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What Ebola Taught Us: The Old and the New

BY

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What Ebola Taught Us: The Old and the New

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An abstract of
A Thesis submitted to the Faculty of the
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Abstract

What Ebola Taught Us: The Old and the New

BY
Renee Crawford

In late 2013, an Ebola virus outbreak began that quickly grew into an epidemic of extraordinary magnitude, killing more people than all previous outbreaks combined. Although the epidemic was unprecedented, the world had previously experienced several acute public health emergencies requiring international coordination. However, in each case, coordination had proved problematic, and this latest event was no exception. The purpose of this project was to identify persistent vulnerabilities within international public health emergency response and to identify areas for future research and improvement. A literature review and key informant interviews were conducted. Data were analyzed using MAXQDA qualitative data analysis software. Results showed a number of issues, including a shortage of personnel and resources, policy barriers that hinder long-term international response, itemized funding streams that limit flexibility to direct resources, challenges to deploying responders internationally, cultural and political clashes within responding agencies and a lack of confidence in those agencies. Most troubling is that data point to the world remaining ill prepared to handle sustained responses and global pandemics. The study identified major vulnerabilities persistent within global public health response and offers recommendations and opportunities for further focused research to fully understand why these challenges persist.

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Table of Contents

List of Acronyms

AIDS……..……..Acquired Immune Deficiency Syndrome

CAQDAS……..…Computer-Assisted Qualitative Data Analysis Software

CDC……..…U.S. Centers for Disease Control and Prevention

CGH……..….Center for Global Health

DG……...……...Director-General

DRC…….……Democratic Republic of Congo

EID…….Emerging Infectious Diseases

EIS…….Epidemic Intelligence Service

EOC……...……....Emergency Operations Center

ERRB…….…..Emergency Response and Recovery Branch

ETU……...……..Ebola Treatment Unit

EUA……..Emergency Use Authorization

EVD……...Ebola Virus Disease

FDA…….…Food and Drug Administration

GHSA……..Global Health Security Agenda

GOARN……...Global Outbreak Alert and Response Network

Global RRT……..….Global Rapid Response Team

HIV……..……...……..Human Immunodeficiency Virus

HHS……...…Health and Human Services

IDI…….……..In Depth Interview

IFRC……. International Federation of Red Cross and Red Crescent Societies

IHR……International Health Regulations

IMS……..…..Incident Management System

IRB…….…….....Institutional Review Board

MAXQDA……Max Qualitative Data Analysis

MERS CoV…….....Middle East Respiratory Syndrome Corona Virus

MOH……...…….Ministry of Health

MSF……..… Medecins Sans Frontieres

NIH……...….National Institutes of Health

NGO……..……..Nongovernmental Organization

NPO……..…Nonprofit Organization

PHE…….……..Public Health Emergency

PHEIC……..…….Public Health Emergency of International Concern

PI……...…..Principal Investigator

PLOS……...……..Public Library of Science

PPE…….…..Personal Protective Equipment

SARS……..…….Severe Acute Respiratory Syndrome

SME……...…….Subject Matter Expert

WHO……..World Health Organization

I. Introduction

"*SARS must change us, the way we treat our planet, and how we deliver health care, forever. Will we be ready when it returns? SARS brought one of the finest publicly funded health systems in the world to its knees in a matter of weeks. It has unnerved me to contemplate what the disease might do to a community without our resources and technologies. Without substantive changes to the way we manage the delivery of health care, both locally and on a worldwide scale, we risk the otherwise preventable annihilation of millions of people, either by this virus, or the next*." – Dr. Paul Caulford, physician at Scarborough Hospital in Toronto, December 2003 (Caulford, 2003).

Background

In late 2013, an Ebola virus disease (EVD) outbreak quickly grew into an epidemic of unprecedented magnitude, killing many more than all previous EVD outbreaks combined. The epidemic originated in a rain forest village in southern Guinea, when a toddler named Emile Ouamouno likely contracted the virus by touching bat feces while playing (Sieff, 2015; Yan & Smith, 2015). By March 2014, the virus had traveled to Conakry, the capital of Guinea, in what became the first-ever urban EVD outbreak (BBC, 2014). Subsequently, EVD spread from Guinea to Liberia and Sierra Leone, and into Senegal, Nigeria, Mali, Spain, Italy, the United Kingdom and the United States. As of July 2015, there were a total of 27,550 confirmed, probable, and suspected cases with 11,235 confirmed fatalities (WHO, 2015c).

Although EVD had never reached Europe or the U.S. before 2014, it has been known in Africa for decades. The disease was first identified in 1976 when two outbreaks occurred simultaneously, one in Sudan and another in the Democratic Republic of Congo (DRC) (WHO, 2015d). The virus was named after the Ebola River near the Congolese village of Yambuku, the

scene of the DRC outbreak (WHO, 2015d). High fatality rates, as high as 88%, were observed in those initial outbreaks collectively killing over 400 people (CDC, 2015c; Harrod, 2014).

The next major outbreak, which occurred in 1995 in the DRC city of Kikwit, was traced to patient zero working in a nearby forest prior to symptom onset. The disease spread through personal contact and hospitals, eventually killing 250 people (CDC, 2015c). In 2000, another outbreak occurred in Uganda, highlighting the risks of African burial practices and close physical contact with infected family members (CDC, 2015c). In 2007, there were two more outbreaks, one in the DRC and another in Uganda, where a new species of the virus was found (Harrod, 2014). Several other smaller outbreaks occurred between 1976 and 2014, but these were of greatest importance due to the death tolls and identification of new species.

To date, five species of Ebola virus are known: *Zaire ebolavirus, Sudan ebolavirus, Tai Forest ebolavirus, Bundibugyo ebolavirus*, and *Reston ebolavirus* (Harrod, 2014). Reston causes disease in primates, but not humans (CDC, 2015a). The Zaire species caused the West Africa epidemic, a species that has historically demonstrated the highest ever case-fatality rate (up to 90%) (M. G. Dixon & Schafer, 2014).

Characterizing the disease and its transmission are important in order to understand the evolution of the 2013-2015 EVD epidemic. Ebola is a filovirus, an RNA virus that uses surface proteins to attach to the host cells, causing it to become highly pathogenic and initiate an often lethal hemorrhagic fever (Harrod, 2014). Infection causes a range of symptoms that can lead to death, including fever, headache, fatigue, diarrhea, and vomiting (CDC, 2014b). Once exposed, the incubation period is 2 to 21 days, with human-to-human transmission possible after the infected person is symptomatic (CDC, 2014b; Harrod, 2014). The natural reservoir is thought to be fruit bats or primates. Scientists believe that EVD outbreaks begin through a zoonotic

transmission, where patient zero is initially infected through contact with an infected animal (CDC, 2014c). Close contact with the blood, secretions, organs, or other bodily fluids of infected animals introduces the virus to humans (WHO, 2015d). Human to human transmission then occurs via direct contact with the blood, secretions, organs, and other bodily fluids of the infected person or via contact with contaminated surfaces or materials (e.g., bedding or clothing) (WHO, 2015d). Those in most danger are healthcare workers and family and friends in close contact with EVD patients.

Unfortunately, the severity of the 2013-2015 epidemic was exacerbated because the virus remains alive in bodily fluids for days after death, leaving the recently deceased still highly contagious. Traditional burial practices in West Africa contributed to the spread as it was customary for the community and family members to wash dead bodies for funeral preparation (Nielsen et al., 2015). In Guinea alone, 60% of all EVD cases were linked to unsafe burial practices (WHO, 2014a).

Uniqueness of the 2013-2015 Epidemic

The pathogenesis of EVD is only one reason why the West Africa epidemic became a Public Health Emergency of International Concern (PHEIC) (WHO, 2014b). Appearance of the disease in urban centers, community resistance, poor healthcare infrastructures, and porous borders between Guinea, Liberia, and Sierra Leone, made this outbreak different (MSF, 2015; Sack, Fink, Belluck, & Nossiter, 2014; WHO, 2015d). Previous EVD outbreaks had typically occurred in isolated rural settings within Central Africa (WHO, 2015d). Far from remaining in a remote village, this outbreak occurred at the intersection of three of the world's poorest and least developed countries, where people pass through borders unhindered (MSF, 2015; Sack et al., 2014).

All three countries – Guinea, Liberia, and Sierra Leone – recently endured civil wars that left them with dysfunctional healthcare systems and few healthcare workers (Buseh, Stevens, Bromberg, & Kelber, 2015). Sub-Saharan Africa accounted for 24% of the global disease burden, yet had only three percent of the global health workforce in 2013 (WorldBank, 2013). In Liberia alone, fewer than 250 doctors served 4 million people when the EVD epidemic started (Sack et al., 2014). Many people in these countries were already subject to premature deaths from common, treatable conditions like pneumonia and diarrheal diseases (Ingeno, 2014). Mistaking EVD for malaria or other endemic febrile diseases led to initial misdiagnoses, aiding to the epidemic's spread.

Civil wars not only contributed to ravaged healthcare systems, but also to distrust of government (Sack et al., 2014). Pervasive corruption and atrocities added to the disdain for government. Therefore, populations demonstrated great resistance to some measures implemented by governments to contain the disease. A curfew and quarantine imposed on a Monrovia slum in Liberia, for example, resulted in riots. Although Sierra Leone was immersed in civil war from 1991-2002, a mandatory lockdown to contain the disease's spread in September 2014 was a first for the nation (Belluz, 2014). With no schools or businesses open, already impoverished communities sustained even greater financial distress. Forced quarantines and criminalizing the failure to report suspected cases drove people underground and away from care, and ultimately bred fear and unrest, rather than aiding containment (Liu, 2014).

Concern over community resistance rose after the murders of eight humanitarian aid workers in September 2014 in Guinea (R. Dixon, 2014). Resistance for some districts was upwards of 60%, creating "shadow zones" too dangerous for workers to enter (CDC, 2014a). Resistance usually originated from fear, often caused by a lack of knowledge, frequently

occurring in communities of low socioeconomic status. Many believed aid workers were bringing the disease to their village. Additionally, the Ebola Treatment Units (ETUs) were seen as death camps, because so many patients did not emerge alive. Death rates rose because patients often waited until they were gravely ill before going to an ETU. Others waited because they did not know they had EVD, as malaria and other endemic diseases present similar symptoms.

Thorough contact tracing is important to contain epidemics; it is simple and helped contain Severe Acute Respiratory Syndrome (SARS) and to eradicate smallpox (Bonifield, 2014). Contact tracing involves finding all individuals with close contact to the infected, tracking them for 21 days (the incubation period for EVD), then isolating and treating them if necessary. This process broke down in Africa with deadly consequences. Many contacts had no address and there was a lack of personnel to do the tracing. In addition, many people were uncooperative with the tracers, sometimes throwing stones at them (Bonifield, 2014).

Perhaps most importantly, critical months passed before the international community began to respond in earnest. This failure to act aggressively stemmed from previous EVD outbreaks being contained early without massive international aid (Sack et al., 2014). One agency, Medecins Sans Frontieres (MSF), did respond quickly and initially treated two thirds of the cases. However, by December 2014, MSF president Joanne Liu declared her teams exhausted and resources depleted (Liu, 2014). Despite the World Health Organization's (WHO) authority, no single organization had the capability to handle the outbreak, making mass cooperation and coordination among agencies a necessity.

