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The Bioterrorist Threat of Ebola in East Africa and Implications for Global Health and Security

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Abstract

Last year's natural outbreaks of Ebola hemorrhagic fever in Africa alarmed global health experts because of the disease's increasing appearance in Central and East Africa. The greater frequency with which Ebola is appearing raises questions about human accessibility to the virus and human usages of the virus for harmful purposes. The increase in natural outbreaks in the region, coupled with a possibility of a terrorist group recruiting experts to acquire the virus and to prepare it to use as a bioweapon, should lead policymakers to consider the risk of a deliberate outbreak. This prospect is worthy of consideration, particularly in East Africa due to the history of terrorist attacks by different groups in the area; the potential for these groups to obtain Ebola in the field; the lack of political capacity in the region and global will to develop a vaccine; and the pathogen's natural occurrence in the region. The possibility of a deliberate outbreak in East Africa is a global health and security issue because of Ebola's contagiousness in a globalized world; the increasing rate at which Ebola is appearing; the fear that could potentially arise from misinformation during an outbreak; and the lack of a vaccine. Based on an analysis of the conditions that make an Ebola bioterrorist attack in East Africa a potential threat, there are several recommendations for changing or enhancing global policy with regard to infectious diseases in general and Ebola specifically. These measures will better prevent and mitigate the spread of a deliberate outbreak and lessen the effects of a natural outbreak.

Policy Implications

- Policymakers need to recognize the benefits of strengthening global political will and regional capacity to develop an Ebola vaccine so that terrorists or other groups are deterred from considering obtaining the virus to use in a deliberate outbreak.
- Public health organizations should intensify surveillance and prediction of natural Ebola outbreaks in East Africa; knowledge of natural outbreaks can help mitigate a deliberate outbreak.
- Global increased sharing of information and resources is key to preventing the spread of infectious diseases, and collaboration should be encouraged; immediately after a potential Ebola case has been identified, it should be shared with the World Health Organization (WHO) so that more resources can be dedicated to an investigation into whether the outbreak is natural or deliberate and in order for misinformation to be limited. Additionally, biosecurity infrastructure should be enhanced to increase state capacity to fight infectious diseases and biological events.
- Members of governmental and nongovernmental organizations working in East Africa should be trained in infectious disease outbreaks and in how to prevent and mitigate the spread of such pathogens; in a globalized world, increased knowledge and awareness are paramount to limiting infections and fatalities.

Introduction

The Ministry of Health of the East African county of Uganda reported an outbreak of Ebola hemorrhagic fever to the WHO on 24 July 2012 (WHO, 2012a). Five days later, 14 died of the disease (WHO, 2012a) and by the beginning of October, when the outbreak was declared over, there had been a total of 24 confirmed and probable cases, 17 of which resulted in death (CDC, *Outbreak postings*). On the heels of this outbreak came another occurrence in Uganda on 17 November, killing three (WHO, 2012b). A total of seven confirmed and probable cases and four fatalities were reported as of 02 December 2012 (WHO, 2012b). Prior to the two most recent occurrences last year in East Africa, there had been five natural outbreaks of Ebola hemorrhagic fever in the east African region since 1976 when the virus was first discovered in neighboring Democratic Republic of Congo (Allaranga *et al*., 2010, p.32). While these recent outbreaks have not resulted in a large number of deaths, this paper focuses on the increasing rate at which these outbreaks have occurred and how this could affect terrorist access to the virus and the subsequent possibility of bioterrorism.

The natural recurrence in East Africa of Ebola hemorrhagic fever (Pourrut *et al*., 2005, p.1005), which kills 25 to 90 per cent of those who contract it (WHO, 2012c), is cause for concern from a global health and security perspective. Not only can Ebola be a highly contagious infectious disease, the virus which causes it has the potential to be used as a bioweapon (Lederberg, 1999, p.67). The threat of an Ebola bioweapon being used in East Africa is possible because Ebola already occurs naturally in the region and terrorists already present in the area might want to access the virus. Because it is an infectious disease, Ebola could spread in the globe's interconnected environment. The fact that there is low political will to develop a vaccine maximizes this threat because there is little to deter desire to obtain and deliberately use the virus. This paper will examine the threat of an Ebola bioterrorist attack in East Africa. It will also analyze the implications of a deliberate outbreak for global health and security and will present policy recommendations for minimizing the threat of an attack.

Terrorism in East Africa

Before turning to the threat of bioterrorism in East Africa, I will discuss terrorism in the region in order to establish its history. In this paper, I use Schmid's academic consensus definition of terrorism, which includes the following:

> Terrorism refers, on the one hand, to a doctrine about the presumed effectiveness of a special form or tactic of fear-generating, coercive political violence and, on the other hand, to a conspiratorial practice of calculated, demonstrative, direct violent action without legal or moral restraints, targeting mainly civilians and non-combatants, performed for its propagandistic and psychological effects on various audiences and conflict parties (Schmid, 2012, p.158).

Schmid (2012, p.158) includes in the definition that a terrorist can be a state actor or a non-state actor, indicating that 'terrorism as a tactic is employed in three main contexts: (i) illegal state repression, (ii) propagandistic agitation by non-state actors in times of peace or outside zones of conflict and (iii) as an illicit tactic of irregular warfare employed by state- and non-state actors.'

