 1996 Booue in Ivindo province	24 (70.8%)	Animal to human
	Gabon 1996-1997 Booue in Ivindo province	60 (74%)	Animal to human
Gabon 2001-2002 Ivindo province	65 (84.6%)	Animal to human	
<i>Southern Africa</i>	South Africa Johannesburg 1997	2 (50%)	Human to human
<i>West Africa</i>	Cote D’Ivoire 1994 Tai Forest	1 (0%)	Animal to human
	Guinea 2014 (Gueckedou)		Animal to human
	Liberia 2014 Foya	6,878 (40.88%)	Human to human
	Sierra Leon 2014	5,586 (21.45%)	Humana to human
	Nigeria 2014 Lagos	20 (40%0	Human to human
	Mali 2014	4 (75%)	Human to human
	Senegal 2014 Dakar	1 (0%)	Human to human

Western Equatorial State (WES)

Source: (Alexander et al., 2015; Baron et al., 1983;Formenty et al., 1999; Gatherer, 2014; Georges et al., 1999; Heymann et al., 1980; Khan et al., 1999; Kratz et al., 2015; Lamunu et al., 2004; Leroy et al., 2009; Maganga et al., 2014; Nkoghe et al., 2011; Okware et al., 2015; Oleribe et al., 2015; Shoemaker et al., 2012; WHO, 1978a, 1978b, 2003, 2005).

DISCUSSIONS

The virus type that caused the EVD in literature were Zaire Ebola virus (n= 16), Sudan Ebola virus (n= 7), Bundibugyo Ebola virus (n=2) and Tai Forest Ebola virus (n=1). One paper reviewed all the outbreaks in Democratic Republic of Congo (DRC) and two papers on Gabon with one of the papers also describing the South Africa case. Three papers each reviewed all the outbreaks in Sudan and Uganda. We found two on West Africa, one each on Liberia, Guinea, and Cote d'Ivoire. Six papers described all the seven outbreaks in DRC. Three articles included in literature review were WHO documents.

The review is organized into three sections based on the aim of the paper. First section looks at Ebola epidemic profile in SSA from 1976 to 2014. The second section briefly describes the location of the various EVD outbreaks. This is followed by the third section which discusses the implication of the spread of EVD for border towns across the globe.

Ebola Epidemic Profile in SSA from 1976 to 2014

A number of literatures has examined EVD in East Africa and has recorded eight (8) EVD epidemics, all occurring in South Sudan and Uganda. Sudan recorded three epidemics in 1976, 1979 and 2004; all were caused by Sudan Ebola virus (SUDV) and occurred in the Western Equatorial State. According to WHO (1978) East Africa recorded the first documented EVD in SSA in June 1976, in Nzara and Maridi villages with the index case being an employee of a cotton factory in Nzara. The resultant epidemic recorded 284 cases with case fatality rate (CFR) of 53%. Baron, et al (1983) indicated that, Sudan was again hit by EVD in 1979 in the villages of Nzara and Yam bio with the index case again being an employee of the same cotton factory recorded in the previous outbreak. In all, 34 cases and CFR of 65% were recorded (Baron, et al.,1983). In a WHO (2005) report Sudan recorded another outbreak in 2004 in Yam bio with 17cases and CFR of 41%.