Problem Statement

While the West Africa EVD epidemic was unique, the world had experience with other acute public health emergencies requiring international coordination, including HIV/AIDS,

SARS, and H1N1 influenza. In 2000, WHO established the Global Outbreak Alert and Response Network (GOARN) (Burkle, 2015; Snowden, 2008), a network of technical and research institutions, universities, and international health organizations tasked with aiding global health security. GOARN provides technical support to assist with disease control, assess risks and investigate events for emerging threats, and support preparedness for sustained containment of these threats (WHO, 2015f). The network was tested in 2003, when SARS spread from southern China to 37 other countries in just weeks (Burkle, 2015).

Response to the SARS epidemic also revealed inadequacies within the out-of-date International Health Regulations (IHR), catalyzing a much-needed revision. Previously only requiring the reporting of cholera, plague, yellow fever, and smallpox, the purpose and scope of the IHR were expanded (Morse, 2012). The revision established a global surveillance system for public health emergencies of international concern (Baker & Fidler, 2006). Member States were given five years to develop and implement a minimum of eight core public health capacities: 1) human resources, 2) surveillance, 3) laboratory, 4) response, 5) legislation, policy and financing, 6) national focal point communications, 7) preparedness, and 8) risk communication (Ijaz, Kasowski, Arthur, Angulo, & Dowell, 2012). Unfortunately, by the 2012 deadline, less than 20% of the 194 Member States achieved the required capacities and most filed two-year extensions (Braden, Dowell, Jernigan, & Hughes, 2013; Ijaz et al., 2012; WHO, 2012).

The next test of the revised IHR and global response in a public health emergency (PHE) came in 2009 with the H1N1 influenza pandemic. While Thailand's response to H1N1 was scrutinized, Mexico's response was lauded as being proactive, rapid, and transparent (Mackey & Liang, 2012; Ungchusak et al., 2012). Even so, many countries enacted travel and trade restrictions against Mexico despite any solid scientific evidence the restrictions were warranted,

violating international trade treaties (Mackey & Liang, 2012). PHEICs have an economic impact on any country, which can affect a nation's willingness to acknowledge the severity of a public health threat within its borders.

In 2014, Sierra Leone was initially so unwilling to acknowledge the severity of their EVD outbreak they restricted reporting only to laboratory confirmed cases, leaving out scores of probable and suspected cases (MSF, 2015). Despite lessons from previous PHEs, WHO admitted many failures on their part with the EVD epidemic (WHO, 2015i). Responding to the Special Session of the Executive Board on Ebola held in January 2015, WHO reported lessons learned and declared commitment to reform (Miles, 2015).

Clearly, global responses to PHEICs have been complex and varied depending on the nature of the pathogen and the location of the outbreak. As several acute PHEs revealed, the world remains incredibly vulnerable to the threat of infectious disease outbreaks.

Purpose Statement

The purpose of this project is to identify persistent vulnerabilities within international public health emergency response in light of the 2013-2015 West Africa EVD epidemic and to identify areas for future research and improvement.

Research Questions

This study proposes to gain insight into the following questions:

1. What were the lessons learned from previous momentous acute public health emergencies – HIV/AIDS, SARS, and Novel H1N1 influenza?
2. What vulnerabilities in international public health response did these events reveal?
3. What was the tipping point in these events that finally galvanized the public and those with decision-making authority to take action?

4. In light of the West Africa EVD epidemic response, what limitations and challenges in international public health response remain?

Significance

Although past events have taught the public health community valuable lessons about optimal responses to PHEs, severe challenges and vulnerabilities remain. It is critical that patterns of these persistent vulnerabilities be identified, allowing for a greater ability for multiple international entities to coordinate and respond effectively in the future.

Journal Selection

The investigator chose PLOS (Public Library of Science) One as the primary journal for manuscript submission. PLOS One had an impact factor of 3.73, providing their articles free to the public via Google, PubMed, Web of Science, and more (PLOS, 2015). In addition to making articles readily accessible, the journal publishes all work if it meets a high technical and ethical standard. Other criteria for publication include:

- The study presents results of primary research;
- Results have not been previously published;
- Analyses are described in sufficient detail; and
- Conclusions are presented appropriately and supported by the data.

Manuscripts of any length are considered with no restrictions for number of words or figures.

PLOS One publishes work from multiple scientific disciplines, making its audience broad. Articles are frequently downloaded at a rate of over 1 million a month being highly cited and over 20,000 articles receiving 10 or more citations.

II. Literature Review

Many articles, reports, and systematic reviews compared the responses to HIV/AIDS, SARS, H1N1, and EVD. The literature listed lessons learned throughout the years, with authors identifying consistent problems and making recommendations for the future. Additionally, the literature identified several components to disease outbreaks that influence response. This review will summarize insights gained through HIV/AIDS, SARS, H1N1, and EVD. The recurring themes affecting responses to these previous PHE's will be organized by: fear and stigmatization; risk communication; the media; surveillance and reporting; lack of resources; and lack of enforcement. Finally, the review will detail how and why the response to the EVD epidemic was delayed.

Review of the Literature

Fear and Stigmatization

When the nature of a pathogen is not well understood, false beliefs regarding transmission frequently occur. These false beliefs can cause people to take unwarranted precautions and ultimately stigmatize those infected.

The HIV/AIDS epidemic began in the U.S. in 1981, but not until 1983 was the human immunodeficiency virus (HIV) identified as the cause (EU, 2015; Snowden, 2008). The mystery of the illness and its transmissibility were large obstacles in the beginning of the response. Since transmission was misunderstood, people avoided eating with the infected, children were banned from schools, and some healthcare workers refused to care for the sick (EU, 2015; Jaffe, 2015; Minkoff & Ecker, 2015). Also, since most of the initial cases were among homosexual men, HIV/AIDS was labeled a "gay" disease. This stigmatization caused people to avoid seeking care

and adhering to treatment (Davtyan, Brown, & Folayan, 2014; Keusch, Wilentz, & Kleinman, 2006).

Although the cause of EVD was not a mystery, the public responded with fear and shunning to it as well (EU, 2015; Jaffe, 2015). Both epidemics were initially characterized by false beliefs that the disease only affected certain groups of people – e.g., poor Africans for EVD and homosexual men for HIV/AIDS (Davtyan et al., 2014). Some people thought the government engineered the disease for population control or that it was "divine retribution" for wrongdoers. Both diseases inspired scientifically unfounded fears (Davtyan et al., 2014).

The incubation periods for EVD and HIV/AIDS are vastly different: 2 to 21 days for EVD and up to 10 years for HIV/AIDS (EU, 2015; Jaffe, 2015). While the short incubation period for EVD raised fears, it also contributed to containment. Within weeks of contracting EVD, a person succumbs or develops immunity. Therefore, EVD outbreaks were eventually contained with infection control procedures (EU, 2015; Jaffe, 2015).

Proper health information that clarified routes of transmission helped mitigate fears and stigmatization during HIV/AIDS, SARS, and EVD and was an important part of risk communication.

Risk Communication

In response to fears and misconceptions, Surgeon General C. Everett Koop issued a report titled "Understanding AIDS" in 1988 (Jaffe, 2015). The U.S. government mailed over 100 million copies to every household. Solid, evidence based guidance from this highly credible person helped to alleviate irrational fears. Also, distribution of health information in cooperation with community leaders proved more effective than programs aimed solely at individuals (Davtyan et al., 2014). The HIV/AIDS crisis also showed that advocacy groups could aid in

mobilizing response. Advocacy from the gay community helped to raise awareness of many issues when there was little public interest or funding from Congress (Jaffe, 2015).

Stigma was associated with SARS too, since it was mysterious and possibly fatal (Person, Sy, Holton, Govert, & Liang, 2004). The perception of risk was much higher than the true risk, prompting some to wear surgical masks when performing routine tasks (Heymann, 2004). The literature reiterated that in times of uncertainty, risk communication was both necessary and difficult (Menon, 2008). Singapore and Vietnam gained the most praise for their management of the SARS crisis. High levels of leadership engagement early on, transparency, and earning public trust marked their strategies. But, risk communication during EVD was more difficult due to the public's prevalent distrust of government. So, the best ways to alert, educate, and prepare a population depended to some degree on the population itself (Menon, 2008). Understanding how people form perceptions of risk and make decisions was foundational to effective risk communication during PHEs (Menon, 2008).

The H1N1 response also frequently exhibited appropriate risk communication and public health education strategies. Dr. Anne Schuchat, Assistant Surgeon General and frequent CDC spokesperson throughout H1N1, adhered to principles outlined in WHO's Outbreak Communication Guidelines (Chastney, 2014; WHO, 2005). Schuchat touted the CDC for being quick and accurate in its communication and admitted uncertainty when information was unknown (Chastney, 2014). WHO broke the guidelines into five pillars: trust, announcing early, transparency, understanding the public, and planning. The guidelines stressed the importance of building and maintaining trust, as the consequences for losing trust can be devastating. As Schuchat said, some trust-building strategies are not intuitive, like acknowledging uncertainty. Trust was also implicitly tied to transparency. Communicating candid, easily understood, and

accurate information had the benefit of allowing the process of outbreak management to be understood more fully (WHO, 2005). However, HHS found that some communications were not clear or simple enough and did not reach some minority and disadvantaged populations (HHS, 2012).

Announcing the H1N1 outbreak early aided containment, while the delay with EVD inhibited containment. Additionally, understanding how and what the public thought affected communication efficacy in both crises.

The Media

The literature notes turning points in the responses for HIV/AIDS, SARS, H1N1, and EVD. These turning points represent either a change in the interest of the public health community or of the general public with the media playing a large role in affecting the public's interest. The public remained largely complacent about HIV/AIDS until its transmission was understood to be blood borne and capable of effecting people on a widespread scale. The disease no longer only affected intravenous drug users or homosexuals since the virus could be passed through heterosexual contact and the blood supply. Once the public realized that anyone could be at risk, they paid more attention to the crisis (EU, 2015; Jaffe, 2015). SARS gained the attention of the public health community and the media after an unaware superspreader checked into a hotel in Hong Kong. This doctor's one night stay at the Metropole infected 15 others, causing the virus to spread to Vietnam, Canada, Singapore, the Philippines, Australia, and the U.S (Braden et al., 2013; Heymann, Mackenzie, & Peiris, 2013; Khabbaz, 2013). H1N1 did not initially gain much attention even upon the discovery of a novel virus circulating among children. However, when the virus spread widely within Mexico and clinical samples were sent to the CDC for

analysis, the media picked up on the story and the pandemic received a great deal of coverage (Chastney, 2014).

The literature indicates different turning points with EVD – for the responders and for the public. For physicians and epidemiologists, the game changer came in May 2014. Cases were detected in Conakry, the Guinean capital, which has a population of 2 million. Patients came in for treatment, infected through what appeared to be numerous unrelated chains of transmission, signaling a wider spread of the outbreak (Burkle, 2015; MSF, 2015; Sack et al., 2014). The turning point for the international community and the media occurred when the virus crossed the ocean into the U.S. Two aid workers from the organization Samaritan's Purse transferred from Liberia to Emory University Hospital in Atlanta for treatment. Then, a patient returning from West Africa received treatment at a Dallas hospital and infected two nurses. Human-to-human transmission of the virus outside of Africa made the epidemic no longer a humanitarian emergency, but an international threat to public health and security (Burkle, 2015; EU, 2015; Jaffe, 2015; MSF, 2015; Sack et al., 2014).