Crenshaw (2008, pp. 513-517) notes that individuals or groups may resort to terrorism if other methods for extremist change do not work; if they are weak and unable to recruit enough members to effectively change policy using nonviolent means; if the outlook of the organization has recently changed to reflect urgency and optimism; if new resources such as money are acquired; or if there have been innovations in technology, strategy or weapons. While these characteristics can be conditions for terrorist activity, there is no one determinant of whether or not individuals or groups will engage in terrorism.

Groups that have engaged in terrorist activity exist in East Africa and have pursued targets in East Africa. In this paper, East Africa refers to a region broadly consisting of countries in the East African Community: Burundi, Kenya, Rwanda, United Republic of Tanzania and Republic of Uganda (East African Community, n.d.) and the Horn of Africa: Djibouti, Eritrea, Ethiopia, Somalia, Sudan and South Sudan (Social Science Research Council, n.d.). Since 1998, there have been several terrorist attacks in the region, most notably the 1998 U.S. embassy bombings in Kenya and Tanzania by Al Qaeda; the 2002 attacks in Mombasa, Kenya; the 2008 suicide attacks in Somalia by Al Qaeda; and the 2010 bombings in Uganda by Al Shabaab (Ploch, 2010, p.1).

The existence of terrorist groups in East Africa highlights an opportunity for them to locally engage in terrorist acts across the region. According to Crenshaw (2009), Al Qaeda is not a popular movement. 'Instead it is a web of overlapping conspiracies, often piggy-backing on local conflicts

and grievances….Clandestine cells are the norm, not rallies and demonstrations pulling in large numbers of supporters. It cannot mobilize the vast majority of Muslims. Its options are limited' (Crenshaw, 2009). This description of Al Qaeda highlights several characteristics that can determine terrorist activity, such as being weak and unable to recruit enough members.

The Somali-based Islamist group, Al Shabaab, also exhibits characteristics of a terrorist group, including an ideological commitment to jihadism and Islamic law and support from Al Qaeda (Gartenstein-Ross, 2009). The group emerged after the Islamic Courts Union unsuccessfully led an insurgency against the transitional and Western-backed government of Somalia. Al Shabaab grew out of a failure of other methods to implement a strict version of Islam in Somalia (Gartenstein-Ross, 2009). This explanation of the origins of Al Shabaab corresponds with Crenshaw's characteristic of a terrorist group: the inability to effect change through nonviolent means.

Terrorist groups have existed in East Africa for some time because many of the states in the region are weak:

> Al Qaeda and affiliated groups have had a presence in East Africa for almost 20 years. The region's porous borders, proximity to the Arabian Peninsula, weak law enforcement and judicial institutions, pervasive corruption, and, in some cases, state complicity in terrorist activities, combined with the almost 20-year absence of central authority in Somalia, have provided an enabling environment for Al Qaeda and other violent extremist groups (Ploch, 2010, p.4).

It should be emphasized here that besides the commonly known non-state actors such as Al Qaeda, individuals as well as state actors are clearly capable of engaging in or sponsoring terrorism and should not be overlooked as potential perpetrators. Mickler (2010, p.5) notes that the military actions of the government of Sudan in Darfur beginning in 2003 could be considered state terrorism because 'there is compelling evidence that civilians were the deliberate and primary targets of violence; the strategy involved instilling fear into the wider regional population; and the violence against civilians and communication of fear to the wider population was intended to punish and deter support for the insurgency against the state.' Mickler's characterization of the government of Sudan engaging in terrorism coincides with Schmid's definition of terrorism.

The state and non-state actors that have previously engaged in terrorism in East Africa and that have ties and access to resources in East Africa demonstrate the possibility of another attack in the region. The conditions that are present in East Africa (as described above by Ploch) facilitate the mobilization of terror groups (Rabasa, 2009, p.xi). While it is important to note that these conditions exist in other regions of the world, the focus of this paper is East Africa.

One method of terrorism involves using biological weapons, or bioterrorism. 'Bioterrorism using human beings as the vector from which the biological "bomb" would ensue is a subset of suicide terrorism' (Valenty Shepherd, 2006, p. 424). Ebola is a potential bioterrorist agent (Lederberg, 1999, p. 67) and East Africa is among the areas in which Ebola occurs naturally (Pourrut *et al*., 2005, p.1005). This creates a threat nexus: the region, terrorism and Ebola. In the following section, I will discuss the epidemiology of Ebola and its potential to be used as a bioterrorist agent.

Epidemiology of Ebola

Ebola virus, having five known subtypes, is part of the family of filoviruses and causes the infectious disease Ebola hemorrhagic fever (CDC, 2009, p.1). The virus occurs naturally in animal populations and can be transmitted to and among human populations through 'direct contact with the body, bodily fluids, or contaminated clothes or linens of an infected person' (MacNeil and Rollin, 2012, p.1). Commonly, human infection has been associated with entering caves or mines or handling bushmeat (p.2). Telltale symptoms include fever and bleeding from orifices, with an incubation period of two to 21 days (WHO, 2012c). Other symptoms include 'vomiting, diarrhea, fatigue, headache, and myalgia,' which are symptoms of other tropical diseases (MacNeil and Rollin, 2012, p.1). The presence of symptoms that are commonly associated with other diseases is problematic because it makes the disease difficult to diagnose (MacNeil and Rollin, 2012, p.1). A person with Ebola hemorrhagic fever exhibiting symptoms typical of common tropical diseases can be misdiagnosed and mistreated, and quarantine measures may not be taken. This poses a public health threat.

