Ebola and Yellow Fever Crisis Management Insights

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ABSTRACT

This paper provides insight into crisis management of infectious disease outbreaks by comparing the current 2014 Ebola outbreak with a well-documented 1793 Yellow Fever outbreak. These reflections on crisis approaches and management from a human factors and cognitive engineering perspective may help encourage the application of historical epidemiology to better prepare for the next global infectious disease outbreak.

Keywords

Ebola, epidemic, outbreak, Yellow Fever.

INTRODUCTION

From the terrible and deadly Ebola outbreak comes a silver lining in the form of insights to better manage fast spreading infectious disease. Ebola was first identified in 1976, but it was not until 2014 that Ebola traveled across continents. Public health and crisis managers have experienced difficult lessons including some damage to social capital, and loss of life. This is particularly grievous, as many first responders were also persecuted for selfless efforts.

This paper begins by investigating parallels between Philadelphia's 1793 Yellow Fever outbreak, and the 2014 presence of Ebola in the United States, from a human factors and cognitive engineering perspective, then continues by evaluating issues and lessons from the current Ebola outbreak in Africa. This paper serves as a call to apply historical epidemiology to identify potential insights for future crises by conducting thorough evaluations of management successes and failures associated with both current and past outbreaks.

It is important to remember that even though Ebola has proven difficult to contain in the difficult conditions of West Africa, Ebola is not the worst-case public health scenario. Evaluations are needed for the current outbreak, as well as anticipation of more infectious contagion. In only a matter of months, for example, the 1918 Spanish Influenza killed over 50 million worldwide (FluGov, 2015).

1793 YELLOW FEVER OUTBREAK PARALLELS

Ebola is classified as a viral hemorrhagic fever (VHF). This term describes a group of distinct ribonucleic acid viruses affecting multiple organs and the vascular system, accompanied by "hemorrhage" or bleeding. There is no known cure or drug treatment for most VHFs. VHF begins by zoonosis, where an animal or insect host infects the human. In severe cases, such as Ebola, transmission

continues between humans. In addition, handling and testing VFH microbes require the highest "biosafety lab" level, BSL-4 (CDC, 2013). For these distinctions, there have been economic and political comparisons of Ebola to other VHF outbreaks in history, including several Yellow Fever outbreaks (Glantz, 2014; Golden, 2014; Scott, 2014; Susan, 2014).

Despite notable differences in transmission, Philadelphia's 1793 Yellow Fever outbreak evokes parallels to the current Ebola outbreak, including public fear, isolation and quarantine debates, policy confusion, frontline responder risks, burial difficulties, demographic exposure, orphan challenges, and economic impacts. These issues initially surprised Ebola responders, but might have been expected from a review of previous outbreaks (Glantz, 2014).

In the summer of 1793, Yellow Fever erupted in Philadelphia, the capital of the newly formed United States. By winter five thousand citizens had died, representing ten percent of the population. Fear quickly gripped Philadelphia, causing forty percent to evacuate to summer homes. Within the city victims lay dying and unattended where they fell, while neighbors threatened to burn down treatment units if not relocated. Neighboring communities effectively quarantined Philadelphia by blocking further evacuation (Glantz, 2014).

Similarly, fear surfaced in the United States upon the first confirmed Ebola Virus Disease (EVD) case at Texas Health Presbyterian Hospital Dallas, increasing with the patient's subsequent death October 8, 2014, and the confirmation of EVD in two hospital nurses (Steinhauer, 2014).

Misguided calls were made to isolate Africa, and quarantine health care providers returning to the United States from Africa (Reuters, 2014). Additionally, a cruise ship was denied permission to dock with a patient of interest on-board (Yang, 2014), a university cancelled a presentation by Washington Post Ebola photojournalist Michel du Cille (Bever, 2014), and a Maine teacher was put on paid leave for simply having been in Dallas (Steinhauer, 2014).

Disputes among policy experts delays critical action, and may increase public confusion and fear. In 1793, disputes stemmed from minimal understanding of the diagnosis, treatment, or transmission of Yellow Fever (Glantz, 2014). The severity of the 2014 African outbreak was initially disputed (Yang, 2014), as well as whether to mandate quarantines in the United States (Drazen et al., 2014).