Surveillance and Reporting

Like HIV/AIDS, SARS was a mystery illness in 2003. SARS showed the world how quickly a pathogen could spread globally and how damaging the effects could be (Braden et al., 2013). The SARS response was problematic, but overall successful. Within four months, the virus was identified with all known cases traced and contained in 27 countries (Heymann, 2004). The containment resulted from transparent international cooperation and coordination of surveillance, diagnostics, infection control procedures, and real-time information sharing (Braden et al., 2013; Heymann, 2006; Khabbaz, 2013). SARS left a legacy of improved surveillance and increased transparency in reporting.

The literature suggests that a lack of field investigating, laboratory testing, and accurate reporting from China contributed to a delay in reporting the illness to WHO (Braden et al., 2013). China delayed reporting cases due to fear of economic harm (Mackey & Liang, 2012). Countries also failed to report illness for fear of stigmatization and believing the situation was within their jurisdiction (Wilson, McDougall, & Upshur, 2006). After SARS, transparent reporting became both "expected and respected" (Heymann et al., 2013). China's surveillance system transformed from a politically controlled unit to a model of transparency (Burkle, 2015).

SARS most enduring lesson was that the inadequate surveillance and response capacity of only one country can threaten global health security (Heymann et al., 2013). SARS underscored the need for interconnected, well-prepared, and flexible public health systems (Khabbaz, 2013). Recognizing that need birthed two major initiatives aimed at strengthening surveillance. The CDC created the Global Disease Detection Program (GDDP) as an international collaborative effort to enhance countries' surveillance and outbreak response capacity. Also, the One Health Movement gained more traction due to its interdisciplinary approach of addressing human, animal, and environmental health as a whole (Braden et al., 2013). Furthermore, the SARS aftermath led to a major revision of the IHR, which the World Health Assembly adopted in 2005 (Khabbaz, 2013). The revised IHR serves as a legally binding agreement among 194 United Nations Member States.

WHO revised its IHR after SARS, broadening the purpose and scope "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade" (Morse, 2012). The revisions give WHO the authority to declare a public health emergency of international concern (PHEIC) and

require that Member States increase their response capabilities. The IHR define a PHEIC as "an extraordinary event which is determined to constitute a public health risk to other states through the international spread of disease and to potentially require a coordinated international response" (WHO, 2011). Only WHO's DG has authority to determine if an event constitutes a PHEIC and can only do so after seeking the advice of an emergency committee of external experts.

Additionally, the revised IHR requires WHO Member States compliance in four specific areas:

1. Notifying WHO of events that may be PHEICs;
2. Meeting minimum requirements for surveillance and response;
3. Meeting minimum screening and other requirements at country points of entry; and
4. Improving how public health events are managed (Harben, 2015).

WHO allowed a provision for countries to "opt-out" of certain provisions in order to expedite ratification of the new IHR (Fairman, Chigas, McClintock, & Drager, 2012). Some Member States opted out and most did not meet the minimum core capacities. If the minimum requirements for surveillance had been met in West Africa and the reporting transparent, then WHO would have had much better information with which to execute a response to EVD.

Lack of Resources

A lack of resources plague most outbreaks, making prolonged responses even more problematic. Limited expertise, personnel, and funding are the critical gaps the literature concentrates on.

Several initiatives to enhance outbreak response and global security have been developed over the years, the Global Outbreak Alert and Response Network (GOARN) being one of the

most successful. Recognizing the need for increased communication between local and international partners, GOARN was created in 2000 to consolidate technical efforts to outbreak response (Chan et al., 2010). GOARN established a network of numerous partners willing to participate in coordinated outbreak responses (Mackenzie et al., 2014). GOARN includes on their website alerts, assistance requests, operational updates, offers for support, and details of deployments. Deployments revolve around clinical management, epidemiology, infection control, laboratory support, social mobilization, risk communication, and logistics (Mackenzie et al., 2014). GOARN linked individual and international surveillance and response systems and quickly had over 120 partners worldwide by 2004 (Heymann, 2004). SARS marked the first time GOARN responded to a disease that was spreading rapidly internationally and the network was lauded for enabling WHO to fulfill its alert and response obligations during H1N1 (WHO, 2011).

Since its establishment, GOARN has grown to incorporate 153 institutions and 37 additional networks, each consisting of 355 members (Mackenzie et al., 2014). Partners have extended over a large geographic area encompassing a broad range of technical skills and disciplines. SARS made the difficulties of coordinating multiple simultaneous responses in different countries obvious (Mackenzie et al., 2014), and in 2015, EVD revealed GOARN still needed to be faster, more organized, and gain an even broader skill set capacity (Heymann et al., 2015).

WHO also addressed the consistent lack of adequate resources in a formal response to the Special Session of the Executive Board on Ebola. They acknowledged limitations of surge capacity, as responses to small outbreaks were effective, but national and international responses continued to be lacking for larger outbreaks. Challenges persisted with coordinating response amongst numerous partners (WHO, 2015i). As they did in the aftermath of H1N1, WHO

committed to creating a multidisciplinary surge capacity team that can be automatically released from normal duties, so qualified staff is ready to deploy if needed. This Global Health Emergency Workforce would be created from health and social scientists, logisticians, project managers, healthcare workers, communication experts, and community laborers (WHO, 2015b, 2015e, 2015g, 2015h, 2015i).

To ensure adequate funding in the event of another outbreak, WHO recommitted to establishing the contingency fund they initially committed to after H1N1 so resources are readily available when needed. The purpose of the fund would be to finance reliably and quickly WHO's initial response to PHEs. WHO hopes this fund would save lives, alleviate suffering, provide medical care, enable preparedness and surveillance, and quickly address factors that could lead to escalation of a given emergency. The target would be $100 million, fully funded by voluntary contributions from WHO member states (WHO, 2015a, 2015e, 2015h, 2015i).

Lack of Enforcement

The 2009 H1N1 flu pandemic systematically tested the effectiveness of the provisions of the 2005 IHR for the first time (Fineberg, 2014; Mackey & Liang, 2012). The revised IHR's strengths lay in their flexibility and being internationally binding. Also, to incentivize accurate reporting of potential PHEICs, those countries reporting such occurrences are granted representation on the advisory committee for any international measures taken. However, there were shortcomings with IHR's implementation (Burkle, 2015). The IHR requires that reporting be done within 24 hours of the assessment of data or public health information that point to the possibility of a PHEIC. Without cooperation of states or individual provinces, this requirement could be problematic. Another unique challenge occurred during H1N1 when Indonesia did not provide avian influenza samples for vaccine development in a timely manner. WHO did not have

the authority to force Indonesia's hand, but the DG ensured the public that those who did not share these samples would be in breach of the IHR. A frequent criticism of the revised IHR is the lack of enforceable sanctions (Fineberg, 2014; WHO, 2011). If a Member State does not comply with the regulations, e.g., adopts stricter travel restrictions beyond what WHO recommends, no legal consequences follow (Burkle, 2015).

The new IHR faces other challenges as well. Little attention was given to how the global community would fund and maintain some of the critical capacities defined in the treaty (Burkle, 2015). Ironically, only the countries with the highest capacity and least risk for an outbreak developed adequate systems to meet the IHR by the deadline. Also, WHO Member States failed to invest in and support the agency to ensure that WHO could address its own global mandate. Although H1N1 revealed weaknesses in the IHR, these weaknesses were not adequately addressed in time to prevent EVD from becoming a PHEIC.

Although it is the responsibility of WHO and its IHR to address PHEICs, some literature accuses Member States of failing the agency (Burkle, 2015; Fineberg, 2014). Some public health experts put blame for Member States' noncompliance on a lack of appropriate metrics for identifying success in achieving the core capacities set forth by the IHR (Ijaz et al., 2012). Providing metrics to measure progress towards attaining goals is considered essential. Only four of the capacities have goals and metrics set forth by the WHO Collaborating Center for IHR implementation of National Surveillance and Response Capacity. For all WHO Member States to develop and enhance their abilities to detect and respond to PHEs, the countries need concrete and well-defined goals to do so (Ijaz et al., 2012).

In 2014, the U.S. created the Global Health Security Agenda (GHSA) to combat the growing frustration over IHR noncompliance. The GHSA aims to address the at-risk countries

and is committed to the recovery of affected countries, and the augmentation of their preparedness and dedication to creating sustainable systems (Burkle, 2015). The U.S. outlined their goal to partner with countries over five years to improve the capability to prevent, detect, and respond to infectious disease outbreaks (Cho & Chu, 2014; Paranjape & Franz, 2015). The GHSA seeks to accelerate progress towards a safer world and to promote international security as a priority by preventing outbreaks, detecting threats early, and responding rapidly to PHEs (Marinissen, Barna, Meyers, & Sherman, 2014). The literature identifies several overlapping objectives between the GHSA and IHR (Katz, Sorrell, Kornblet, & Fischer, 2014). Yet, the initiative is still too young to generate sufficient evidence as to whether the GHSA enhances or duplicates international efforts.

Delayed Response

Delayed recognition of the outbreak severity hampered the initial response to the West Africa EVD epidemic, allowing it to gain momentum (Agyepong, 2014; Koch, 2015; Sack et al., 2014). The response initially depended heavily on NGOs, then the subsequent global response was slow, disorganized, and poorly executed (Burkle, 2015; Drazen, Campion, Rubin, Morrissey, & Baden, 2015; Kalra et al., 2014). Initial response teams falsely believed the epidemic had been contained (Sack et al., 2014). Communication between WHO headquarters in Geneva and its affiliates in six other regions was not forthcoming, as documented cases of EVD were not relayed to senior health officials investigating on the ground. Added to that were WHO's strained resources from budget cuts, Middle East Respiratory Syndrome Corona Virus (MERS CoV) in Saudi Arabia, polio in Syria, and a new highly pathogenic avian influenza strain in China (Sack et al., 2014).

Underreporting of cases, lack of contact tracers, and sporadic cross-border cooperation exacerbated a growing threat (Sack et al., 2014). Medecins Sans Frontieres (MSF) contended that simultaneous cases across multiple locations caused the unprecedented spread making it harder to contain (MSF, 2015). While public health officials struggled to educate populations on the dangers of EVD, communities resisted and evaded treatment. In hindsight, leaders from both WHO and the CDC realized a drop in cases early on should not have triggered "sighs of relief". If the uniqueness of the West African culture had been considered and contact tracing better, many lives may have been saved (Sack et al., 2014).

WHO already acknowledged serious gaps in engaging with local communities; although traditional cultural practices contributed to the outbreak's spread, culturally appropriate messaging and community engagement were not prioritized (WHO, 2015b).

Further, in the Ebola Interim Assessment Panel report by the Secretariat, WHO blamed the delay in declaring EVD a PHEIC on misunderstanding the context and nature of the outbreak, unreliable reporting, problems with information flow within the agency, and difficult negotiations with countries. Despite those admissions, the Panel still did not explain why warnings in early 2014 did not prompt an adequate response (WHO, 2015b).

