



Emerging Infectious Diseases and the Role of Syndromic Surveillance in the Developing World

Catherine Zatorski, Larissa May *

Emergency Medicine, Microbiology, and Epidemiology, The George Washington University, United States

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ABSTRACT

Despite impressive advancements in diagnostic and treatment technologies, infectious diseases still cause a significant amount of mortality and morbidity throughout the world due to the unpredictable and inevitable rise of new or previously dormant pathogens. Emerging infectious disease (EID) outbreaks are mainly associated with changes in physical environment and human behavioral activities, and disproportionately affect developing countries. Syndromic surveillance, while challenged in developing countries by inadequate communication and public health infrastructure, could build on pre-existing systems to complement existing governmental and non-governmental programs for outbreak detection and offers a promising avenue to detect EID events earlier in the course of an outbreak.

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* *Corresponding Author:* Larissa May, PhD., Emergency Medicine, Microbiology, and Epidemiology, The George Washington University, United States. *Tel:* 001 2027412920, *E-mail:* larissa@gwu.edu

Introduction

Infectious diseases are the leading cause of morbidity and mortality in children and adults accounting for 16% of reported deaths worldwide. The majorities of cases occurs in developing countries and are due to preventable and / or treatable diseases, such as lower respiratory infections, diarrhea, and AIDS (1). Despite extraordinary advances in the field of diagnostic, therapy and vaccine development, infectious diseases still remain a viable threat to our global health and security due to the inevitable and unpredictable rise of new pathogens (2). Emerging infectious diseases (EID) i.e. Diseases that are newly discovered or increasing in incidence in certain geographic areas are of particular concern, given that the vast majority of these diseases are of zoonotic origin and humans may not have a naturally occurring immunity.

Historical data, genetic sequencing, and phylogenetic constructions have shown that new infectious agents have been emerging over the past millennia (2). According to the report of the Institute of Medicine in 1992 entitled “*Microbial Threats to Health: Emergence, Detection, and Response*”, the emergence of such new infectious agents or diseases are due to the following factors:

1. Changes in physical environment: climate changes affecting the ecology of vectors, animal reservoirs, and the transmissibility of microbes;
2. Human behavioral activities: global travel, land use, contact with animal reservoirs, globalization of the food;
3. supply, increasing crowding, reforestation, and irrigation;
4. Social / political / economic activities: war or famine leading to a population movement and a deteriorating public health infrastructure;
5. Bioterrorism;
6. Increased use of antimicrobials and pesticides increasing resistance of pathogens to treatment (3).

Our increased ease of world travel, global interdependence, and use of antimicrobials has complicated our efforts to contain outbreaks that threaten not only the health of individual communities, but also worldwide economic stability. During the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak, it was estimated that approximately \$16.8 to \$25.3 billion was lost from the economy due to serious decreases in tourism and trade (4). HIV / AIDS has severely limited labor supply, labor productivity, and trade in African countries that has already reduced the average national economic growth by 2-4 percent across the continent (5). While not all infectious diseases may not have as significant outcome as these examples, they nevertheless, have the potential to cause public panic, economic loss, and other adverse outcomes.

Understanding the Challenges of Emerging Infectious Diseases in the Developing World

Between 1996 and 2009, there were 398 reported cases of verified EID outbreaks by the World Health Organization (WHO). Of these, there was no (or very little) information on the timing and location of 117 of these outbreaks. Of the remaining 281 EID outbreaks, 53% outbreaks occurred in Africa,

11% in the Eastern Mediterranean, 11% in the Western Pacific, 10% in the Americas, 7% in Europe, 7% in South-East Asia, and 2% in non-classified WHO regions (7). Further analysis of these EID outbreaks indicated that they occurred in developing countries with tropical climates with the potential of serving as a location of future zoonotic and vector-borne EIDs (8). The disproportionate burden of EIDs on the developing world is likely due to deforestation, high levels of contact with farm and wild animals, and increased population growth and density.

Containment of an EID outbreak involves several steps including: isolation of infectious patients, quarantine measures per local health authority recommendations, and environmental controls to prevent transmission. Effective deployment of these resources is dependent upon rapid identification of a possible outbreak, possibly through syndromic surveillance. Syndromic surveillance uses pre-diagnostic data and statistical algorithms to detect outbreaks earlier than traditional outbreaks. Unfortunately, syndromic surveillance is reliant on strong communication between clinicians, often via an electronic medical record system and a unified public health system, and can be hampered by political and social motives and poor infrastructure and education.

In 1995 an Ebola outbreak in Congo led to 240 mortalities in 4 months. Due to geographic conditions and a poor or inadequate public health infrastructure, reporting of the outbreak was significantly delayed. Poor infection control practices and the lack of sterilization promoted hospital transmission of the illness, leading to multiple healthcare worker deaths. The provision of disinfectant and personal

protective equipment led to eventual containment. Nonetheless, in a subsequent Ebola outbreak in the Congo in 1997, it took 19 days to outbreak awareness and an additional 49 days to international assistance. The remote location of many outbreaks such as the ones described above and their high mortality make detection and reporting a continued challenge (3).

The SARS epidemic of 2002 illustrates the need for education in outbreak detection, reporting and containment. SARS is a respiratory illness caused by a novel corona virus. It emerged as an atypical pneumonia in the Guangdong Province of China in November 2002 and was first reported in February 2003. The incubation period was 2-10 days and caused severe morbidity and mortality, with between 20-30% of patients requiring mechanical ventilation. SARS was transmitted primarily in healthcare and hospital settings and is thought to be primarily spread by droplets and fomites (surfaces). The delay in recognition, reporting, and sharing of information between governments and health experts contributed to a global outbreak, which led to an estimated 8427 cases in 29 countries with 873 deaths (9). In the case of Middle East Respiratory Syndrome (MERS), we were better prepared for the outbreak of a novel coronavirus and health experts around the world were more inclined to share clinical and microbiological information (10). As of August 2013, there have been only 108 laboratory-confirmed cases of the disease, including 50 deaths, significantly fewer than SARS (11). Nonetheless, the potential for worldwide spread of this pathogen remains an area of international public health concern.

Looking Forward: Syndromic Surveillance, EID, and the Developing World

Despite the challenges, syndromic surveillance could easily be adapted to fit the needs and infrastructure of the developing world. These systems complement existing governmental and non-governmental programs for outbreak detection in tropical areas, such as the WHO Malaria Early Warning Systems. While these syndromic surveillance systems could be better optimized with the use of electronic medical records, currently this expectation may not be feasible in remote areas of low resource countries; however, clinician self-reported data to ministries of health has proven useful to detect outbreaks through informal surveillance networks. Investment to develop transportation and telecommunication infrastructure would only improve information sources and sharing.

Some developing nations have already implemented successful syndromic surveillance systems. For example, Indonesia, with the help of US personnel, implemented the Early Warning Outbreak Recognition System (EWORS) to detect outbreaks of dengue fever, diarrhea, influenza-like illness, etc. In 2002, EWORS detected an outbreak of *Vibrio cholerae*, *Salmonella*, and *Shigella* in North Jakarta following increased reports of diarrheal cases. Healthcare authorities were able to implement immediate containment and preventive measures. Consequently, the outbreak was contained within one month (12). By establishing syndromic surveillance systems such as EWORS throughout the developing world, we would be better able to detect EID events and mitigate its effect on global security and the economy.

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