Ebola virus is capable of causing the disease Ebola hemorrhagic fever. The fever is infectious and has a high mortality rate among those who contract it. Case fatality rates are between 25 and 90 per cent (WHO, 2012c). As of 02 December 2012, the most recent outbreak of Ebola in Uganda had a case fatality rate of 57 per cent, with four deaths

occurring among seven reported cases (WHO, 2012b). There is no vaccine available for the fever and those who contract the disease are infectious 'as long as their blood and secretions contain the virus' (WHO, 2012c). Scientists are working toward finding preventive and post-exposure treatments due to the significant threat the virus presents: 'Ebola virus constitutes an important local public health threat in Africa, with a worldwide effect through imported infections and through the fear of misuse for biological terrorism' (Feldmann *et al.*, 2007, p.849).

While scientists have been conducting research for years to find a vaccine for Ebola virus, no approved vaccine for humans has yet been developed. On 13 June 2012, *Nature* reported the publication of research in *Science Translational Medicine* finding that if given a cocktail of antibodies within 24 hours of exposure to the Ebola virus, monkeys survived and were cured of the virus (Ndhlovu, 2012). Additionally, on 29 January 2013, research was published in *Proceedings of the National Academy of Sciences* journal showing that a vaccine 'protect[ed] macaques from Ebola virus and Marburg virus infections, both prophylactically [pre-exposure] and post-exposure' by eliciting the body to produce certain antibodies (Marzi et al., 2013). These are major advancements in the search for an Ebola cure. However, an effective, approved vaccine against viral hemorrhagic fevers for humans will take time to develop. Due to the threat Ebola poses not only in East Africa but to humanity in general, the scientific and political communities must place more emphasis on finding a cure for humans.

Threat of an Ebola bioterrorist attack

Ebola virus is classified by the CDC as a 'high-priority agent…that pose[s] a risk to national security because [it] can be easily disseminated or transmitted from person to person; result in high mortality rates and have the potential for major public health impact; might cause public panic and social disruption; and require[s] special action for public health preparedness' (CDC, *Bioterrorism agents*). The virus' ability to be used as a bioweapon is a potential global security threat. However, it is important to remember that the virus itself is not a biological weapon and although not known to have occurred, only an expert would have the ability and skill to transform the virus into a bioweapon. Requirements for producing biological agents include obtaining the correct strain of the agent and having the skill in handling the agent, growing the agent with the desired characteristics, storing the agent and effectively dispersing the agent (Leitenberg, 2001, p.309).

Some researchers indicate that the threat of terrorists or other groups obtaining and preparing viruses for use as bioweapons is low, but this view should not prevent policymakers from recognizing the potential threat. In order for a would-be bioterrorist to use a biological agent such as Ebola, Ebola would have to be obtained in its natural environment, in a lab or be produced synthetically. Once obtained, it would have to be weaponized or prepared in such a way that it can be used to infect and kill.

As of 2001, Carus (2001, p.14) counts 8 instances in which terrorists acquired biological agents: one was from a legitimate supplier, one was stolen, one was self-manufactured, two were obtained from natural sources and three had unknown sources.

Isolating an agent in its natural environment

Barletta, Sands and Tucker (2002, p. 57) indicate that it takes 'expertise in microbiology' to collect naturally occurring biological agents and that it is very difficult to weaponize an agent such as anthrax. In fact, the authors note that it would be much easier 'to buy or steal cultures of dangerous pathogens from academic, industrial or commercial labs' (Barletta, Sands and Tucker, 2002, p. 58). While technically difficult, obtaining a biological agent from nature is possible. For example, Leitenberg notes that the Soviets researched and developed natural strains of Ebola for the purposes of biowarfare (Leitenberg, 2001, p.279). Additionally, Carus (2001, p.14) describes six cases in which a biological agent was acquired from nature.

Synthesizing Ebola or exploiting unsecure lab facilities

Tucker (2011, p.70) notes that a would-be bioterrorist needs tacit knowledge, or 'skills, know-how, and sensory cues that are vital to the successful use of a technology but that cannot be reduced to writing and must be acquired through hands-on practice and experience,' in order to synthesize a virus. Tucker (2011, p.69) also concludes that 'de-skilling,' or 'a gradual decline in the amount of tacit knowledge required to master the technology that will eventually make it accessible to non-experts, including those with malicious intent' will not occur in the near future. Specifically, synthesizing an Ebola virus requires synthesizing proteins that make it infectious, a process which necessitates tacit knowledge (Tucker, 2011, p.73).
However, Tucker (2011, p.77) explains that the requirement for tacit knowledge in synthesizing a virus may lessen if a group with malicious intent

could recruit a team of expert scientists. Although difficult and 'unlikely,' recruiting scientists to synthesize a virus or stealing a sample from a lab is still possible. For example, Rappert (2003, p.456) notes that it is difficult to ensure ethical behavior of scientists, as 'the long history of the contribution of scientists and medics to the production of biological weapons would suggest something of the difficulty of ensuring scientists refrain from contributing to such capabilities. Despite international efforts, for reasons of patriotism, professionalism and profit, bioscientists have been willing to go along with substantial covert state-sponsored programmes.' Leitenberg (2001, p.286) indicates that 'Iran has succeeded in recruiting some scientists who worked in the former Soviet [bioweapons] program.'