MSF also reported facing many political obstacles causing "a vacuum of leadership." WHO accused MSF of exaggerating the severity of the outbreak so pleas for additional qualified staff, increased contact tracing, and more health education dissemination went unheeded. Sierra Leone and Guinea's reluctance to recognize the outbreak's severity inhibited early response as well. Also, the ministries of health (MOHs) refused to share data or contact lists with MSF, forcing the teams to work from scratch (MSF, 2015).

Additional literature illuminated multi-level challenges that inhibited the prevention and control of EVD in West Africa. Personal challenges included severe poverty, fear, risk perception, social stigma, limited access to healthcare, and traditional African belief systems. Organizational challenges included disarray from civil wars, endemic morbidities, and poor public health infrastructures. Community challenges included porous borders, mistrust of government, and the practice of using African traditional healers instead of seeking treatment in hospitals (Buseh et al., 2015).

Some reports suggested that the lessons learned likely would not be remembered (MSF, 2015). Few foreign states have interests in building capacities of weaker territories until there is a direct threat to their own soil, so it would be folly to put all the blame on WHO. For this epidemic to spiral, numerous entities failed. A rapid and hands-on emergency response within global health systems still does not exist. EVD underscored the consequences of that omission.

Summary and Relevance

The literature reveals several recurring insights into what influences outbreak response. Fear of a disease can cause stigmatization and hamper identification and treatment of cases. The media plays an important role in the public's interest in a PHE and can be a platform for effective risk communication. Although the revised IHR has many strengths, the absence of enforcement and sufficient funding mechanisms have kept the weakest countries highly vulnerable to disease outbreaks. Historically, most nations have not been proactive in equipping weaker entities unless they observed a direct threat to themselves. Also, a lack of accurate and timely information exchange between multiple entities hindered the initial response to EVD. Many cultural and political obstacles, including poor surveillance and inaccurate reporting, have

historically severely delayed aid and the identification and containment of cases during outbreaks.

In 2009, WHO's H1N1 Review Committee came to an ominous conclusion (Fineberg, 2014). The committee concluded that "the world is ill prepared to respond to a severe influenza pandemic or to any similarly global, sustained and threatening global health emergency" (WHO, 2011). So, the committee recommended that WHO and Member States establish a more extensive global health reserve workforce and create a $100 million contingency fund, readily accessible to WHO to support surge capacity (WHO, 2011).

Unfortunately, WHO did not adhere to these recommendations. Again the world was ill prepared when EVD struck. This study builds on the current body of knowledge to allow for greater understanding in assessing these persistent problems in global health response.

III. Methods

Using PubMed and Google, the principal investigator (PI) conducted a comprehensive search of articles connected to HIV/AIDS, SARS, H1N1 and Ebola responses. Search terms included: Ebola; Ebola and AIDS; Ebola and HIV; Ebola and H1N1; Ebola and SARS; Ebola Response; AIDS response; HIV response; SARS response; H1N1 response; Global Health Regulations; International Health Regulations; Global Health Security Initiative; risk communication best practices; AIDS lessons learned; HIV lessons learned; SARS lessons learned; H1N1 lessons learned; Ebola lessons learned; AIDS after action reports; HIV after action reports; SARS after action reports; H1N1 after action reports; Global Health Security Agenda; and global public health response.

Additionally, the PI conducted in depth interviews (IDIs) with key responders involved in HIV/AIDS, SARS, H1N1, and EVD. All data were analyzed using computer-assisted qualitative data analysis software (CAQDAS) to identify themes and parallels among the different public health emergencies.

Data Collection

The PI recruited participants via email through convenience sampling of individuals recommended by the thesis committee or known by the investigator at the CDC in Atlanta. The PI also recruited through snowball sampling – asking participants if they knew other colleagues meeting the inclusion criteria that might agree to be interviewed for the project. Interviews were conducted with public health professionals with experience in public health, emergency response, or health communication. To fit the inclusion criteria, participants must have been involved with responses to one or more of the following PHEs: HIV/AIDS, SARS, H1N1, or

EVD. However, they did not need to still be working within that field. People not directly involved with the responses were ineligible.

Out of 28 individuals sent recruitment emails, 21 people participated – 10 through convenience sampling versus 11 through snowball sampling. Participant retention was 100% with no dropouts. The PI conducted interviews over a two-month period ceasing snowball sampling for the last 11 interviews due to time constraints.

Instruments

The interview guide was original and developed according to best practices for crafting open and singular interview questions (Patton, 2001; Tong, Sainsbury, & Craig, 2007). Questions were general enough to apply to a broad range of response roles and organized to elucidate the PI's research questions. (See Appendix A.)

Setting

The PI conducted 19 interviews face-to-face either at Emory University or the CDC Roybal campus in private offices or conference rooms. Two interviews took place by telephone. Interviews ranged from 12 to 66 minutes, averaging 35 minutes. All interviews were recorded, in person via smartphone, and by telephone via the Call Recorder application for iPhone.

Sample

The participant sample consisted of thirteen males and eight females. Of the participants, two responded solely to HIV/AIDS, one solely to SARS, two solely to H1N1, eight solely to EVD, and eight responded to more than one of these PHEs. None of the participants responded to all four PHEs.

Participants' areas of expertise included: surveillance, epidemiology, diagnostics, virology, microbiology, infection control, emergency response coordination, laboratory management, outbreak response, medicine, biosafety, behavioral interventions, and military experience. Participants' roles during the responses included: vaccine distribution, laboratory coordination, diagnostic testing, pathogen identification, policy, border entry and control, clinician training, authoring guidance documents, and emergency and incident management. Participants during the responses were team leads, members of task forces, laboratory coordinators, subject matter experts (SMEs), Epidemic Intelligence Service (EIS) officers, emergency response coordinators, an incident manager, a senior science officer, epidemiologists, and those in CDC and WHO leadership positions.

Ethical Considerations and Emory IRB Approval

The primary risks to participation stemmed from participants' colleagues deducing their identities from the data reported. As many interviewees were still working within their respective fields, participant burden could result from colleagues identifying them. To prevent this, confidentiality was maintained by removing identifiers from the data to protect against deductive disclosure of identity. Aggregate data reporting was used when possible. No vulnerable populations were involved. Informed consent was obtained orally and recorded before conducting interviews.

Participants were not compensated monetarily, but their scholarship and experiences may add to the knowledge base of global health response and potentially benefit future responses to international PHEs.

Given the nature of the study, the Emory Institutional Review Board (IRB) determined this project to be exempt from further IRB review.

Data Analysis

The PI transcribed the interviews verbatim with the aid of the Transcriptions (version 1.1) application. Both the interview transcriptions and data gathered from the literature review were organized, coded, and analyzed with the aid of MAXQDAplus (version 11) software.

Data were organized into 190 different codes and subcodes. In all, there were 1,548 coded segments: 532 within the transcripts and 1,016 within the literature. Codes were assigned to segments of text based upon content and relevance to answering the research questions. Some segments were assigned multiple codes. For example, "In the 1980s, there were many publicized examples of providers distancing themselves from any obligation to care for AIDS patients" was assigned three codes: HIV/AIDS, Healthcare workers, and Fear. (See Appendix B).

Data were analyzed for frequency of codes and weighted depending upon the participants' role and expertise. Data were then evaluated according to overarching and repetitive themes. Interview data was separated from the literature to more easily identify nuances from the responders.

Results

Results are organized and reported in aggregate according to recurring themes: successes, turning points, logistics, communication, CDC policy barriers, and political and cultural clashes within responding agencies.

Successes

Although this study aimed to pinpoint weaknesses in global response, it also identified several successful aspects of previous responses. Preparedness planning and exercises and pre-existing relationships within public health contributed to the success of the H1N1 response (HHS, 2012). To prepare for a potential H5N1 influenza pandemic, years of planning and

exercises occurred at various levels of government, both in the U.S. and internationally (Bond, Macfarlane, Burke, Ungchusak, & Wibulpolprasert, 2013; CDC, 2010). H1N1 responders feel the years of pandemic planning beforehand contributed to a successful response. Conversely, CDC conducted no EVD preparedness exercises beforehand, because most exercises are planned according to what is most likely with the hope the plans can incorporate unforeseen or rare events. From the pandemic planning, the number of the CDC's existing partnerships before H1N1 far surpassed those before EVD. Samaritan's Purse had been in Liberia for over ten years, but at the time of the EVD outbreak, the CDC's only presence in West Africa was one malaria researcher in Guinea; this affected each organization's response.

Timely identification of the SARS and H1N1 viruses also helped the response; the CDC rapidly identified both and shared the sequences through a publicly assessable database (CDC, 2010; Chastney, 2014; HHS, 2012). This rapid and transparent information sharing enabled scientists around the world to differentiate between H1N1 and seasonal flu and SARS versus other respiratory illnesses (CDC, 2010).

Turning Points

Participants reiterated and expanded upon turning points within the PHEs. When HIV/AIDS transmission was better understood and the risk groups extended to the general public and celebrities, interest seemed to go from "zero-to-panic" overnight. In December 1982 and January 1983, two Morbidity and Mortality Weekly Report (MMWR) articles described viral transmission occurring through heterosexual contact, from mother to unborn child, and through blood transfusions. Then in 1985, movie star Rock Hudson publically admitted to having AIDS. Afterwards, HIV/AIDS became one of the most covered news stories for the next six or seven years. The SARS superspreader event at the Metropole hotel not only started its international

spread, but also revealed frightening aspects of transmission. The virus spread through very minimal contact. That, combined with the high death rates of infected healthcare workers, made containing SARS a priority among the international public health community early on.

Participants offered additional insights into what the literature revealed as the tipping points in the EVD outbreak. All of WHO's EVD experts had retired or left, so it was the opinion of many that WHO did not have adequate knowledge of EVD. So, in June 2014, the GOARN Steering Committee wrote a letter to the WHO DG outlining the severity of the situation and warning it would get much worse. The letter listed gaps and solutions in all major areas from epidemiology, case management, logistics, and leadership. This letter, authored by members of the CDC, Institute Pasteur, MSF, International Federation of Red Cross and Red Crescent Societies (IFRC), and European Center for Disease Control and Prevention, got the DG's attention. Shortly before that, MSF went onto the public stage declaring the outbreak was out of control and they were unable to keep up with all the cases. Very soon after these incidents, the DG declared EVD a PHEIC.

For the US, the infection of nurses in a Dallas hospital drew substantial media attention. It also placed CDC on the defensive, questioning the agency's capacity to ensure the safety of the American public.

Logistics and Coordination

Logistics are also a major problem with most responses. Many resources no longer needed were wasted during the second half of the EVD response. Money and materials were donated with good intention, but without proper systems to distribute according to need. PPE degraded outside of hospitals because too much was delivered. Sophisticated diagnostic equipment remained idle because the facilities lacked the reagents and personnel to operate it.

Additionally, a lack of formal systems of collaboration and persistent behavioral obstacles has potentially hampered future research. A framework for laboratory coordination and sample collection and preservation was not established at the beginning of the EVD outbreak. This gap in planning has put 400,000 clinical specimens at risk of being lost because the integrity of those samples cannot be ensured.