Both outbreaks put the frontline medical community at risk. In fifteen years of battling Ebola, Médecins Sans Frontières/Doctors without Borders (MSF) had not lost a single staffer. Since March, 2014, however, sixteen have been infected, including nine fatally (Yang, 2014). As of February 22, 2015, Ebola has infected 837 health practitioners, killing 490 (WHO, 2015b). Researchers are also at risk, including five who died before publication of a study on the mutation Ebola in Africa (Ohlheiser, 2014).

An increase in the need for burials during outbreaks overwhelms established logistical capabilities. In 1793 it was not known that Yellow Fever could only be transmitted by mosquito, so it was the fear of infection that made it difficult to find workers willing to transport and bury the dead. Payment eventually motivated some, while others from the African-American community generously volunteered (Glantz, 2014).

Ebola, on the other hand, transmits readily from contact with fluids from a symptomatic (i.e., showing signs of severe illness) Ebola patient. These include urine, saliva, sweat, feces, vomit, breast milk, and semen. Intimate African funeral practices actually served as disease "super-spreaders." Safe burial practices are still contentious. Ideally specialized burial teams reduce funeral transmission, while permitting families to grieve from a safe distance (WHO, 2014a).

Demographically, Philadelphia's poorest suffered most from the Yellow Fever outbreak. They were least able to afford treatment, huddled in cramped housing closest to the source of the mosquitos spreading the disease, without funds to escape the city to summer homes (Glantz, 2014). The poor in Africa were also the greatest EVD victims, as evidenced by fatality rates of 71% for those treated in

Africa, in contrast with 26% for foreign medical staff evacuated for specialized treatment (WHO, 2015a).

The children and orphans of crises, including outbreaks, present special challenges to managers. In Philadelphia, the treatment of orphans was the second highest expense (Glantz, 2014). In Africa, over ten thousand children are now orphans, some facing stigmas from having been associated with the disease (Gettleman, 2014).

The economic impact from wide-spread and long-term outbreaks can be particularly devastating. Philadelphia survived through personal loans arranged by brilliant financier Stephen Girard, and generous gifts from concerned neighbors. The African communities, however, were distressed prior to this outbreak. They are now even more in need of support to prevent starvation and encourage financial recovery (Byanyima, 2015; Leary, 2015).

2014 EBOLA OUTBREAK

It is appropriate, given hindsight, to review factors that made this Ebola outbreak so severe. These include gaps in communication between first responders, health and government organizations, compounded by politics, poverty, and culture.

Prior to the early 2014 Ebola outbreak, much of the West African public health infrastructure was minimal or non-existent. In Guinea there were only ten doctors per 100,000 people (DataTeam, 2015). Liberia had just fifty-one doctors for its entire 4.2 million population (Chothia, 2014). A deep-seated mistrust of government due to prolonged civil war led to attacks on public health messengers in Liberia and Sierra Leone (Chothia, 2014). As a result, security incidents and unsafe burial practices continue to make it difficult to eradicate the outbreak (WHO, 2015b).

Unlike previous Ebola outbreaks, proximity to population centers and mobility permitted its spread to Conakry, capital of Guinea, as well as across the border into Liberia (Yang, 2014). Although these two differences seem significant now, it was difficult at the time to unlearn all that had been reinforced from over thirty years of previous Ebola outbreaks.

The March 2014 first responders included members of MSF, and the International Federation of Red Cross and Red Crescent Societies (IFRC). Although they were initially able to contain the spread in Liberia and Guinea, the greatest difficulty appeared in May 2014 from an unexpected second wave in cases in Sierra Leone. Up until then MSF had not been involved in Sierra Leone, as the Ministry of Health felt its situation was under control. Unfortunately, the virus had been spreading unnoticed, partially due to a transient working community that freely roamed across the borders of Guinea, Liberia, and Sierra Leone. Doctors were insufficient for basic medical care, let alone to coordinate a viral attack response. Uncontrolled, Sierra Leone created a perfect stage for the disease to rage (Yang, 2014).

