

Leveraging Technology in Effective Management of Epidemics in Developing Countries: Lessons from the Ebola Outbreak in West Africa



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ABSTRACT: The problem of disease epidemics is an ever present threat in our increasingly connected world is one that many nations particularly in the developing world, continue to struggle with. However, in recent times, the use of technology has played a crucial role in the effective management of disease outbreaks. The 2014 Ebola outbreak in West Africa witnessed unprecedented applications of digital innovations to key areas of the public health response- disease surveillance, health worker training and public education; with satisfactory results. In Nigeria in particular, these interventions were partly credited with the swift containment of the outbreak and prevention of significant catastrophic damage. These technological solutions, though relatively simple, present the possibility for reverse technology transfer. Long standing protocols and approaches in disaster response currently in use in developed countries can be modified and improved upon, taking into account lessons from successes achieved using technology in the fight against Ebola in West Africa.

Introduction

The 2014 Ebola Virus Disease outbreak remains the worst in history in terms of morbidity, mortality and geographic spread (CDC, 2016). It was the first time the virus crossed continents, affecting not only countries in West Africa where it originated, but Europe and North America. A total of 10 countries in 3 continents were affected (CDC, 2016). As of April 13, 2016, number of cases reported amounts to 28,652 and the total number of deaths that occurred due to the disease stands at 11,325. Liberia was the worst hit, recording 10,678 cases and 4,810 deaths (WHO, 2016) (figure 1).

As the first point of contact, health workers were understandably most vulnerable during the epidemic. Many did not have adequate training or proper equipment to reduce the risk of infection and were constantly at risk of contracting the disease through contact with infected bodily fluids (Otu A. et al, 2016).

Figure 1: 2014 Ebola Outbreak in West Africa- Case Counts
(As of April 13, 2016)

Country	Total Cases	Laboratory-Confirmed Cases	Total Deaths
Guinea	3814	3358	2544
Sierra Leone	14124	8706	3956
Liberia	10678	3163	4810
Nigeria	20	19	8
Mali	8	7	6
Senegal	1	1	0
United States	4	4	1
Spain	1	1	0
United Kingdom	1	1	0
Italy	1	1	0
Total	28,652	15,261	11,325

Source: Centers for Disease Control and Prevention. CDC 2014 Ebola Outbreak in West Africa (2016).

The Ebola outbreak served to fully expose the many failings and weaknesses in the health care systems of affected African nations which, sadly have been in place for years (O'Hare B., 2015). Ranging from poor health infrastructure and access to medical services, to inadequate skilled health personnel, insufficient funding, limited access to training and challenges in data quality and management; these issues have continually plagued the fragile health systems in many African countries and were further exacerbated by the Ebola outbreak. However, with the timely incorporation of technological innovations, several specific health system challenges were overcome during the epidemic, thus improving the overall response. Through these applications, public health education was quickly achieved, frontline health workers received much needed training on diagnosis, management and the preventive measures against the Ebola virus; data was effectively collated and analyzed, while patients and the spread of the disease were systematically tracked (West D.M., 2015).

Technology has also proven effective in managing other public health emergencies in the developing world. In 1997, a poultry outbreak of avian influenza (H5N1 virus) in Hong Kong, SAR, led to the first case of human disease with 18 people clinically affected and 6 deaths. Digitized geographic location of farms in outbreak areas helped with case control studies and efficient data collection (Morris R.S., Jackson R., 2015). In India, cases of Japanese Encephalitis were tracked in real-time using web-based technologies and mobile phones, enabling the authorities to plan an effective disease response in areas affected by the outbreak (United Nations Foundation, 2009).

Research has shown that modern technology continues to facilitate the analysis of disease patterns and the control of disease outbreaks including the spread of polio in northern Nigeria. Combined with mapping of human movements, novel digital tools help drive the rate of advance in real-world epidemiological applications (Eckhof P.A., Tatem, A.J., 2015). With growing positive impact in resource-poor settings, such technological innovations can inspire new approaches to similar challenges in the developed world.