Sadly, old ways of doing research still plague outbreaks as well. Often the science of outbreaks is not fully known until the scientists look at data months later. Some researchers still desire to publish first and advance their careers rather than be transparent in sharing information. Fortunately, this is not always the case, as rapid data dissemination occurred with both SARS and H1N1.

Communication

Understanding the community and location of an outbreak also helps containment and enables the crafting of communication that is trustworthy and effective. Surgeon General Koop and Anne Schuchat were effective and credible communicators during the first years of HIV/AIDS and throughout H1N1. Since information during emergencies is continuously unfolding, responders and risk communicators must do the best with what they know at any given time.

The world looks to both WHO and the CDC for guidance during emergencies, whether in the form of travel advisories, personal precautions, or clinician instructions. The nature of an emergency means this guidance can and often does change. During SARS, a two-person team oversaw the review and release of guidance documents to the CDC website. The task was daunting and many initial documents needed major revisions before publication, including resolving conflicting information.

Since SARS, CDC and WHO guidance documents still lack appropriate review mechanisms to ensure guidance is correct, clear, and without contradictions. One interview participant thought the CDC's guidance for the use of personal protective equipment (PPE), may have contributed to Dallas healthcare workers contracting EVD.

CDC Policy Barriers

Lack of personnel and resources are recurring problems in the face of rapidly escalating, even overwhelming needs during emergency response. At the CDC, few people are designated as emergency responders, e.g., EIS officers and the Emergency Response and Recovery Branch (ERRB). Therefore, personnel from other branches must be used. This becomes problematic because Congress separates funding streams, so people are only paid to work on specific projects within their program. Therefore, if someone working in diabetes research wants to work in the Emergency Operations Center (EOC), the diabetes program must be reimbursed. Money from the CDC Foundation, a separate nonprofit organization that connects the CDC with the private sector, is more flexible and is helpful, but also quickly exhausted in large responses. Like WHO, despite prior recommendations, the CDC still lacks a sufficient contingency fund for surge capacity.

CDC policy barriers also contribute to a lack of personnel in the field, as deploying responders internationally is complicated. Numerous obstacles can prevent getting the right people out the door in a timely manner. The State Department requires special training to deploy internationally in addition to basic passport, VISA, and medical clearance requirements. New training mandates add additional complexity. To deploy for more than 30 days, a five-day course to prepare and work overseas is required. Since January 2015, a new six-hour online course is required for international travel. Also, for countries with less internal security, a one-week course

in Virginia is required. In 2016, this course will be required for any travel to Africa. It is possible to extend the 30-day limit with a waiver from the ambassador, which happened for the West Africa countries; however, this takes time and is rarely done.

This turnover also contributes to a loss of productivity and information transfer. Deployments are supposed to be staggered so the responder's replacement is in country and trained before the first returns to the U.S. This does not always happen, so information flow is interrupted and lessons learned are not passed on and have to be relearned. For short deployments, this can shrink the time of productivity down to only two weeks. Many responders also feel there is a disconnection between leadership in Atlanta and the field. As a result, there is confusion, responders are ill prepared once in country, and guidance from Atlanta can be unrealistic and unfeasible.

Political and Cultural Clashes

There is a lack of confidence in both WHO and the CDC and morale within WHO is low. Some charge WHO with becoming too political and less technical. Over time, many experts have slowly retired and not been replaced; as other established scientists no longer choose to work in that environment. Disease specialists find it difficult to accomplish the technical aspect of the work due to the politics. WHO employees also find it hard to respect leadership that they claim allowed EVD to get out of control.

The CDC may have experienced a similar shift within its culture. After 9/11 and the anthrax mail attacks, the agency was heavily scrutinized over their purported inability to keep the public informed during an emergency. Afterwards, in order to prioritize public relations, some feel that the technical capabilities of the CDC may have suffered in order to appease the general public. SME's complain the push to keep the public, CDC leadership, and the EOC informed

overwhelms them during a response. SMEs spend many hours answering questions to as one put it, “feed the monster.” It is felt that these hours take away valuable time and energy that could be better directed to the field response.

Serious cultural clashes between the EOC and scientists hinder responses. CDC outbreak responses are initially delegated to the branch or program with expertise in the pathogen causing the threat. EOC leadership tends to be ex-military, adhering to “tried and true” incident management systems (IMS). These systems are those that exist to aid response when the disease threat progresses beyond the program’s capacity to respond. One of the criteria for EOC activation is the program must declare they are no longer able to handle the response. Yet, it is felt by some program SME’s that coordinating with the EOC causes the program to lose control of the response. Resentment exists on both sides and ultimately communication and coordination are hampered.

Some participants stated that the CDC has some strained international relationships. Certain responding organizations view the CDC’s response in country as dominating, rather than empowering and supportive. Over time this generates dissatisfaction. Also, policy barriers for responder deployment cause a lot of personnel turnover in country. Since most organizations stay longer, the constant turnover makes it harder for those organizations to collaborate with the CDC in the field.

Summary

The interviews reiterated and expanded upon what the literature revealed. Although aimed at detecting weaknesses within response, this study identified strengths as well. Preparedness planning and rapid data sharing contributed to successful responses to SARS and H1N1. Turning points within the PHEs frequently depend upon the public perceiving the risk as

widespread. The modes of transmission and geographic spread of disease affect this risk perception. Logistics and coordination are problematic for responses. Deficiencies in these areas have hampered future research. In addition, a lack of mechanisms for the review and release of guidance documents has inhibited accurate health information dissemination to the public during PHEs.

CDC has several policies that create barriers in global response. Restricted funding and regulations for staff deployment cause frequent complaints for those coordinating these emergency responses. Lack of understanding and cooperation between scientists and the EOC also cause impediments and delays in response.

Participants describe both CDC and WHO as becoming more political and less technical over time. But, these same participants acknowledge the need to have both scientific knowledge and the ability to engage and inform the public effectively.

The data reveal disturbing information regarding the environments and capabilities of the CDC and WHO. Unfortunately, many lessons are not learned as the same problems occur over and over again. Most troubling is that data point to the world remaining ill prepared to handle sustained responses and global pandemics.

IV. Discussion

Several problems were unique to the West Africa EVD epidemic; however, the outbreak's severity and longevity exposed many persistent vulnerabilities plaguing international public health response.

Both WHO and the CDC realize they need a reserve work force that can be easily released from duties to deploy during an emergency (Burkle, 2015; Fineberg, 2014; Gostin, Waxman, & Foege, 2015; WHO, 2015b, 2015e, 2015g, 2015h, 2015i). However, many obstacles exist to the CDC deploying international staff for long-term response. The frequent turnover causes decreased productivity in the field and frustrates collaboration with organizations that stay longer. The CDC appears to be trying to fill this gap. In June 2015, the CDC established a Global Rapid Response Team (Global RRT) and began recruiting (CDC, 2015b). Also in 2015, WHO developed an international roster to recruit foreign teams to populate a global health emergency workforce (WHO, 2015g). The required competencies for this reserve workforce are public health, clinical, coordination, logistics, social mobilization, communication, and information management. The next PHE will test these reserves.

The CDC also suffers from other policy barriers. The itemized funding streams limit flexibility to direct resources to where they are needed most. Although the CDC's Center for Global Health (CGH) and the CDC Foundation have small funds for response, these are very quickly depleted. The previously recommended contingency fund may alleviate some hurdles and give the CDC greater flexibility in the future. Frequently, a response garners funding and personnel in relation to the public's interest. Public interest in disease is proportional to their perception of risk to themselves or loved ones and often reactions are either minimal or extreme. (EU, 2015; Jaffe, 2015). Emotional reactions not based on scientific evidence can cause

stigmatization, inhibiting containment and treatment of disease outbreaks (Bevington, Kan, Schemm, & Aldridge, 2015; Davtyan et al., 2014; Keusch et al., 2006; MSF, 2015; Person et al., 2004). Therefore, incorporating stigma mitigation strategies into risk communication in addition to raising awareness of a disease threat can be helpful in responses (Jaffe, 2015; Keusch et al., 2006; Person et al., 2004).

Responder interviews illuminate cultural and political clashes within the CDC and WHO that the literature did not. Both agencies are seen as more political and less technical than they once were. Many experienced scientists no longer want to work for WHO, less they become entangled in politics and unable to concentrate on science. Clashes in ideals exist between scientists and the EOC. And SMEs are overwhelmed during responses providing information to CDC leadership and the EOC, diverting their attention away from the field response.

The CDC has some strained relationships internationally as well; some interview participants describe some foreign organizations seeing the agency as arrogant and overbearing. However, some responders found the CDC to be well respected in the environments to which they were deployed. And other responders described their tactics to be supportive, not controlling. Thus, it appears that not all relationships are strained and the CDC has some valuable partnerships in the global health community.

The revised IHR need greater enforcement and accountability from all Member States. The core capacities, once achieved, can greatly enhance global security. Those with ample resources are encouraged to help other nations comply with the regulations by the next deadline (Burkle, 2015; Fineberg, 2014; Katz et al., 2014). These increased national capacities, GOARN, and the GHSA will aid in preventing, detecting, and responding to the next PHE (Mackenzie et al., 2014; Paranjape & Franz, 2015).

Strengths and Limitations

The interview sample was limited to the CDC, WHO liaisons, and one representative from Samaritan's Purse. No MOHs, academic institutions, other foreign public health organizations, or other NGOs were sampled. Additional weaknesses specific to WHO, MOHs, and other NGOs could be revealed if interviewed. Also, the interview responses were subject to and varied according to the responders' own views and experiences. However, the research thoroughly identifies recurring obstacles specific to the CDC's ability to respond to international emergencies. Several obstacles were reiterated and confirmed by many CDC responders. Because of that and the breadth of expertise and numerous roles of these participants, it is unlikely that additional information of importance would be identified through further sampling of CDC responders.

Coding and analysis of the data are subjective. Although the data were organized with MAXQDA software, the PI assigned the codes and retrieved the data based on recurring themes within that framework.

Ultimately, this study does reveal nuances within the CDC and WHO that the literature did not, which is perhaps its greatest strength. Identifying and exposing these internal cultural and political obstacles may prove helpful in preparing for future responses.

Public Health Implications

Identifying weaknesses in outbreak response and taking steps to correct and prevent them are critical to global health security. However, being unable to mitigate the same weaknesses repeatedly is an even greater problem. Both the CDC and WHO have this problem. They are not the only responders to international crises, but they are the largest and most powerful. The EVD crisis was of unprecedented magnitude and did have unique features that made it harder to detect

and contain. However, the data suggest these internal clashes were one of the contributing factors that delayed CDC and WHO mounting substantial responses to the EVD outbreak.

Conclusions and Recommendations

Due to numerous policy barriers facing the CDC, concentrating on implementing policies that expedite emergency response would be beneficial. The Food and Drug Administration (FDA) has Emergency Use Authorizations (EUAs) permitting use of some non-approved diagnostics and interventions in emergency situations that were helpful during H1N1 and EVD (HHS, 2012; Singh, 2015). Providing more waivers like EUAs and legislating policies that allow more flexibility in funding and personnel deployment would help to eliminate time-consuming and resource restricting barriers.