Five (5) EVD epidemic has been documented in Uganda all occurring in 2000, 2007, 2011, 2012 and 2012- 2013 respectively. With the exception of the 2007 epidemic which was caused by BDBV, all the rest were caused by SUDV. In a research by Lamunu et al., (2004) Uganda recorded its first EVD outbreak in 2000 in Gulu in the Northern Acholi Region and spread to the cities of Mbarara and Masindi, with a total of 425 cases with CFR of 53%. Okware et al., (2015) in 2007 documented the new Bundibugyo Ebola virus species which was identified in a 26-year-old pregnant woman from Kabango village in Kasitu of Bundibugyo district. In total, 116 cases and CFR of 34% was recorded. Further, Shoemaker et al.,(2012) recorded an isolated case in 2011 with CFR of 100%. The Index case of a 12-year-old girl from Nakisamata village in Luwero District of Uganda Again, Okware et al., (2015) documented Uganda's fourth EVD outbreak in July 2012 occurring in Kibaale district with the index case, a 16 year old female from Kikaara. The outbreak recorded 24 cases and CFR of 67%. Furthermore, Okware et al., (2015) provided an account on the fifth outbreak which started in October 2012 in Luwero district with a 30 year old man recording 6 cases with CFR of 67%.

Ebola Outbreaks in Central Africa

Several researchers indicate that Central Africa has recorded fourteen (14) EVD epidemic occurring in Gabon, Republic of Congo (ROC) and Democratic Republic of Congo (DRC) with four(4) for the two countries and seven(7) outbreaks respectively. All fourteen outbreaks were caused by the EBOV, with the exception of the 2012 DRC epidemic which was caused by BDBV(Alexander et al., 2015; Heymann et al.,1980; Khan et al., 1999; Kratz et al., 2015; Leroy et al., 2009; Nkoghe et al., 2011; WHO, 1978b). According to WHO (1978), Democratic Republic of Congo (DRC) recorded

her first Ebola outbreak in September 1976 in Yambuku close to the Sudanese boarder where Sudan's first case was recorded. A total of 318 cases and CFR of 88% was recorded. Heymann et al (1980) discovered that EVD made its second appearance in 1977, infecting a 9-year-old girl living in Tandala, a DRC town close to the border with Central Africa Republic (CAR) and Yambuku. Khan, et al., (1999) reported on the DRC 1995 outbreak which recorded 315 cases and CFR of 81%. The index case of a 42-year-old male charcoal maker in the forest of Mwembe but a resident of Kikwit was recorded. Leroy et al (2009) recorded that in 2007, another outbreak hit DRC in Mweka and Luebo of Occidental Kasai. A total of 69 cases and CFR of 71% was recorded with an index case likely to be a 55-year-old woman who lived in Ndongo. They further document another outbreak from 2008-2009 in Inkanamongo village in the vicinity of Boende town in Equateur province. In all 32 cases and CFR of 43.8% was recorded, and index case was believed to be an 18 years old girl. Kratz et al., (2015) indicated that the sixth DRC- EVD outbreak occurred in 2012 with 36 cases and 54.8% CFR in Isiro, the capital of Haut-Uele District, Province Orientale both the index case and the source of infection was not known (Kratz et al., 2015). Alexander et al., (2015) and Maganga et al (2014) gave an account of the 2014 Boende, DRC Ebola outbreak. The index case was a pregnant woman who handled bush meat(Maganga et al., 2014). In all a total of 67 cases and CFR of 74% occurred.

Georges et al. (1999) and WHO (2003) indicated that, Gabon have had four successive EVD outbreaks in 1994, 1996, 1997 and 2001-2002. The Gabon- Makouka 1994 outbreak involved gold-diggers in the Mekouka, Andock and Minke be Forest of the OgooueIvindo province who had killed a sick gorilla for food. In total, 52 cases with 60% mortality were recorded. Again, Georges et al (1999) recorded in 1996, the second outbreak in Gabon which hit the villages of Mayi bout I and II, located near Mekouka in OgooueIvindo province the site of the first outbreak. The index cases were 18 children in Mayi bout II village who had helped to carry and butcher a chimpanzee carcass found in the forest. In total, this outbreak affected 37 people with mortality rate of 57% (Georges et al., 1999).They further noted that the third outbreak occurred in the Booue of OgooueIvindo province in 1997 with the index case being a hunter. In all, 60 cases with CFR of 74% were recorded. This outbreak caused an isolated case in South Africa (Georges et al., 1999). In 2001-2002, OgooueIvindo province, was again affected by a fourth epidemic causing 65 cases with 82% mortality with the index case coming into contact with either gorilla, monkey and chimpanzee(WHO, 2003).