Role of Technology in the Ebola Response

Technology solutions applied during the Ebola crisis in West Africa were largely preventive in nature. Public education and health worker training were sorely needed and digital applications were soon discovered to be an effective means of achieving these goals (West D.M., 2015). Low-cost, high-impact and simple solutions such as bulk SMS used to disseminate pertinent information on the disease and digital tutorials (targeted at health workers) discussing the causes, spread, diagnosis and management of Ebola were effective in bridging the information gap that existed in many affected areas and providing education to support behavior change (Otu A. et al, 2015).

In Liberia, simple phone SMS were used by the International Red Cross to provide people with information about screening, diagnosis and treatment of Ebola. As many as 2 million text messages were sent each month, thus strengthen-

ing communication efforts already in place. The text messages provided accurate information and connected people at a faster rate than ever before (West D.M., 2015). In Mali, a free SMS service was created through which people could send the word EBOLA to a short code and then receive several text messages on Ebola over a 2day period. Sierra Leone made use of a government provided hotline through which individuals could obtain vital information on Ebola by calling contact officials (Unwin T., 2014).

A major problem was the lack of education and knowledge, especially among health care workers who were a high risk group and vital in delivering medical care to those affected by the disease. Many lacked basic information on mode of spread of the virus, infection prevention procedures and use of personal protective equipment. Mobile-based tutorials deployed in Nigeria and subsequently Liberia and Sierra Leone, were used to overcome this challenge successfully (West D.M., 2015).

Tracking the spread of the virus, disease surveillance and contact tracing were also key components of the Ebola response significantly aided by the use of modern technology. Ushahidi (originally developed in Kenya), leveraging crowdsourcing technology in Liberia, created a mapping tool that tracked the spread of Ebola, by compiling information on where the disease was spreading thus informing and guiding the response of public health authorities (West D.M., 2015). In Guinea, a smart-phone based contact tracing system built on the mobile application CommCare and Tableau, business intelligence software allowed for effective contact tracing using GPS points. Real-time identification of contacts that have not been visited is possible, allowing same-day intervention (Sacks J.A. et al, 2015). This system was a great improvement on the paper-based model previously used. A similar system was put to use in Nigeria where GPS-tracked handheld devices enabled contact tracing teams to report accurately from various locations (Odutolu A.O. et al, 2016).

The Nigerian Experience

The Ebola outbreak in Nigeria was unique in many ways. The disease was introduced into the country by a single individual via a large, densely populated city, Lagos with about 21 million people. Overcrowding and overstretched infrastructure including health systems, created an ideal environment for easy spread and transmission of any communicable disease (CDC, 2014). In spite of these challenges, the spread was rapidly contained through the implementation of a robust response effort employing all available resources. In all, a total of 20 confirmed cases and 8 deaths were recorded, with over 18,500 in-person interviews carried out in three affected states- Lagos, Port Harcourt and Enugu. The country was certified Ebola free by WHO on October, 20, 2014 (3 months after the arrival of the index case) after 42 days of no new reported cases (Freedman A., 2014). Compared to other neighboring nations hit by the crisis, Nigeria was able to contain the virus before it attained significant proportions. This success in part is credited to the innovative use of digital interventions in the response.

Social media played an important role in providing timely and accurate information to the public about the disease and events concerning the outbreak. Within a short time, several social media platforms were developed- on Twitter and Facebook, EbolaAlert and EbolaFacts were created. Through these web-based applications, the populace was furnished with essential information using simple and easy to understand messages (Freedman A., 2014). These platforms also helped dispel false information and misconceptions that were rife at the time particularly those concerning remedies for the disease. They served as a channel for recruitment of interested individuals as volunteers in the response and helped in the distribution of educational materials as well. Online chat sessions- #EbolaChat and #StopEbola, were also developed to stimulate an ongoing conversation addressing issues on the transmission, management and prevention of Ebola (Brown M., 2014).