To help bridge communication and understanding between scientists and the EOC, the CDC should consider organizing preparedness exercises with more programs within their agency. Although EOC activation is often not needed with outbreaks, exercises would equip more program offices with knowledge of how the EOC and the IMSs work. Additionally, some relationships between EOC leadership and scientists could be established to help them work together more seamlessly in the future.

It is beyond the scope of this study to identify the reasons the CDC and WHO did not adopt previous recommendations from other PHEs. However, the study did identify major vulnerabilities persistent in global public health response. Additionally, because the sample was limited, conducting similar studies of other major international responders could be helpful. Findings may aid coordination among multiple partners in future responses.

Some factors of an outbreak cannot be changed. Building response capacities cannot change pathogen characteristics, for example; they can only help to detect and contain the

pathogen more quickly. Other factors can be changed, some more easily than others. Regulations and policies can be changed and meta-analyses of after action reports can be conducted. The more difficult changes can be those that are behavioral. It is this PI's recommendation that the CDC and WHO work hard to understand and change the cultures within their walls and that they would approach this task with urgency, open minds, and humility. These agencies are tasked with the monumental responsibility of keeping the world safe from disease, and the world is counting on them to do so.

V. Journal Article

What Ebola Taught Us: The Old and the New

Renee Crawford

Abstract

In late 2013, an Ebola outbreak began that quickly grew into an epidemic of extraordinary magnitude, killing more people than all previous Ebola outbreaks combined. Although the outbreak was unprecedented, the world had previously experienced several acute public health emergencies requiring international coordination. However, in each case, coordination had proved problematic, and this latest event was no exception. The purpose of this project was to identify persistent vulnerabilities within international public health emergency response and to identify areas for future research and improvement. A literature review and key informant interviews were conducted. Data were analyzed using MAXQDA qualitative data analysis software. Results showed a number of issues, including a shortage of personnel and resources, policy barriers that hinder long-term international response, itemized funding streams that limit flexibility to direct resources, challenges to deploying responders internationally, cultural and political clashes within relevant agencies and a lack of confidence in those agencies. Most troubling is that data point to the world remaining ill prepared to handle sustained responses and global pandemics. The study identified major vulnerabilities persistent within global public health response and offers recommendations and opportunities for further focused research to fully understand why these challenges persist.

Introduction

In late 2013, an Ebola virus disease (EVD) outbreak quickly grew into an epidemic of unprecedented magnitude, killing many more than all previous EVD outbreaks combined. By March 2014, the virus had traveled to Conakry, the capital of Guinea, in what became the first-ever urban EVD outbreak (BBC, 2014). Subsequently, EVD spread from Guinea to Liberia and Sierra Leone, and into Senegal, Nigeria, Mali, Spain, Italy, the United Kingdom and the United States killing almost 30,000 people by mid-2015 (WHO, 2015c). Appearance of the disease in urban centers, community resistance, poor healthcare infrastructures, and porous borders between Sierra Leone, Liberia, and Guinea, made this outbreak different (Buseh et al., 2015; MSF, 2015; Sack et al., 2014; WHO, 2015d). This outbreak occurred at the intersection of three of the world's poorest and least developed countries, where people pass through borders

unhindered (MSF, 2015; Sack et al., 2014). All three countries – Sierra Leone, Liberia, and Guinea – recently endured civil wars that left them with dysfunctional healthcare systems and few healthcare workers (Buseh et al., 2015).

Civil wars not only contributed to ravaged healthcare systems, but also contributed to distrust of government (Sack et al., 2014). Pervasive corruption and atrocities suffered during these wars created the disdain for government. Therefore, populations demonstrated great resistance to some measures implemented by governments to contain the disease. Forced quarantines and criminalizing the failure to report suspected cases drove people underground away from care, and ultimately bred fear and unrest, rather than aiding containment (Liu, 2014).

Perhaps most importantly, critical months passed before the international community began to respond in earnest. The failure to act more aggressively stemmed from previous EVD outbreaks being contained early without massive international aid (Sack et al., 2014). Medecins Sans Frontieres (MSF) did respond quickly and initially treated two thirds of the cases. However, by December 2014, MSF president Joanne Liu declared her teams exhausted and resources depleted (Liu, 2014). Despite the World Health Organization's (WHO) authority, no single agency or organization had the capability to handle the outbreak, making mass cooperation and coordination among agencies a necessity.

Delayed recognition of the outbreak's severity hampered the initial response to the West Africa Ebola epidemic, allowing it to gain momentum (Agyepong, 2014; Koch, 2015; Sack et al., 2014). The response initially depended heavily on NGOs, then the subsequent global response was slow, disorganized, and poorly executed (Burkle, 2015; Drazen et al., 2015; Kalra et al., 2014). In hindsight, leaders from both WHO and CDC realized a drop in cases early on

should not have triggered “sighs of relief”. If the uniqueness of the West African culture had been considered and contact tracing better, many lives may have been saved (Sack et al., 2014).

The turning point for the international community and the media occurred when the virus crossed the ocean into the USA. A patient returning from West Africa received treatment at a Dallas hospital and infected two nurses. Human-to-human transmission of the virus outside of Africa made the epidemic no longer a humanitarian emergency, but an international threat to public health and security (Burkle, 2015; EU, 2015; Jaffe, 2015; MSF, 2015; Sack et al., 2014).

While the West Africa EVD epidemic was unique, the world had experience with other acute public health emergencies requiring international coordination, including HIV/AIDS, SARS, and H1N1 influenza. In 2000, WHO established the Global Outbreak Alert and Response Network (GOARN) (Burkle, 2015; Snowden, 2008), a network of technical and research institutions, universities, and international health organizations tasked with aiding global health security (Chan et al., 2010; Mackenzie et al., 2014). GOARN provides technical support to assist with disease control, assess risks and investigate events for emerging threats, and support preparedness for sustained containment of these threats (WHO, 2015f). GOARN linked individual and international surveillance and response systems and quickly had over 120 partners world-wide by 2004 (Heymann, 2004). Since its establishment, GOARN has grown to incorporate 153 institutions and 37 additional networks, those networks consisting of 355 members (Mackenzie et al., 2014). SARS made the difficulties of coordinating multiple simultaneous responses in different countries obvious (Mackenzie et al., 2014), and EVD revealed GOARN still needed to be faster, more organized, and gain an even broader skill set capacity (Heymann et al., 2015).

Response to the SARS epidemic also revealed inadequacies in the out-of-date International Health Regulations (IHR), catalyzing a much-needed revision. Previously only requiring the reporting of cholera, plague, yellow fever, and smallpox, the purpose and scope of the IHR were expanded "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade" (Morse, 2012). The revisions give WHO the authority to declare a Public Health Emergency of International Concern (PHEIC) and demanded that Member States begin increasing their response capabilities.

The revised IHR's strengths lay in their flexibility and being internationally binding. However, a frequent criticism of the revised IHR is the lack of enforceable sanctions (Fineberg, 2014; WHO, 2011). If a Member State does not comply with the regulations, e.g., adopts stricter travel restrictions beyond what WHO recommends, no legal consequences follow (Burkle, 2015). Member States were given five years to develop and implement a minimum of core public health capacities. Unfortunately, by the 2012 deadline, less than 20% of the 194 Member States had achieved the required capacities and most filed two-year extensions (Braden et al., 2013; Ijaz et al., 2012; WHO, 2012). Ironically, only the countries with the highest capacity and least risk for an outbreak developed adequate systems to meet the IHR by the deadline.

The 2009 H1N1 flu pandemic systematically tested the effectiveness of the provisions of the 2005 IHR for the first time (Fineberg, 2014; Mackey & Liang, 2012). H1N1 was also the first event to be declared a PHEIC by the WHO Director-General (DG) (CDC, 2010).

In spite of an overall successful response to the pandemic, WHO's H1N1 Review Committee came to an ominous conclusion (Fineberg, 2014). The committee concluded that "the

world is ill prepared to respond to a severe influenza pandemic or to any similarly global, sustained and threatening global health emergency" (WHO, 2011). The committee recommended WHO and Member States establish a more extensive global health reserve workforce and for Member States to establish a $100 million contingency fund, readily accessible to WHO to support surge capacity (WHO, 2011). Unfortunately, WHO did not adhere to these recommendations. Again the world was ill prepared when EVD struck.

In 2014, the USA created the Global Health Security Agenda (GHSA) to combat the growing frustration over IHR noncompliance. The GHSA seeks to accelerate progress towards a safer world and to promote international security as a priority by preventing outbreaks, detecting threats early, and responding rapidly to public health emergencies (PHEs) (Marinissen et al., 2014). The USA has outlined their goal to partner with countries over five years to improve the capability to prevent, detect, and respond to infectious disease outbreaks (Cho & Chu, 2014; Paranjape & Franz, 2015).

Clearly, global responses to PHEICs have been complex and varied depending on the nature of the pathogen and the location of the outbreak. As several acute PHEs revealed, the world remains incredibly vulnerable to the threat of infectious disease outbreaks. For future responses, it is imperative to understand the complexities of the problems that continue to plague global health security. Identifying patterns of these vulnerabilities may allow for greater ability for multiple international entities to coordinate and respond appropriately in the future.

The purpose of this project is to identify persistent vulnerabilities within international public health emergency response in light of the 2013-2015 West Africa EVD epidemic and to identify areas for future research and improvement.

Materials and Methods

Using PubMed and Google, the principal investigator (PI) conducted a comprehensive search of articles connected to HIV/AIDS, SARS, H1N1 and EVD responses. Additionally, the investigator conducted in depth interviews (IDIs) with key responders involved in HIV/AIDS, SARS, H1N1, and EVD. The PI recruited participants via email through convenience and snowball sampling. To fit the inclusion criteria, participants must have been involved with responses to one or more of the following PHEs: HIV/AIDS, SARS, H1N1, or EVD. However, they did not need to still be working within that field. People not directly involved with the responses were ineligible.

The interview guide was original and developed according to best practices for crafting open and singular interview questions (Patton, 2001; Tong et al., 2007). Questions were general enough to apply to a broad range of response roles and organized to facilitate answering the PI's research questions:

1. What were the lessons learned from previous momentous acute public health emergencies - HIV/AIDS, SARS, and Novel H1N1 influenza?
2. What vulnerabilities in international public health response did these events reveal?
3. What was the tipping point in these events that finally galvanized the public and those in decision-making authority to take action?
4. In light of the West Africa EVD epidemic response, what limitations and challenges in international public health response remain?

Out of 28 individuals sent recruitment emails, 21 people participated -10 through convenience sampling versus 11 through snowball sampling. Participant retention was 100% with no dropouts. The PI conducted interviews over a two-month period ceasing snowball sampling for the last 11 interviews due to time constraints. The PI conducted 19 interviews face-

to-face either at Emory University or CDC Roybal campus. Two interviews took place by telephone. Interviews ranged from 12 to 66 minutes, averaging 35 minutes. All interviews were recorded, in person via smartphone, and by telephone via the Call Recorder application for iPhone.

The participant sample consisted of thirteen males and eight females. Of the participants, two responded solely to HIV/AIDS, one solely to SARS, two solely to H1N1, eight solely to Ebola, and eight responded to more than one of these PHEs. None of the participants responded to all four PHEs.