Although MSF recognized early that this outbreak could be different, they could not successfully communicate this to the United Nation's World Health Organization (WHO). As late as July 2014, WHO's director-general, Dr. Margaret Chan, felt that Joanne Liu, international president of MSF, was being overly pessimistic (Yang, 2014).

Some have criticized WHO for waiting until August 2014 to first declare a Public Health Emergency of International Concern (Gostin, 2014). This was eight months after the death of the index case, a 2-year-old Guinea boy, and five months after the spread of confirmed clusters in both Guinea and Liberia.

WHO was not helped by its local representatives; as political appointees, they did not report directly to the WHO organization. In addition, WHO's ability to fund a response suffered when its 2013 infectious disease budget was reduced $72 million, along with a 51% reduction in its outbreak and crisis response budget.

In WHO's defense, they saw themselves as more of a technical resource, not intended to replace country health organizations needed to manage the spread of infectious disease. However, the governments and organizations that thought would help only responded with four medical teams, as opposed to the 151 teams for the Philippines 2013 Typhoon Haiyan (Yang, 2014).

APPROACHES AND MANAGEMENT

Despite a slow start, this outbreak has lasted long enough to provide an opportunity for several innovations. These include development of dedicated Ebola treatment units (ETU), improvements in personal protective equipment (PPE), oral rehydration strategies, big data and intelligence techniques, and improved understanding of the role of culture and communication.

First, the ETUs provide frontline facilities to isolate patients under investigation, permitting investigation into exposure history with symptoms of EVD. Prior to dedicated ETUs, traditional hospitals unfortunately served as points of amplification spreading the disease forward. An ETU provides points of demarcation that control and regulate directional flow of staff and patients into high-risk areas, where confirmed EVD patients reside. Patients progress from triage, to suspected EVD housing, to confirmed EVD housing. Segregated areas are provided for improving patients to safely communicate with families. Specialized facilities provide water, as well as process the enormous amounts of hazardous waste that is generated (Washington & Meltzer, 2015).

Second, Ebola changed PPE requirements to reduce risk of health care provider exposure. In October 2014, the CDC released new guidelines emphasizing rigorous training and practice in donning and doffing the PPE, permitting no skin exposure when wearing the PPE, and requiring a trained supervisor to monitor workers (CDC, 2014).

The revised PPE requirements did increase worker safety, but decreased a worker's time in the ward, as well as masked visual cues of compassion needed by the suffering. Heat and dehydration, including three layers of gloves, limited PPE workers to less than one hour in the ward. While there, the workers appear distant and alien-like. Awareness of these issues has led to design improvements, including those from a PPE competition addressing these limitations (Rhodes, 2015).

Third, although Ebola lacks a cure its mortality can be reduced through aggressive replenishing of fluids and electrolytes. This includes early use of almost five liters of oral rehydration salts daily. It is challenging to get patients to drink, however, as they are often too weak to even speak (Quist-Arcton, 2014).

Fourth, data science, including big data and intelligence analysis, is improving and will continue in this and future outbreaks. Data analytics company Metabiota, for example, uses tools to investigate disease threats through identification and tracking of pathogens, the detection of disease, and other threat characterizations. Pathogens develop, mutate, and spread over time, allowing some outbreaks to be anticipated, and others to be tracked (Hay, George, Moyes, & Brownstein, 2013; Metabiota, 2014). WHO began mapping the outbreak in August to identify transmission zones and assign priorities (Chan, 2014; WHO, 2015c). At the other end of the data spectrum, college students helped create local maps to assist MSF (Cain, 2014).

Finally, understanding culture and its role in the spread and control of Ebola continues to be important (WHO, 2015b). In one case, a funeral for a respected healer became responsible for spreading the disease to over 360 others (WHO, 2014b). Since then, efforts have been made to work with families to conduct safe burials by specialized teams (NPR, 2014). Initial public health messages to villagers were met with distrust, including a fatal September 2014 attack on members of an aid group. To overcome resistance, Ebola awareness messages are now more positive, and includes non-traditional public health messengers such as small-town preachers, soap-opera stars, taxi-drivers, town criers, local reporters, and cameramen (Stillman, 2014).