Koblentz (2010, p.115) reiterates that the insider threat is a global concern because those with legitimate access to pathogens may exploit that access. 'The growth of biodefense programs in the United States and around the world has increased the risk of the insider threat: a scientist who uses his or her knowledge and access to pathogens or toxins for malicious purposes.'

Alternatively, research published on Ebola and Ebola manipulations can make it easier for a non-expert to learn about the processes required to handle and prepare the virus to be used as a weapon. Although there is U.S. policy regulating dual-use research (research that can be used for 'both beneficial and detrimental purposes'), foreign research is not officially regulated (Holtcamp, 2012, pp.239-242), making it possible for an author or publisher to accidentally publish research that could enable the preparation, storage and usage of biological weapons. The would-be bioterrorist using this research would need to have tacit knowledge of the processes, though, as mentioned above.

Weaponization

Besides obtaining the virus and knowing how to handle the agent, another condition for a would-be bioterrorist to effectively use Ebola as a bioweapon would be to weaponize the virus, or prepare it for use as a bioweapon. This includes growing, storing and dispersing the agent.

Tucker (2011, p.73) quotes virologist Jens Kuhn on the likelihood of a terrorist weaponizing Ebola: 'The methods to stabilize, coat, store, and disperse a biological agent are highly complicated, known only to a few people, and rarely published. They will in all likelihood get stuck during the weaponization process.'
An article by Ustun and Ozgurler (2005, p.3) supports Kuhn's analysis, claiming that the risk of a bioterrorist attack is minimal because bioweapons are not easy to 'prepare, keep and use.' However, an aerosol attack is possible and could be devastating, they note. A 'demonstration [by Johnson, Jaax, White and Jahrling] of fatal aerosol transmission of the Ebola virus in monkeys reinforces the importance of taking appropriate precautions to prevent its potential aerosol transmission to humans. This reveals that the possibility of aerogenic infection using the Ebola virus is an important threat' (Ustun and Ozgurler, 2005, p.3). Zubay (2005, p.73) notes that Ebola can be 'stable in small aerosol particles,' and has been an effective mode of transmission of Ebola between animals. In humans, the transmission of Ebola in aerosol form is 'not a major mode of transmission' because there have been few human cases without 'prior direct contact with blood or fluid secretions' (Zubay, 2005, p.73). However, 'with advancing knowledge about how to manipulate viruses, the traits that make these [hemorrhagic fever virus agents] difficult to weaponize might be a diminishing barrier' (Kellman, 2007, p. 31).

Another form of the weaponization of Ebola is Ebolapox, or a hybrid of Ebola and smallpox. Ebolapox would cause "blackpox," causing external bleeding, black skin and internal bleeding (Zubay, 2005, p. 74). 'A weapon composed of Ebolapox would possess the violent hemorrhaging and high fatality rate characteristic of the Ebola virus and the contagiousness of the smallpox virus.'

According to Zubay (2005, p.75), a 'reverse genetics system provides a way to produce highly virulent mutated viruses for the purpose of biological warfare or biological terrorism.' This system involves the replication and transcribing of the filoviral RNA genome, 'causing the formation of functional virions from a DNA copy of the filoviral genome. Volchkov and colleagues at the Institut für Virologie in Marburg, Germany, used the reverse genetics system for Ebola to create a mutated virus.' The mutant virus was more toxic to cells than the naturally occurring virus.

While Tucker (2003, p.3) details the unlikelihood of a terrorist obtaining and weaponizing a virus, he also points out the need for global standards to prevent pathogens from getting into the hands of terrorists. '[I]t is critical to impede biological attacks by making it more difficult for terrorists to obtain [in labs] deadly pathogens and toxins' (Tucker, 2003, p. 3). Global biosecurity, or 'policies and procedures designed to prevent the deliberate theft diversion of malicious use of high-consequence pathogens and toxins' (Tucker, 2003, p. 3) needs to be enhanced.

Likelihood of a bioterrorist attack, Ebola, and political implications

While some authors highlight the unlikelihood of a bioterrorist attack, others state that this should not prevent policymakers from preparing for the potential global health and security risk posed by a bioterrorist attack.

Badey and Cappellanti (2009, p.6) indicate that 'based on the analysis of the constraints on the potential use of biological agents by terrorists, a biological attack by terrorists remains highly unlikely.' Some researchers believe the threat of bioterrorism is low because a terrorist would have to become infected by the virus in order to communicate the disease to targets (Cuhna, 2002, p.491), a suicide-infector. But according to Bhardwaj, Srivastava and Karan (2009), besides terrorists using cars and robotic devices to spread a disease, another concern is 'suicide coughers,' who have been self-infected and infiltrate large gatherings with the intention of infecting and killing. While groups such as Al Qaeda and Al Shabaab are known for using suicide methods to draw attention to their causes, Tucker (2010, p. 4) notes specifically that 'Al Qaeda would probably not launch a biological attack unless it was confident it could inflict mass casualties. Although the group's operatives may be willing to undertake suicide missions, they do not wish to die in vain, and a failed attack would be seen as a major setback for the organization.'