Participants' areas of expertise included: surveillance, epidemiology, diagnostics, virology, microbiology, infection control, emergency response coordination, laboratory management, outbreak response, medicine, biosafety, behavioral interventions, and military experience. Participants' roles in response included: vaccine distribution, laboratory coordination, diagnostic testing, pathogen identification, policy, border entry and control, clinician training, authoring guidance documents, and emergency and incident management. Participants were team leads, members of task forces, laboratory coordinators, subject matter experts (SMEs), Epidemic Intelligence Service (EIS) officers, emergency response coordinators, an incident manager, a senior science officer, epidemiologists, and those in CDC and WHO leadership positions.

The primary risks to participation stemmed from participants' colleagues deducing their identities from the data reported. To prevent this, confidentiality was maintained by removing identifiers from the data to protect against deductive disclosure of identity. No vulnerable populations were involved. Informed consent was obtained orally and recorded before

conducting interviews. Given the nature of the study, the Emory Institutional Review Board (IRB) determined this project to be exempt from further IRB review.

The PI transcribed the interviews verbatim with the aid of the Transcriptions (version 1.1) application. Both the interview transcriptions and data gathered from the literature review were organized, coded, and analyzed with the aid of MAXQDAplus (version 11) software.

Data were organized into 190 different codes and subcodes. In all, there were 1,548 coded segments: 532 within the transcripts and 1,016 within the literature. Codes were assigned to segments of text based upon content and relevance to answering the research questions. Some segments were assigned multiple codes. Data were analyzed for frequency of codes and weighted depending upon the participants' role and expertise. The PI then evaluated the data according to overarching and repetitive themes, separating the interview data from the literature to more easily identify nuances from the responders.

Results

Results are organized and reported in aggregate according to recurring themes: successes, turning points, logistics, communication, CDC policy barriers, and political and cultural clashes within responding agencies.

Successes

Although this study aimed to pinpoint weaknesses in global response, it also identified several successful aspects of previous responses. Preparedness planning and exercises and pre-existing relationships within public health contributed to the success of the H1N1 response (HHS, 2012). To prepare for a potential H5N1 influenza pandemic, years of planning and exercises occurred at various levels of government, both in the U.S. and internationally (Bond et al., 2013; CDC, 2010). H1N1 responders feel the years of pandemic planning beforehand

contributed to a successful response. Conversely, CDC conducted no EVD preparedness exercises beforehand, because most exercises are planned according to what is most likely with the hope the plans can incorporate unforeseen or rare events. From the pandemic planning, the number of CDC's existing partnerships before H1N1 far surpassed those before EVD. Samaritan's Purse had been in Liberia for over ten years, but at the time of the EVD outbreak, the CDC's only presence in West Africa was one malaria researcher in Guinea; this affected each organization's response.

Timely identification of the SARS and H1N1 viruses also helped the response; the CDC rapidly identified both and shared the sequences through a publicly assessable database (CDC, 2010; Chastney, 2014; HHS, 2012). This rapid and transparent information sharing enabled scientists around the world to differentiate between H1N1 and seasonal flu and SARS versus other respiratory illnesses (CDC, 2010).

Turning Points

Participants reiterated and expanded upon turning points within the PHEs. When HIV/AIDS transmission was better understood and the risk groups extended to the general public and celebrities, interest seemed to go from "zero-to-panic" overnight. In December 1982 and January 1983, two Morbidity and Mortality Weekly Report (MMWR) articles described viral transmission occurring through heterosexual contact, from mother to unborn child, and through blood transfusions. Then in 1985, movie star Rock Hudson publically admitted to having AIDS. Afterwards, HIV/AIDS became one of the most covered news stories for the next six or seven years. The SARS superspreader event at the Metropole hotel not only started its international spread, but also revealed frightening aspects of transmission. The virus spread through very

minimal contact. That, combined with the high death rates of infected healthcare workers, made containing SARS a priority among the international public health community early on.

Participants offered additional insights into what the literature revealed as the tipping points in the EVD outbreak. All of WHO's EVD experts had retired or left, so it was the opinion of many that WHO did not have adequate knowledge of EVD. So, in June 2014, the GOARN Steering Committee wrote a letter to the WHO DG outlining the severity of the situation and warning it would get much worse. The letter listed gaps and solutions in all major areas from epidemiology, case management, logistics, and leadership. This letter, authored by members of the CDC, Institute Pasteur, MSF, International Federation of Red Cross and Red Crescent Societies (IFRC), and European Center for Disease Control and Prevention, got the DG's attention. Shortly before that, MSF went onto the public stage declaring the outbreak was out of control and they were unable to keep up with all the cases. Very soon after these incidents, the DG declared EVD a PHEIC.

For the US, the infection of nurses in a Dallas hospital drew substantial media attention. It also placed CDC on the defensive, questioning the agency's capacity to ensure the safety of the American public.

Logistics and Coordination

Logistics are also a major problem with most responses. Many resources no longer needed were wasted during the second half of the EVD response. Money and materials were donated with good intention, but without proper systems to distribute according to need. PPE degraded outside of hospitals because too much was delivered. Sophisticated diagnostic equipment remained idle because the facilities lacked the reagents and personnel to operate it.

Additionally, a lack of formal systems of collaboration and persistent behavioral

obstacles has potentially hampered future research. A framework for laboratory coordination and sample collection and preservation was not established at the beginning of the EVD outbreak. This gap in planning has put 400,000 clinical specimens at risk of being lost because the integrity of those samples cannot be ensured.

Sadly, old ways of doing research still plague outbreaks as well. Often the science of outbreaks is not fully known until the scientists look at data months later. Some researchers still desire to publish first and advance their careers rather than be transparent in sharing information. Fortunately, this is not always the case, as rapid data dissemination occurred with both SARS and H1N1.

Communication

Understanding the community and location of an outbreak also helps containment and enables the crafting of communication that is trustworthy and effective. Surgeon General Koop and Anne Schuchat were effective and credible communicators during the first years of HIV/AIDS and throughout H1N1. Since information during emergencies is continuously unfolding, responders and risk communicators must do the best with what they know at any given time.

The world looks to both WHO and the CDC for guidance during emergencies, whether in the form of travel advisories, personal precautions, or clinician instructions. The nature of an emergency means this guidance can and often does change. During SARS, a two-person team oversaw the review and release of guidance documents to the CDC website. The task was daunting and many initial documents needed major revisions before publication, including resolving conflicting information.

Since SARS, CDC and WHO guidance documents still lack appropriate review mechanisms to ensure guidance is correct, clear, and without contradictions. One interview participant thought the CDC's guidance for the use of personal protective equipment (PPE), may have contributed to Dallas healthcare workers contracting EVD.

CDC Policy Barriers

Lack of personnel and resources are recurring problems in the face of rapidly escalating, even overwhelming needs during emergency response. At the CDC, few people are designated as emergency responders, e.g., EIS officers and the Emergency Response and Recovery Branch (ERRB). Therefore, personnel from other branches must be used. This becomes problematic because Congress separates funding streams, so people are only paid to work on specific projects within their program. Therefore, if someone working in diabetes research wants to work in the Emergency Operations Center (EOC), the diabetes program must be reimbursed. Money from the CDC Foundation, a separate nonprofit organization that connects the CDC with the private sector, is more flexible and is helpful, but also quickly exhausted in large responses. Like WHO, despite prior recommendations, the CDC still lacks a sufficient contingency fund for surge capacity.

CDC policy barriers also contribute to a lack of personnel in the field, as deploying responders internationally is complicated. Numerous obstacles can prevent getting the right people out the door in a timely manner. The State Department requires special training to deploy internationally in addition to basic passport, VISA, and medical clearance requirements. New training mandates add additional complexity. To deploy for more than 30 days, a five-day course to prepare and work overseas is required. Since January 2015, a new six-hour online course is required for international travel. Also, for countries with less internal security, a one-week course

in Virginia is required. In 2016, this course will be required for any travel to Africa. It is possible to extend the 30-day limit with a waiver from the ambassador, which happened for the West Africa countries; however, this takes time and is rarely done.

This turnover also contributes to a loss of productivity and information transfer. Deployments are supposed to be staggered so the responder's replacement is in country and trained before the first returns to the U.S. This does not always happen, so information flow is interrupted and lessons learned are not passed on and have to be relearned. For short deployments, this can shrink the time of productivity down to only two weeks. Many responders also feel there is a disconnection between leadership in Atlanta and the field. As a result, there is confusion, responders are ill prepared once in country, and guidance from Atlanta can be unrealistic and unfeasible.

Political and Cultural Clashes

There is a lack of confidence in both WHO and the CDC and morale within WHO is low. Some charge WHO with becoming too political and less technical. Over time, many experts have slowly retired and not been replaced; as other established scientists no longer choose to work in that environment. Disease specialists find it difficult to accomplish the technical aspect of the work due to the politics. WHO employees also find it hard to respect leadership that they claim allowed EVD to get out of control.

The CDC may have experienced a similar shift within its culture. After 9/11 and the anthrax mail attacks, the agency was heavily scrutinized over their purported inability to keep the public informed during an emergency. Afterwards, in order to prioritize public relations, some feel that the technical capabilities of the CDC may have suffered in order to appease the general public. SME's complain the push to keep the public, CDC leadership, and the EOC informed

overwhelms them during a response. SMEs spend many hours answering questions to as one put it, “feed the monster.” It is felt that these hours take away valuable time and energy that could be better directed to the field response.

Serious cultural clashes between the EOC and scientists hinder responses. CDC outbreak responses are initially delegated to the branch or program with expertise in the pathogen causing the threat. EOC leadership tends to be ex-military, adhering to “tried and true” incident management systems (IMS). These systems are those that exist to aid response when the disease threat progresses beyond the program’s capacity to respond. One of the criteria for EOC activation is the program must declare they are no longer able to handle the response. Yet, it is felt by some program SME’s that coordinating with the EOC causes the program to lose control of the response. Resentment exists on both sides and ultimately communication and coordination are hampered.

Some participants stated that the CDC has some strained international relationships. Certain responding organizations view the agency’s response in country as dominating, rather than empowering and supportive. Over time this generates dissatisfaction. Also, policy barriers for responder deployment cause a lot of personnel turnover in country. Since most organizations stay longer, the constant turnover makes it hard for those organizations to collaborate with the CDC in the field.

Discussion

Several problems were unique to the West Africa EVD epidemic; however, the outbreak’s severity and longevity exposed many persistent vulnerabilities plaguing international public health response.

Both WHO and the CDC realize they need a reserve work force that can be easily released from duties to deploy during an emergency (Burkle, 2015; Fineberg, 2014; Gostin et al., 2015; WHO, 2015b, 2015e, 2015g, 2015h, 2015i). However, many obstacles exist to the CDC deploying international staff for long-term response. The frequent turnover causes decreased productivity in the field and frustrates collaboration with organizations that stay longer. The CDC appears to be trying to fill this gap. In June 2015, the CDC established a Global Rapid Response Team (Global RRT) and began recruiting (CDC, 2015b). Also in 2015, WHO developed an international roster to recruit foreign teams to populate a global health emergency workforce (WHO, 2015g). The required competencies for this reserve workforce are public health, clinical, coordination, logistics, social mobilization, communication, and information management. The next PHE will test these reserves.