CRITICAL REFLECTION

Since outbreaks extend beyond biomedical constraints to include political, social, cultural, and economic considerations, there is an opportunity to utilize the sub-discipline historical epidemiology, as in this paper, to improve awareness and management of future outbreaks. This integrates critical knowledge at the intersection of history, medicine, and epidemiology to improve policy decisions (Webb Jr, 2013, 2015).

Crises managers need to continue recognizing the importance of culture while addressing the tendency toward fear or even panic at the beginning of an outbreak. As in the Philadelphia outbreak, certain conditions can enable fear to burn itself out, giving way to resolve, leading eventually to hope (Glantz, 2014). Creativity is needed to identify and respond to existing social and political influences that

impact treatment and control. Managers in Africa demonstrated this creativity when modifying its message and messengers, leading to a change in public behavior, including where possible modifications to deeply held funeral practices.

It is likely similar creativity would have been needed in America, had its Ebola outbreak expanded, especially in regards to whether quarantines should be mandated. Two commonly used epidemic control measures are isolation for the infected, and quarantine for the exposed. While isolation is most always desireable, the same is not true for quarantine, which is more controversial due to the significant social, psychological, and econcomic costs. The decision to quarantine needs to consider whether future infections could be prevented (Day, Park, Madras, Gumel, & Wu, 2006). It is not likely that quarantine could be justified in the case of Ebola, which does not have significant asymptomatic transmission.

Perhaps less obvious, and contradictory to those wishing to isolate Africa, and mass quarantine travelers, is the need to aggressively manage outbreaks at the source. This requires careful understanding of the disease transmission, and modeling of the benefits of quarantines. All world communities are otherwise at risk, and thus must be willing to provide medical and financial support, even if this means exposure to the contagion. The analogy is that when it comes to outbreaks, the world is one house, and part of it is on fire. The fire cannot be safely ignored, nor expected to go out unattended.

An error in the African outbreak did not adequately consider porous borders, permitting Ebola to reach urban areas and air travelers. Fortunately steps are underway to prevent future gaps, although it will be challenging for WHO to overcome funding limitations and experienced staff reductions (WHO, 2015a, 2015c). Success is important to first responders who depend on world health support, and are also needed to provide human intelligence on the outbreak. Big data and intelligence analysis can identify some threats, but the human intelligence from first responders will always be needed.

Nontraditional healthcare facilities were effectively used during Philadelphia's Yellow Fever outbreak, as well as ETU's in Africa. These approaches challenge presumptive models that will burden existing hospitals with specialized care requirements, putting traditional patient populations at risk. Further, the ETU in Africa is not only highly specialized to manage Ebola, but could flexibly be established near outbreaks. It is conceivable that more effective home treatment and preparedness will also need to be enhanced, as demonstrated in the Spanish Flu of 1918.

CONCLUSION

Unfortunately, Ebola is not the World's scariest scenario, however it is sufficient to reveal challenges to current and future outbreaks. Although local government and organizations ultimately must manage infectious disease, not all are sufficiently staffed or financially viable to be successful without assistance. World governments and health organizations should then expect to provide medical and financial support to control outbreaks at the source, preventing risk of a global spread. World Health Organization changes, including involvement in local outbreaks, and reduced financial resources, impacts the effectiveness of first responders, such as MSF and IFRC. Either way, the current reactive "fire-brigade" approach to outbreaks needs to be updated with one more coordinated and proactive, including greater awareness and sensitivity to public needs, concerns and cultural practices, improved crisis communication, and extended plans for recovery.

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REFERENCES

1. Bever, L. (2014, October 17). Syracuse University disinvites Washington Post photographer because he was in Liberia 3 weeks ago. *The Washington Post*, pp. 1–3. Washington, D.C. Retrieved from

http://www.washingtonpost.com/news/morning-mix/wp/2014/10/17/syracuse-university-disinvites-washington-post-photographer-3-weeks-after-he-returned-from-liberia/