In the studies of Nkoghe et al (2011), Republic of the Congo was struck by four successive Ebola outbreaks, 2001-2002, 2002-2003, 2003 and 2005. In 2001-2002, two independent index cases were infected with EVD while poaching gorilla carcasses in the villages of Olloba and Entsiami in Mbomo and Kelle Districts of Cuvette Ouest Region. In all, 57 cases with CFR of 73.7% was recorded (Nkoghe, et al., 2011). They further noted that in 2002-2003, EVD re-emerge affecting 143 individuals in Mbomo and Kelle of the same Cuvette Ouest Region and 128 deaths were recorded(Nkoghe et al., 2011).

Furthermore, Nkoghe (2011) recorded in 2003, the third EVD outbreak in ROC which occurred at Mbandza village in Mbomo District of Cuvette Ouest Region. In all 35 case with CFR of 82.9% was recorded. The index cases were infected after handling and consuming the carcass of a great white nose monkey (Nkoghe et al., 2011). In 2005 another EVD erupted in ROC town of Etoumbi in the Cuvette Ouest County with two index cases who were infected while poaching. A total of 12 cases with CFR of 83% were noted (Nkoghe et al., 2011).

Ebola Outbreaks in Southern Africa

Georges and his team studied "Ebola Haemorrhagic Fever Outbreak in Gabon" and noted that the 1997 EDV in

South Africa was caused by a sick Gabonese physician who travelled to Johannesburg for medical treatment. There, he infected a nurse who died a few days later but he survived (Georges et al., 1999).

Ebola Outbreaks in West Africa

Formenty et al (1999) pointed out that in 1994 EVD appeared in Cote d'Ivoire which led to the discovery of a new species of Ebola virus, Tai Forest Ebola virus (TAFV). The index case and the only case was an ethnologist who was infected whilst performing an autopsy on a dead chimpanzee.

In the study of Oleribe et al., (2015) and Alexander et al., (2015), in 2014 EVD hit the sub region with the index case being two-year-old in Guéckédou, Guinea, a small village bordering Sierra Leone and Liberia. The outbreak spread mainly through major capitals including the capitals of Guinea, Liberia, Nigeria and Sierra Leone. As of September 2015, WHO has reported 28,200 cases and 11,306 death (CDC, 2015). According to Oleribe et al., (2015), the first case, which was imported to Nigeria, was through a commercial airline and within days the disease spread to Lagos and Port Harcourt, Abuja, Ibadan and Ille-Ife, 20 cases with 8 deaths. Senegal had one case being a student from Guinea Conakry who travelled to Senegal. Due to interventions put in place the case was confirmed early and treated (Oleribe et al., 2015). Both Mali and Sierra Leone reported cases which were imported from Guinea with Mali reporting 4 cases with 75% mortality and Sierra Leone reporting 5,586 cases 21.45% with mortality (Oleribe et al., 2015).

Location and Spread of EVD in SSA

Given the observation made in literature, EVD has mainly been centred in the remote, rural forest zones of Sudan and DRC (Pigott et al., 2014). However, in 1994 a non-fatal case of EVD appeared in the rural Tai forest of Cote d'Ivoire (Formenty et al., 1999). Since then, the incidence of EVD has increased and limited to the rural forest zone of East and Central Africa. In their study of the 2013 West Africa outbreak Oleribe et al., (2015), also noted that EVD appeared in Gueckedou, Guinea, a small village bordering Sierra Leone and Liberia. They equally observed the widespread importation of EVD to capitals of Guinea, Sierra Leone, Liberia, Nigeria, Senegal and Mali (Oleribe et al., 2015). In most of the affected countries, the disease has circulated in few areas within the same country. For instance, all four outbreaks in ROC happened in rural areas of Cuvette Quest Region (Nkoghe et al., 2011). Sudan's outbreaks took place in the villages of Nzara, Maridi and Yambio (Baron et al., 1983; WHO, 1978a, 2005). Also, two each of the outbreak in DRC and Gabon took place in occidental Kasai province and Booue respectively (Georges et al., 1999; Kratz et al., 2015; Leroy et al., 2009). However, the recent West Africa outbreak started in Guinea and spread to other West Africa countries and beyond (Oleribe et al., 2015).