The CDC also suffers from other policy barriers. The itemized funding streams limit flexibility to direct resources to where they are needed most. Although the CDC's Center for Global Health (CGH) and the CDC Foundation have small funds for response, these are very quickly depleted. The previously recommended contingency fund may alleviate some hurdles and give the CDC greater flexibility in the future. Frequently, a response garners funding and personnel in relation to the public's interest. Public interest in disease is proportional to their perception of risk to themselves or loved ones and often reactions are either minimal or extreme. (EU, 2015; Jaffe, 2015). Emotional reactions not based on scientific evidence can cause stigmatization, inhibiting containment and treatment of disease outbreaks (Bevington et al., 2015; Davtyan et al., 2014; Keusch et al., 2006; MSF, 2015; Person et al., 2004). Therefore, incorporating stigma mitigation strategies into risk communication in addition to raising

awareness of a disease threat can be helpful in responses (Jaffe, 2015; Keusch et al., 2006; Person et al., 2004).

Responder interviews illuminate cultural and political clashes within the CDC and WHO that the literature did not. Both agencies are seen as more political and less technical than they once were. Many experienced scientists no longer want to work for WHO, less they become entangled in politics and unable to concentrate on science. Clashes in ideals exist between scientists and the EOC. And SMEs are overwhelmed during responses providing information to CDC leadership and the EOC, diverting their attention away from the field response.

The CDC has some strained relationships internationally as well; some interview participants describe some foreign organizations seeing the agency as arrogant and overbearing. However, some responders found the CDC to be well respected in the environments to which they were deployed. And other responders described their tactics to be supportive, not controlling. Thus, it appears that not all relationships are strained and the CDC has some valuable partnerships in the global health community.

The revised IHR need greater enforcement and accountability from all Member States. The core capacities, once achieved, can greatly enhance global security. Those with ample resources are encouraged to help other nations comply with the regulations by the next deadline (Burkle, 2015; Fineberg, 2014; Katz et al., 2014). These increased national capacities, GOARN, and the GHSA will aid in preventing, detecting, and responding to the next PHE (Mackenzie et al., 2014; Paranjape & Franz, 2015).

The interview sample was limited to the CDC, WHO liaisons, and one representative from Samaritan's Purse. No MOHs, academic institutions, other foreign public health organizations, or other NGOs were sampled. Additional weaknesses specific to WHO, MOHs,

and other NGOs could be revealed if interviewed. Also, the interview responses were subject to and varied according to the responders' own views and experiences. However, the research thoroughly identifies recurring obstacles specific to the CDC's ability to respond to international emergencies. Several obstacles were reiterated and confirmed by many CDC responders. Because of that and the breadth of expertise and numerous roles of these participants, it is unlikely that additional information of importance would be identified through further sampling of CDC responders.

Coding and analysis of the data are subjective. Although the data were organized with MAXQDA software, the PI assigned the codes and retrieved the data based on recurring themes within that framework.

Ultimately, this study does reveal nuances within the CDC and WHO that the literature did not, which is perhaps its greatest strength. Identifying and exposing these internal cultural and political obstacles may prove helpful in preparing for future responses.

Identifying weaknesses in outbreak response and taking steps to correct and prevent them are critical to global health security. However, being unable to mitigate the same weaknesses repeatedly is an even greater problem. Both the CDC and WHO have this problem. They are not the only responders to international crises, but they are the largest and most powerful. The EVD crisis was of unprecedented magnitude and did have unique features that made it harder to detect and contain. However, the data suggest these internal clashes were one of the contributing factors that delayed CDC and WHO mounting substantial responses to the EVD outbreak.

Due to numerous policy barriers facing the CDC, concentrating on implementing policies that expedite emergency response would be beneficial. The Food and Drug Administration (FDA) has Emergency Use Authorizations (EUAs) permitting use of some non-approved

diagnostics and interventions in emergency situations that were helpful during H1N1 and EVD (HHS, 2012; Singh, 2015). Providing more waivers like EUAs and legislating policies that allow more flexibility in funding and personnel deployment would help to eliminate time-consuming and resource restricting barriers.

To help bridge communication and understanding between scientists and the EOC, the CDC should consider organizing preparedness exercises with more programs within their agency. Although EOC activation is often not needed with outbreaks, exercises would equip more program offices with knowledge of how the EOC and the IMSs work. Additionally, some relationships between EOC leadership and scientists could be established to help them work together more seamlessly in the future.

It is beyond the scope of this study to identify the reasons CDC and WHO did not adopt previous recommendations from other PHEs. However, the study did identify major vulnerabilities persistent in global public health response. Additionally, because the sample was limited, conducting similar studies of other major international responders could be helpful. Findings may aid coordination among multiple partners in future responses.

Some factors of an outbreak cannot be changed. Building response capacities cannot change pathogen characteristics, for example; they can only help to detect and contain the pathogen more quickly. Other factors can be changed, some more easily than others. Regulations and policies can be changed and meta-analyses of after action reports can be conducted. The more difficult changes can be those that are behavioral. It is this PI's recommendation that the CDC and WHO work hard to understand and change the cultures within their walls and that they would approach this task with urgency, open minds, and humility. These agencies are tasked

with the monumental responsibility of keeping the world safe from disease, and the world is counting on them to do so.

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Appendix A: Interview Guide

1. What was your role during (insert public health emergency)?

   Probes:

   - At what point during the response did you enter?
   - What is your specific/primary area of expertise?
   - What was your/your team's mission/responsibility?

2. What were the major challenges or obstacles you faced during your work?

   Probes:

   - What effect did these challenges have on your effectiveness?
   - To what extent did these challenges emerge from outside the public health community?
   - To what extend did these challenges emerge from within the public health community?
   - How did global entities and international cooperation contribute to resolving these challenges?
   - How early were you able to recognize problems and develop the means to address them? How did you go about this?

3. In your opinion, how appropriate was the cumulative public health response to (this outbreak)?

   Probe:

   - How difficult was it to garner support from key stakeholders; i.e., the scientific, policy/political, vulnerable populations, the media and the public at large?

4. What things worked well and facilitated accomplishing your mission?

Probes:

- To what extent did collaboration evolve from outside the public health community?
- To what extend did these collaboration evolve from within the public health community?
- How did global entities and international cooperation contribute to these accomplishments?

5. At what point did this public health emergency receive the attention and aid you feel it deserved?

   Probe:

   - What events or developments led up to that point?
   - In retrospect, can you propose ways that might have heightened awareness and engagement sooner?

6. What were your primary lessons learned during this response?
7. How would you apply those lessons to the current Ebola outbreak?

   Probe:

   - What persistent challenges face international public health response leaders that you saw then and that remain to this day?

8. What do you think would be the best way to address these unmet challenges to international public health response?
9. Do you have anything else you would like to add?
10. Can you recommend anyone else associated with this response that you think it may benefit my research to interview?

Appendix B: Codes and Subcodes

Codes	Code Frequency
Advocacy	2
Capacity building	5
CDC authority	1
CDC IMS	3
CDC objectives	4
Collaboration	28
Partnerships	8
Collaboration with community leaders	7
Collaboration with NGO's	2
Communication	17
Community empowerment	9
Community engagement	6
Contact tracing	5
Contingency fund	10
Delayed detection	3
Delayed response	6
Diagnostics	5
Early 2014 Ebola response	17
Ebola patient zero	1
Ebola and HIV/AIDS	15
Ebola and SARS	3
Ebola lessons learned	5
Ebola successes	4
EOC	7
EPT	1
Fear	24
False beliefs related to pathogen	6
Future	4
Recommendations	32
Warnings	9
GHS	2
GHSA	16
Guidance documents	7
GOARN	17
GOARN and H1N1	1
GOARN successes	8
GOARN capabilities	3
GOARN limitations and gaps	4
WHO and GOARN	2
H1N1	11
H1N1 Successes	20

	H1N1 Lessons learned		33
Health care workers			14
HIV/AIDS			14
	HIV/AIDS lessons learned		1
HHS			1
IHR			14
	IHR implementation		5
	Original IHR		2
	IHR strengths		6
	IHR weaknesses		18
		Deadlines missed	7
	IHR revision		15
		IHR capacities	11
Infection control			4
Infectious diseases			4
Information management			3
Information sharing			14
Interviews			0
	Interviewee expertise		18
	Interviewee lessons learned		40
	Interviewee opinion on response		5
		Other responses compared to Ebola	16
		HIV/AIDS	3
		SARS	6
		H1N1	4
		Ebola	16
	Interviewee opinion of turning point		21
	Interviewee response role(s)		39
	Interview specific obstacles		11
		Arrogance	6
		CDC EOC	5
		Changing dynamic	4
		Communication	13
		Containment	1
		Corruption	1
		Cultural obstacles	2
		Data management	4
		Delayed response	2
		Disconnect between leadership and field	6
		Disorganization	9
		Field specific obstacles	7
		Funding restrictions	1
		Guidance Documents	6
		Inadequate resources	2

		Incompetence		5
		Information sharing		5
		Lack of EOC		2
		Lack of expertise		7
		Lack of information		10
			Mystery illness	3
		Lack of personnel		11
			Deployment obstacles	12
			Personnel turnover	9
		Leadership		1
			CDC	6
			WHO	14
				Director-General 1
		Logistics		6
		Movement		3
		Political obstacles		12
		Regulatory		3
		Research		2
		Resistance		2
		Security		1
		Strained relationships with partners		4
		Volume of work		4
	Interview specific recommendations			21
	Interview specific successes			33
		Collaboration		20
		Communication		9
		Flexible funding		2
		Pre-existing relationships		4
		Religion/Spirituality		1
Knowing/understanding the target population				4
Laboratory				11
Leadership				6
Media				12
Medical countermeasures				9
MOH				5
MSF				5
Obstacles to outbreak response				17
	Civil war			8
	Community resistance			4
		Hiding sick		3
	Competing endemic diseases			4
	Cultural obstacles			6
	Economic impact			6
	Geography			1

	Infrastructure	7
		Limited access to healthcare	3
	Lack of local leadership	1
	Lack of personnel	7
		Skill gaps	2
	Limitations to staff deployment	2
	Limited information	1
	Mistrust of government	5
	Political obstacles	10
	Poverty	2
	Travel and trade	10
Pathogen characteristics		2
	Transmission	3
	Ebola virus characteristics	4
	Incubation period	1
PH education		12
PHEs		3
PHEIC		11
Preparedness		11
	Exercises	6
Quarantine/Isolation		8
Regulatory obstacles		3
	EUAs	7
Reporting		15
Reserve staff/workforce		11
	Staff training	1
Response		12
	Interventions	2
	Needs assessment	1
	Outbreak containment	12
	Response capabilities	1
	Safe burials	3
Response coordination		1
Risk communication		17
Risk perception		10
Same lessons repeated		26
SARS		23
	SARS successes	17
	Lessons from SARS	24
SMEs		9
Stigma		26
	Mitigation of stigma	7
Superspreader		3
Surveillance		33

Digital/Web-based surveillance	5
Timeliness	2
Tipping/turning point	10
Transparency	8
Trust	8
Uganda outbreak	4
UNMEER	3
WHO	3
Ebola Review Committee	1
WHO authority	20
WHO regional offices	1
WHO criticism	23
WHO limitations	2
WHO Member States	9
WHO successes	1
WHO objectives	3
Zoonosis	2