2. Byanyima, W. (2015). Oxfam calls for massive post-Ebola Marshall Plan. Retrieved January 30, 2015, from http://www.oxfam.org/en/pressroom/pressreleases/2015-01-26/oxfam-calls-massive-post-ebola-marshall-plan
3. Cain, C. (2014, October 25). New tool in Ebola battle: Smith College hosts map-making workshops. *Daily Hampshire Gazette*, pp. 1–3. Northampton, MA. Retrieved from http://www.gazettenet.com/living/health/14052555-95/new-tool-in-ebola-battle-smith-college-hosts-map-making-workshops-to-help-first-responders-navigate
4. CDC. (2013). Viral Hemorrhagic Fevers. Retrieved January 25, 2015, from http://www.cdc.gov/ncidod/dvrd/spb/mnpages/dispages/Fact_Sheets/Viral_Hemorrhagic_Fevers_Fact_Sheet.pdf
5. CDC. (2014). CDC tightened guidance for U.S. healthcare workers on personal protective equipment for Ebola. Retrieved January 25, 2015, from http://www.cdc.gov/media/releases/2014/fs1020-ebola-personal-protective-equipment.html
6. Chan, M. (2014). *WHO Director-General briefs Geneva UN missions on the Ebola outbreak* (pp. 1–4). Geneva, Switzerland. Retrieved from http://www.who.int/dg/speeches/2014/ebola-briefing/en/#
7. Chothia, F. (2014, September 24). Ebola drains already weak West African health systems. *BBC News Africa*, pp. 1–4. Lon. Retrieved from http://www.bbc.com/news/world-africa-29324595
8. DataTeam. (2015, January). The toll of a tragedy. *The Economist Newspaper NA, Inc.*, 1–2. Retrieved from http://www.economist.com/node/21624322/print
9. Day, T., Park, A., Madras, N., Gumel, A., & Wu, J. (2006). When is quarantine a useful control strategy for emerging infectious diseases? *American Journal of Epidemiology*, *163*(5), 479–485.
10. Drazen, J. M., Kanapathipillai, R., Campion, E. W., Rubin, E. J., Hammer, S. M., Morrissey, S., & Lindsey R. Baden. (2014). Ebola and Quarantine. *The New England Journal of Medicine*, *371*(21), 2029–2030. Retrieved from http://www.nejm.org/doi/pdf/10.1056/NEJMe1413139
11. FluGov. (2015). Pandemic flu history. Retrieved January 25, 2015, from http://www.flu.gov/pandemic/history/
12. Gettleman, J. (2014, December 13). An Ebola orphan's plea in Africa: "Do you want me?" *The New York Times*, pp. 1–5. New York. Retrieved from http://www.nytimes.com/2014/12/14/world/africa/an-ebola-orphans-plea-in-africa-do-you-want-me.htm
13. Glantz, E. J. (2014). Community crisis management lessons from Philadelphia's 1793 epidemic. In S. R. Hiltz, M. S. Pfaff, L. Plotnick, & P. Shih (Eds.), *ISCRAM 2014 Conference* (pp. 556–564). University Park, PA.
14. Golden, J. (2014, October 21). Yellow Fever and Ebola: similar scourges, centuries apart. *The Philadelphia Inquirer*, pp. 1–3. Philadelphia. Retrieved from http://www.philly.com/philly/blogs/public_health/Yellow-fever-and-Ebola-similar-scourges-centuries-apart.html
15. Gostin, L. O. (2014). Ebola: towards an international health systems fund. *The Lancet*, *384*(9951), e49–51. doi:http://dx.doi.org/10.1016/
16. Hay, S. I., George, D. B., Moyes, C. L., & Brownstein, J. S. (2013). Big data opportunities for global infectious disease surveillance. *PLoS Medicine*, *10*(4), 1–4. doi:10.1371/journal.pmed.1001413
17. Leary, M. K. (2015). The socio-economic impacts of Ebola in Liberia. Retrieved January 30, 2015, from http://www.worldbank.org/en/topic/poverty/publication/socio-economic-impacts-ebola-liberia
18. Metabiota. (2014). *Long before the Ebola outbreak began, the Metabiota team was there* (pp. 1–3). San Francisco, CA. Retrieved from http://metabiota.com/media/EbolaSpotlight.pdf
19. NPR. (2014). As epidemic in Liberia slows, burying bodies remains a challenge. Retrieved January 25, 2015, from

http://www.npr.org/blogs/goatsandsoda/2014/11/01/360685119/as-epidemic-in-liberia-slows-burying-bodies-remains-a-challenge