With the average Nigerian spending a significant amount of time using their mobile devices – over 3 hours daily (probably the highest on record in the world (Brown M., 2014), the use of social media and mobile applications was a natural and ultimately effective strategy. EbolaAlert recorded over 200,000 hits per day in Nigeria, while the website had 4 million hits in August 2014 alone (one month after the initial confirmation of the virus in the index patient). EbolaFacts, a similar website, had 600,000 visitors in the first week and 2.8 million on the Facebook platform in August as well (Brown M., 2014).

In addition to these mobile applications, 24-hour emergency phone service and bulk SMS were also employed during the response.

Inadequate knowledge and skills among frontline health workers in the early phases of the Ebola outbreak was a huge problem. To address this challenge, an education intervention that used tablet computers as a medium to facilitate the training of remote frontline health workers was implemented in Nigeria. The intervention was a component of the 'Front Line health worker Education and disease Management (FLEM) project', developed by *Instrat* and *Anadach* and implemented on the Vecna Cares CliniPAK system. (Otu A et al, 2016).

GPS technology, initially used in the national WHO polio program, was employed for contact tracing and case-finding, ensuring effective disease surveillance (WHO, 2016).

Other Examples of Impact of Technology in Fighting Disease Outbreaks in the Developing World

In India and Sri Lanka, outbreaks of Dengue Fever are monitored effectively using mobile technology, reducing data reporting time drastically. An average of 15 to 30 days was needed before now to collate and distribute data on the disease outbreak to the relevant authorities, leading to increased spread of infection and reduced treatment response (West D.M., 2015). With the application of digital technology through the Real-Time Biosurveillance Program, much needed data is obtained on time and analyzed by the public health authorities. Resources for diagnosis and treatment are then immediately disbursed to areas in dire need, thus limiting spread of the disease (West D.M., 2015).

The CommCare mobile application applied in the Ebola response has been modified for use in other outbreak situations- Cholera, Measles and Polio (Fletcher A., 2016).

Lessons Learned (and potential for technology transfer)

The technological interventions employed during the Ebola crisis helped strengthen health systems by improving health worker knowledge and skills through training; providing effective and efficient disease surveillance and contact tracing as well as stimulating behavioral change through dissemination of educational messages. These tools and strategies can be applied to other public health emergency situations and can thus be leveraged by developed nations in similar circumstances. This experience has shown that using technology to solve local problems and improve on traditional protocols in an appropriate manner can help swiftly contain a national crisis. Possible adoption of this technological strategy by the developed world may prove valuable particularly to the management of the current Zika outbreak in the Western Hemisphere, and now Singapore. However, some challenges may arise in the implementation of interventions such as the use of GPS tracking in contact tracing which would raise privacy issues. There would therefore be a need to balance individual privacy with the desire to achieve community good.

Conclusion

There is increasing potential for reverse technology transfer in containment of disease epidemics with the recent successes in emerging economies. New approaches developed and tested in low-resource settings can be applied and prove immensely beneficial to similar emergency situations in industrialized nations, although careful consideration must be given to each country's unique circumstances, environment and laws.

Biographies

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Dr. Susan Ekuri is a medical doctor with experience in health management, development and consulting. A senior consultant with Anadach Group, she provides technical assistance on client projects. Prior to this, she was involved in managed care and health care financing, providing oversight and coordination for aspects of private health insurance programs.

Dr Enoma Alade, a partner at Anadach group is a dentist with over 20 years experience providing healthcare in the US and Nigeria. Enoma was previously Dental Director at a US Federally Funded Facility where she was responsible for overseeing the care of at least 30,000 patients a year, and was also previously Associate Clinical Professor at the Schools of Dentistry of University of Southern California School and New York University.

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