Besides terrorists obtaining biological agents on their own, there is a possibility that states with biological agents can provide them or sell them to terrorists; however, this is also unlikely. Leitenberg (2001) cites a 1996 U.S. Defense Intelligence Agency statement that confirms this: 'Most of the state sponsors have chemical, biological or radioactive material in their stockpiles and therefore have the ability to provide such weapons to terrorists if they wish. However, we have no conclusive information that any sponsor has the intention to provide these weapons to terrorists' (p.290). A state that has biological weapons capability and wants to develop these agents for use would most likely use its own resources of scientists to weaponize and disseminate the agent (Leitenberg, 2001, p.290). Nevertheless, the *New York Times* recently reported the leader of Hezbollah, a militant group in Lebanon, announcing that Syria would be providing it with '"unique weapons that it never had before" that would "change the balance" of power' (Barnard, 2013). The article reports speculation that these unique weapons could be chemical weapons.

Gould and Zanders (2005, p. 7) indicate that 'the most catastrophic scenarios [of biological terrorism] involving mass casualties, though possible, are the least likely to occur.' However, they also note that states should be prepared for a bioterrorist attack anyway. 'Because of the potential consequences for the targeted society of a terrorist attack with bioweapons, governments must be prepared for such an attack.' The authors suggest a balance of policies that prepare a state for a bioterrorist attack while not overemphasizing the threat, which could lead to chaos.

There are political implications associated with the notion that a bioterrorist attack is unlikely, particularly with an Ebola bioagent: the political will to develop a vaccine is low if a bioterrorist attack is assessed as not probable. For example, if it were recognized that an Ebola bioterrorist attack were probable, political leaders would create urgency in finding a vaccine. In addition, Kellman (2007, p.150) notes that there are political implications for being underprepared for an attack that utilizes a lesser-known weapon. If Ebola were used as a bioweapon, authorities would be held less accountable for being underprepared, as opposed to an outbreak of anthrax, which is a biological agent that has been used, studied and is understood (Kellman, 2007, p.150). If political will to create a vaccine is low, there is little urgency and few resources devoted to develop one. This lack of political will, urgency and resources devoted to finding a vaccine may tempt terrorists to try to obtain the virus and acquire the resources necessary to prepare it and use in an attack.

Another danger comes from the fact that there is no approved vaccine and that the benefits of devoting resources to developing one was uncertain 'because of the disease's rarity, little interest by industry, and the potential cost' (Feldmann and Geisbert, 2011, p.857). However, 'frequent outbreaks in the past decade, several imported cases of viral haemorrhagic fever and laboratory exposures, and the potential misuse of Ebola virus as a biothreat agent has changed that view'. Now, states are making efforts to develop vaccines for disease-causing agents that are biothreats such as Ebola. According to National Institute of Allergy and Infectious Diseases (NIAID) director, Anthony Fauci, 'an effective Ebola vaccine not only would provide a life-saving advance in countries where the disease occurs naturally, it also would provide a medical tool to discourage the use of Ebola virus as an agent of bioterrorism' (National, 2003).

Carus (2001, p.11) notes the increase in terrorist groups using biological weapons: between 1990 and 1999, there were nineteen cases of terrorists using biological agents; between 1980 and 1989, there were only three. The author also identifies

reasons why bioterrorist attacks in the future may cause more deaths.

> First, an increasing number of terrorist groups…are adopting the tactic of inflicting mass casualties to achieve ideological, revenge, or "religious" goals; second, the technological sophistication of the terrorist groups is growing. We now know that some terrorists have tried to master the intricacies of aerosol dissemination of biological agents. Some terrorists might gain access to the expertise generated by a state-directed biological warfare program. Finally, Aum Shinrikyo demonstrated that terrorist groups now exist with resources comparable to some governments. Therefore, it is seems increasingly likely that some group will become capable of using biological agents to cause massive casualties. (Carus, 2001, p.11).

Global political will to develop a vaccine

It was previously mentioned that global political will to develop an Ebola vaccine is low. This section attempts to explain why. Post, Raile and Raile (2010, p.671) define political will as 'a sufficient set of decision makers with a common understanding of a particular problem on the formal agenda [who are] committed to supporting a commonly perceived, potentially effective policy solution.' A group of government or industry leaders who understand the serious threat and implications of a natural or deliberate Ebola outbreak and who are committed to finding a vaccine to mitigate the effects of an outbreak constitutes political will for developing an Ebola vaccine. These leaders would be dedicated to providing resources to scientists in an effort to assist their discovery of a vaccine. Bausch *et al*. (2008, p.159) note that if the political will existed, field experiments with filoviruses could be used more effectively in research programs for 'realistic therapeutic and preventive options' [i.e., vaccines] for filoviruses.

One explanation for the low political will in finding an Ebola vaccine is that Ebola, for now, has occurred most frequently in the developing world. De Winter (2012, p.75) explains that the research agenda in the health sciences is distorted against poor countries. While there is extensive research for health issues in the developed world, there is little research being devoted to health issues in the developing world. According to De Winter (2012, p.76), this is called the 'problem of neglected diseases.' Because most funding for research is provided by developed countries, most of this research is tailored to fighting health issues of the developed world. Additionally, the pharmaceutical industry has focused on developed world health issues because developed countries have the resources to buy these pharmaceuticals. '[A]s poor people cannot afford such expensive products, investigating their diseases is not very interesting from a business perspective' (De Winter, 2012, p.76).