This review highlights the fact that the geographic range of EVD is apparently expanding from the east to the west of SSA. However, all outbreaks were within the tropical rain forest zone. Peterson et al., (2004) indicate that, more than 50% of African evergreen forest is predicted to be within the niche of Ebola. Since its discovery in 1976, the 26 EVD outbreaks in Africa have all occurred within 10° north and south of the equator except the South Africa imported episode (Groseth et al., 2007). In the past spread of cases over longer distances is often associated with treatment seeking, which mostly involves domestic land travel as documented in the first Sudan outbreak where patients left Nzara to Khartoum (WHO, 1978a). In some instances, international importation by air travel have been documented in the Gabon case to South Africa case (Georges et al., 1999), However in recent times the spread of the disease to other countries has been associated with both medical and other factors. For instance the index case in Senegal was a Senegalese student who

attends university in Guinea and imported the disease to Senegal on one of his vacations (Oleribe et al., 2015). Also the disease was imported to Nigeria by air by a Liberian who was attending a conference (Oleribe et al., 2015).

Interestingly, with the exception of the 2000, 2011 and 2013 outbreaks in Uganda, as well as 1995, 2007, 2008 and 2014 outbreaks in DRC, all reported EVD outbreaks seem to be associated with the region near borders. For instance border towns like Yambio (Sudan), Olloba and Entsiami (ROC), Gueckedou (Guinea) have all played major roles in the spread of EVD in SSA (Alexander et al., 2015; Baron et al., 1983; Bausch et al., 2014; Nkoghe et al., 2011). In a well-documented study, Pourrut et al., (2005) noted that between 1976 and 2005 not less than seven (7) outbreaks started from boarder regions of SSA. However this review suggest that, all the South Sudan outbreaks, ROC outbreaks from 2001 to 2004 and Gabon outbreak from 1994 to 1997 occurred in the border regions. Also DRC outbreak in 1976, 1977 and 2012 as well as Cote d'Ivoire outbreak have been documented to have occurred in border regions (Baron et al., 1983; Formenty et al., 1999; Georges et al., 1999; Heymann, 1980; Nkoghe et al., 2011;WHO, 1978a, 1978b). These findings bring to light the fact that border regions are at risk to EVD outbreaks in SSA.

Implication for Border Towns across the Globe

Globalization and internationalization have made migration easy for people to move across the globe with ease in search of opportunities. Mobility by air, land and sea of people seem to support the spread of EVD outbreak across the globe. Review of literature has shown that migration has played important role in the spread of EVD in SSA with border towns being the high risk area of EVD outbreak and this has implication for border towns across the globe. The reviewed also affirmed the fact that EVD is not only in the SSA but people import the EVD to other parts of the world knowingly and unknowingly. For example, during the Liberia outbreak people moved to the United States in search of treatment knowingly with the virus in search of treatment. While others also moved to the United States unknowingly with the Virus through their border towns (Chowell, et al, 2015; Rubin et al, 2014; Liddell et al., 2015; Lyon et al., 2014; Oleribe et al., 2015).

Review has shown that border towns are high risk areas of EVD outbreak in SSA. Several research indicate that, out of a total of 26 EVD outbreaks in SSA, 19 had occurred in border regions(CDC, 2015; Pourrut et al., 2005). With the exception of the 2000, 2011 and 2013 outbreaks in Uganda(Okware et al., 2015; Towner et al., 2008), as well as 1995, 2007, 2008 and 2014 outbreaks in DRC(Alexander et al., 2015; Leroy et al., 2009), all reported EVD outbreaks seem to be associated with the region near borders.