20. Ohlheiser, A. (2014, August 29). Five co-authors of a new Ebola study died of the virus before their research was published. *The Washington Post*, pp. 1–4. Washington, D.C. Retrieved from http://www.washingtonpost.com/news/world/wp/2014/08/29/five-co-authors-of-a-new-ebola-study-died-of-the-virus-before-their-research-was-published/
21. Quist-Arcton, O. (2014). Ebola survivor: Faith and oral rehydration salts got her through. Retrieved January 25, 2015, from Ebola Survivor: Faith And Oral Rehydration Salts Got Her Through
22. Reuters. (2014, November 8). Nurse who fought Maine Ebola quarantine moving out of state. *Thomson Reuters*, p. 1. New York. Retrieved from http://www.reuters.com/article/2014/11/08/health-ebola-usa-maine-idUSL1N0SY0UN20141108
23. Rhodes, M. (2015, January). A brilliantly designed hazmat suit for Ebola workers. *Wired*, 1–5. Retrieved from http://www.wired.com/2015/01/brilliantly-designed-hazmat-suit-ebola-workers/
24. Scott, C. (2014). The Ebola outbreak was political — just like every disease outbreak. Retrieved January 25, 2015, from http://www.theverge.com/2014/12/30/7466989/the-ebola-outbreak-was-political-just-like-every-disease-outbreak
25. Steinhauer, J. (2014, October 19). In U.S., fear of Ebola closes schools and shapes politics. *The New York Times*, pp. 1–5. New York. Retrieved from http://www.nytimes.com/2014/10/20/us/fear-of-ebola-closes-schools-and-shapes-politics.html
26. Stillman, S. (2014, November). Ebola and the culture makers. *The New Yorker*, 1–7. Retrieved from http://www.newyorker.com/news/daily-comment/ebola-culture-makers
27. Susan. (2014). Yellow Fever: The Ebola of earlier centuries. Retrieved January 25, 2015, from http://blog.nyhistory.org/ebola-yellow-fever/
28. Washington, M. L., & Meltzer, M. L. (2015, January). Effectiveness of Ebola treatment units and community care centers. *Morbidity and Mortality Weekly Report (MMWR)*, *64*, 1–4. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm64e0123a2.htm
29. Webb Jr, J. L. A. (2013). Historical epidemiology and infectious disease processes in Africa. *The Journal of African History*, *54*(01), 3–10. doi:10.1017/S0021853713000042
30. Webb Jr, J. L. A. (2015). The historical epidemiology of global disease challenges. *The Lancet*, *385*(9965), 322–323. doi:10.1016/S0140-6736(15)60108-8
31. WHO. (2014a). New WHO safe and dignified burial protocol - key to reducing Ebola transmission. Retrieved February 23, 2014, from http://www.who.int/mediacentre/news/notes/2014/ebola-burial-protocol/en/
32. WHO. (2014b). *Sierra Leone: A traditional healer and a funeral*. *Global Alert and Response (GAR)* (pp. 1–2). Geneva, Switzerland. Retrieved from http://www.who.int/csr/disease/ebola/ebola-6-months/sierra-leone/en/#
33. WHO. (2015a). *Ebola response: What needs to happen in 2015* (pp. 1–10). Geneva, Switzerland. Retrieved from http://www.who.int/csr/disease/ebola/one-year-report/response-in-2015/en/#
34. WHO. (2015b). *Ebola situation report* (pp. 1–14). Geneva, Switzerland. Retrieved from http://apps.who.int/iris/bitstream/10665/153582/1/roadmapsitrep_25Feb15_eng.pdf?ua=1
35. WHO. (2015c). *The importance of preparedness – everywhere* (pp. 1–4). Geneva, Switzerland. Retrieved from http://www.who.int/csr/disease/ebola/one-year-report/preparedness/en/#
36. Yang, J. (2014, October 17). What went wrong in response to the Ebola crisis? *The Toronto Star*. Toronto. Retrieved from http://www.thestar.com/news/world/2014/10/17/what_went_wrong_in_response_to_the_ebola_crisis.html