Some authors suggest that the reason for low political will in finding vaccines for some infectious diseases is lack of political capacity. Filauri, Ferraro and Ragon (2011, p.15) note that 'many neglected tropical and vector-borne diseases continue to emerge and reemerge in Africa where a significant number of governments have limited state capacity.' Gizelis (2009, p.124) argues that countries whose governments have strong state capacity are more effective in hampering the spread of infectious diseases: 'high state capacity, that is the ability of states to penetrate and shape society, will increase the effectiveness of state institutions in dealing with communicable diseases or building preventive measures that slow down the spreading of the disease.' The author found that states whose political systems are in transition are more likely to have a difficult time managing a communicable disease; the state will have low capacity to respond to an outbreak or prevent one (Gizelis, 2009, p.128). For example, Sidahmed (2010, p.20) characterized Sudan's political disposition in 2010 as a regime transitioning from authoritarianism to democracy following a transition from democracy to dictatorship. According to Gizelis' analysis, politically transitioning Sudan is a state that would be more likely to have low capacity. If a government has low state capacity, it is less likely to devote resources to developing a vaccine.

Developing a vaccine takes time and resources, both monetary and human. According to Barrett and Beasley (2009, p.D2), it takes 18 to 20 years from the time a vaccine is discovered to the time it is licensed, and the entire process could cost more than $500 million. While preliminary research on a vaccine for filovirus hemorrhagic fever (FHF) can be carried out in a laboratory, clinical research should be carried out during an outbreak, which is unpredictable and may occur in an area not conducive to human clinical trials. 'If clinical research on FHF is to be carried out it must occur in endemic areas in sub-Saharan Africa, most likely under outbreak conditions in areas with rudimentary medical infrastructures. Any plan to conduct prospective clinical research on FHF must deal with a staggering array of scientific, logistical, political, social, financial, legal, and ethical

challenges' (Bausch *et al*., 2008, pp.151-152). Bausch *et al.* (2008, p.159) note that if political will exists, a clinical research program can be carried out due to the advances in field experience in FHFs.

While I have pointed out the international contagion threat the Ebola virus poses, to date no outbreak has been classified as a pandemic. Policymakers must be careful not to assume the disease never will be. The importance of strengthening global political will to develop a vaccine for Ebola has increased recently due to 'frequent outbreaks in the past decade, several imported cases of viral hemorrhagic fever and laboratory exposures, and the potential misuse of Ebola virus as a biothreat agent' (Feldmann and Geisbert, 2011, p.857).

Is bioterrorism in East Africa a concern?

Terrorists, as defined above, have not used bioweapons in East Africa to date, and while it may be unlikely, there is still a possibility because of a threat nexus: the region, terrorist activity and the presence of naturally occurring pathogens.

For example, Al Qaeda, a terrorist organization with a history of executing attacks in East Africa, has 'demonstrated the desire to cause mass casualties and an interest in using disease as a weapon' (Koblentz, 2010, p.114). While the group has not been able to develop a biological weapon with the capability to cause a large number of deaths, it may do so in the future, if it is able to recruit experts and obtain an agent such as Ebola.

Due to the presence of naturally occurring pathogens in East Africa and the increasing appearance of Ebola, there is concern that someone with malicious intentions could access these pathogens. 'Disease-causing micro-organisms occur naturally in the region [of East Africa] and are therefore accessible to those with sufficient knowledge to use to deliberately cause disease. This is an adequate reason to presume that eastern Africa, like other regions with similar conditions, faces a potential threat from [bioweapons]' (Njuguna, 2005, p.14).

Leroy *et al.* (2011, p.964) find that despite the fact that filoviruses are a 'major public health issue for Africa and a category A biothreat' due to the explosive disease course; high case fatality rate; and lack of specific treatments or vaccines, these viruses are a 'minor public health threat' due to the low disease burden compared to other diseases in Africa. As a 'major public health issue for Africa,' the naturally occurring Ebola virus needs more attention, especially since it is appearing more frequently in East Africa. While bioterrorism in East Africa is a concern, resources devoted to one health threat should not be diverted to another health issue.

The potential for a deliberate biological attack in Africa is a security concern and methods to reduce the risk should be put in place. Borrie and Loye (2005, p.102) note that 'it is in the political interest of African countries to take cognizance of the increasing potential of the life sciences being misused for hostile purposes. Preventive action will reduce the vulnerability of the countries to endemic diseases as well as to biological attacks.' With this statement, the author is careful to point out that this does not mean fewer resources be devoted to issues also facing Africa. While a bioterrorist attack in East Africa is unlikely, it is still possible due to terrorist activity in the region and the presence of the more frequently appearing Ebola, and steps should be taken to prevent and mitigate this major public health issue.

Natural occurrence of Ebola in Africa and the state of health systems

Ebola virus occurs naturally in Central and East Africa and the disease caused by the virus is appearing with more frequency. This has implications for global health and security because it makes the virus potentially accessible to groups who may want to recruit an expert to find the virus and prepare the virus for use as a bioweapon.

Human interaction with the environment can cause the emergence and reemergence of infectious diseases. 'Increasing human numbers have been a principal factor leading to uncontrolled urbanization, changes in agriculture, land use and animal husbandry practices, and accelerated globalization, all of which have been major and inter-related drivers of the re-emergence of epidemic infectious disease' (Wilcox *et al*., 2008, pp.113-114).