Although importation of EVD by sea (water) has not been documented, research on the first outbreak in Yambuku, DRC which was located near the Ebola River suggest that EVD patients were transported across the river to seek health transported the disease to the various health centres.. However, international importation of EVD by air travel have been documented in the Gabon to South Africa case (Georges et al., 1999), Liberia to Nigeria and from Africa to the other parts of the world (Chowell, et al, 2015; Rubin et al, 2014; Liddell et al., 2015; Lyon et al., 2014; Oleribe et al., 2015). Also, domestic land travel has been documented in the first Sudan outbreak where patients left Nzara to Khartoum (WHO, 1978), Guinea to Liberia, Guinea to Sierra Leone (Oleribe et al., 2015).These routes of transportation has aided the spread of EVD in SSA and could play a major role in the spread of the disease in any possibly EVD outbreak in the W/R. Since its discovery in 1976, the 26 EVD outbreaks in Africa have all occurred within EVD geographical niche of 10°north and south of the equator except the South Africa, Mali and Senegal imported episodes (Groseth et al., 2007). The research affirmed the fact that Ebola in sub-Saharan Africa are said to be constantly moving across the borders. Border community

inhabitants often have socioeconomic and cultural relationships. This has led to a situation where suspected border cases and confirmed cases have moved across borders in public road transport and air transport accordingly (Chowell, et al, 2015; Rubin et al, 2014; Liddell et al., 2015; Lyon et al., 2014; Oleribe et al., 2015).

This review highlights the fact that the geographical range of EVD is apparently expanding from the east to the west of SSA with all outbreaks within the tropical rain forest zone except the South Africa episode (Peterson et al., 2004). Border towns which are located in the heart of this tropical rain forest also put their region of risk of a future EVD outbreak. For example border towns located in the forest zone of SSA where almost all EVD outbreaks had occurred. Secondly, border towns situated within the EVD geographical niche of 10 ° north and south of the equator are high risk of EDV outbreak. Lastly, town which are better connected internally and internationally by land, air and sea transportation can aid the importation and exportation of disease across the globe. Again, the research reviewed showed that SSA EVD outbreaks entry point is through border towns. Therefore border towns across the globe stand high risk of being affected and effected with EVD.

A key part of maintaining this momentum is continuing to create incentives for innovation and environments where it can take place. Countries across the Globe have historically provided for the best environments for innovation when it comes to infectious disease control. Nevertheless, governments across the globe must create more such environments that enable competition and innovation to curtail Ebola outbreak across the Globe. In view of this, there is the need for a transcendental shift in how to approach the development of treatment, as well as a shift in how the global policymaking and scientific communities approach multilateral, multi faceted responses to infectious diseases like Ebola across the globe. A global call to action is needed to reassess how to approach Ebola outbreak across the Globe better than the SSA approach. It calls for collaboration among multiple partners but should not be done in an environment that avoids direct competition (Okware et al., 2015; Oleribe et al., 2015; Shoemaker et al., 2012).

CONCLUSIONS

Finally, this research has brought to the fore the changing pattern of the spread of EVD in SSA. EVD outbreaks have increased in SSA over the period of 15 years with high morbidity and mortality. The spread of EVD is within and across several borders towns in different countries with the geographical niche expanding from the east to the west with border towns being the starting point for most of the outbreaks.

This paper therefore suggests that border towns across the globe need to prepare for any contingency through capacity building and Ebola awareness creation and education. This calls for holistic preparedness across the globe to combat possible EVD outbreak in the future. This paper also suggests further research in the areas of clinical presentation and progress in management of EVD to equip stakeholders to prepare for any eventuality.

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