An article in the *Lancet* notes that an increase in human consumption of wildlife products has led pathogens to find new hosts: the transmission of Ebola to humans is an 'example of organisms or pathogens exploiting new host opportunities resulting from human behaviour' (Karesh *et al*., 2012). Because of the consumption of wildlife products in Africa and the link to the incidence of infectious diseases, the region is ripe for anyone with specific expertise to harvest a naturally occurring virus.

Attempts at obtaining pathogens from nature that can be weaponized have been successful. For example, the Japanese cult Aum Shinrikyo

obtained a natural strain of anthrax; however, it turned out to be a non-virulent strain (Barletta, Sands and Tucker, 2002, pp.57-58). And, as stated before, Carus (2001, p.14) notes six instances in which a biological agent was acquired from a natural source.

In addition to the natural occurrence of Ebola in East Africa, the region and Africa in general is more susceptible to a lethal infectious disease outbreak because of the lack of health infrastructure. 'Due to lack of proper equipment and hygienic practices, large-scale epidemics occur mostly in poor, isolated areas without modern hospitals or well-educated medical staff' (Tyagi, Kumar and Singla, 2010, p.3). Mackey and Liang (2012, p.67) report a shortage of 1.5 million health workers in Africa due in part to brain drain, or a migration of health care workers from developing countries to developed countries. One result of this shortage of health care professionals is a weak formal health system. Another result is that patients instead use traditional healers, some of whom treat the sick in their own homes, which may not be sterile environments (Allaranga *et al*., p.34). These practices promote transmission of infectious diseases.

From a global health and security perspective

Koblentz (2010, p.100) notes that the international health and security risk posed by a biological agent is increasing because of 'advances in science and technology, the emergence of new diseases, globalization, and the changing nature of conflict. It is the convergence of these trends that has propelled biological threats onto the international agenda.'

An Ebola bio-attack in East Africa is a potential threat for global public health for several reasons. First, because we are now living in a globalized world where people and objects can travel quickly from one part of the globe to another, a disease as potentially contagious as Ebola could also travel as rapidly. The east African region is a destination for foreign investors, tourists, health workers, diplomats, students and non-governmental organization representatives. For example, 'the growing popularity of China as a destination for both short- and long-term training for Kenyans…cannot be separated from the wider involvement of China in Kenya's infrastructure development…and Chinese migration to East Africa' (King, 2010, p.488). The steady flow of people and goods to and from East Africa demonstrates the ease with which a pathogen can travel. Additionally, the 'globalization of the pharmaceutical and biotechnology industries and the diffusion of information about the life sciences are making the ingredients necessary to develop biological weapons—knowledge, expertise, equipment, and materials—more widely available' (Koblentz, 2010, p.102). While globalization has made it easier for an infectious disease to travel and for non-experts to access biotechnological advancements, it has also provided improvements in more effectively responding to Ebola outbreaks. However, the fact remains that there is no cure, and once someone is infected with Ebola, there is a chance it will spread and infect others.

Additionally, an Ebola bioterrorist attack in East Africa is a danger to global health because it presents a global political security risk. The virus can infect anyone that it comes in contact with; it does not discriminate. The virus is contagious and, coupled with the fact that humans come in closer contact with a wide range of people now more than ever, it is possible for anyone to become infected, even world leaders.

Second, natural Ebola outbreaks are occurring more frequently in Sub-Saharan Africa, and this indicates a greater potential for transmission to a greater number of people and a greater potential for a terrorist to obtain the virus. Authors of an article in *Trends in Microbiology* point out that Ebola has become a global health concern because of the recent increase in cases as well as the possibility for it to be used as a bioweapon:

> There has been an increasing frequency of filovirus [i.e. Marburg virus and Ebola virus] outbreaks reported from endemic regions of Africa in recent years which, together with its potential for introduction into non-endemic countries through international travel and its potential for use as a bioweapon, has made [the Ebola virus] a worldwide public health concern (Groseth, Feldmann and Strong, 2007, p.408).

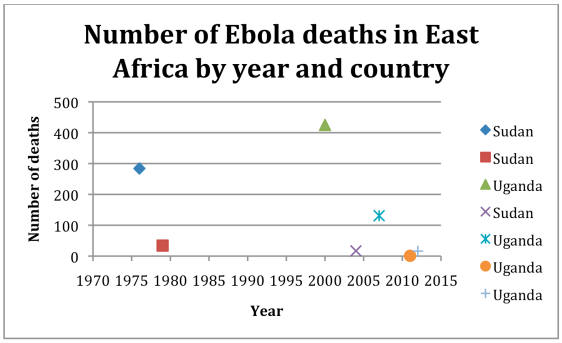
Between 1976 and 1997, there were two outbreaks in East Africa; between 2000 to present, there were five outbreaks (CDC, *Known cases*). Table 1 shows the frequency of occurrence and number of deaths associated with Ebola outbreaks in East Africa.

Third, the 'outbreak narrative' of a bioterrorist attack in East Africa can create fear and can further the spread of the disease. The 'outbreak narrative,' or the journey of an infection from identification through containment chronicled by science, media and dramatizations, affects the way people perceive the disease and how they handle it:

> As [outbreak narratives] disseminate information, they affect survival rates and contagion routes. They promote or mitigate the stigmatizing of individuals, groups, populations, locales, behaviors and lifestyles and they change economies. They also influence how both scientists and the lay public understand the nature and consequences of infection, how they imagine the threat and why they react so fearfully to some disease outbreaks and not others at least as dangerous… (Wald, 2008, p.2-3).

Therefore, the outbreak narrative may include misinformation that may cause fear and alter the path of the disease.

Finally, the lack of an Ebola vaccine or effective treatment protocol potentially threatens global health and security because in the event of an outbreak, only strict quarantine measures would prevent the spread of a disease which is already difficult to diagnose, as previously mentioned.



Policy recommendations

The potential dangers that an Ebola bio-attack in East Africa presents to global health and security cannot be overlooked. In fact, one of the reasons there is no vaccine is too little attention has been paid to the virus. Due to its potential to cause morbidity and mortality across the globe, the threat of an Ebola bio-attack should not be ignored. Therefore, the WHO, individual states and other organizations must formulate a response to this global health concern. A strong response will be comprised of the following.

First, states should strengthen political will and capacity to develop a vaccine for use in an outbreak and to deter bioterrorists. While a cure may be decades away, if scientists are actively supported in looking for a cure, it is more likely that one will be discovered sooner, discouraging a deliberate Ebola outbreak, rather than highlight any weakness in global defense against Ebola.

Second, public health organizations should increase surveillance and their ability to detect and identify an infectious disease. For example, USAID's Predict project mapping tool can be used as a model[1]. According to an article in the *East African Journal of Public Health*,

> collaboration with those in charge of the conservation of wildlife is essential for the early detection of viral hemorrhagic fever epidemics. Hemorrhagic fever epidemics caused by Ebola and Marburg viruses are occurring more and more frequently in Sub-Saharan Africa and only an adapted epidemiological surveillance system will allow for early detection and effective response (Allaranga *et al*., 2010, p.32).

Early detection of Ebola can help mitigate its spread, in either a natural outbreak or a deliberate attack.

Third, states and public health organizations should support African disease control centers and sharing of resources (human resources, financial and material/testing, prevention and treatment equipment). An article on the 1995 Ebola outbreak in Kikwit, Democratic Republic of Congo, reveals that shortly after the disease was suspected,

> nine international medical teams, including the WHO, Doctors Without Borders and the CDC, arrived, bringing supplies and knowledge. The arriving teams helped to augment the understaffed hospital, provided barrier supplies and disinfectant, improved the quality of the isolation unit's effectiveness, assisted in developing safer burial procedures and improved the triage system for sick patients (Hall, Hall and Chapman, 2008, p.447).

According to Njuguna (2005, p.17), 'if a terrorist attack with a biological agent were to occur, medical microbiology laboratories would be instrumental in helping to detect and identify the agent and in alerting the authorities. Referral centres should have all necessary resources to support the field laboratories.'

[1] http://healthmap.org/predict/

Additionally, the benefits of biosecurity measures should be shared with practitioners and policymakers in East Africa. During seminars held in developing countries, Rappert and Gould (2009, p.90) found a pattern: 'a low prior recognition of dual-use issues by practicing scientists, students and policymakers.' Specifically, in Africa, the authors found that there was a positive response to investment in science but at the same time a suspicion of new technologies (Rappert and Gould, 2009, p.81). The international community and developed states should share ways in which biosecurity can protect people. Advanced knowledge of lab security measures and investment in biosecurity infrastructure is a positive step toward limiting biological outbreaks, whether natural or deliberate.

Fourth, states, non-governmental organizations and public health organizations should closely collaborate and effectively communicate. The more aware expert organizations are of infectious disease outbreaks, the more high level institutions such as the WHO and the CDC will be able to become involved, prevent the spread of misinformation, and devote resources to handling not only the outbreak but also the investigation.

Finally, public health organizations should encourage and facilitate training in infectious disease outbreaks and prevention practices for members of organizations who are serving in East Africa (i.e., diplomats, members of the armed forces). These members should be trained in infectious disease outbreaks to help prevent their own infection and mitigate an outbreak by taking necessary precautions. For example, in 2009, the U.S. 'Armed Forces Health Surveillance Center, Division of Global Emerging Infections Surveillance and Response System (AFHSC-GEIS) supported…training initiatives in 40 countries for …U.S. military, civilian and host-country personnel' (Otto *et al,* 2005, p.1). Increased public knowledge and awareness is an important step in preventing and containing an infectious disease.

Conclusion

The threat of an Ebola bioterrorist attack in East Africa is a global health and security concern, and should not be ignored. While the threat is unlikely due to difficulties in obtaining the virus and recruiting experts to handle and weaponize the virus, the threat still exists and is increasing due to the more frequent outbreaks and subsequent accessibility to the virus in East Africa. A threat nexus occurs in East Africa: there is a history of terrorism in the region; Ebola naturally occurs there; the virus has the ability to be used as a lethal bioterrorist agent, killing 25 to 90 per cent of those infected; and there is no vaccine for Ebola. Ebola's epidemiological makeup creates circumstances in which it could spread quickly to all parts of the globe. Global health and security are currently compromised because a vaccine has not been discovered to prevent and treat the virus and to deter bioviolence. The political will in both the developed and developing world does not exist to cultivate such a vaccine. Several steps need to be taken to change the threat a deliberate Ebola attack in East Africa poses to global health and security, including stronger political will to develop a vaccine; increased surveillance and prediction capabilities; sharing of information and resources with partners in East Africa; and training individuals working in East Africa in prevention. These measures will help deter an offensive Ebola outbreak in East Africa and will mitigate the effects of another natural outbreak in the region.

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Table 1 (CDC *Known cases*)