Zika Virus: Epidemiology and Environmental Health Comprehensive Application of Epidemiology Criteria

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Zika virus (ZIKV) has evolved as a significant public health concern globally. The increasing cases of Guillain-Barré syndrome, congenital anomalies, and autoimmune and neurologic syndromes underscore the implications of ZIKV for public health. Both the World Health Organization (WHO) and the Pan American Health Organization (PAHO) issued an alert on May 7, 2015 about the potential transmission of ZIKV in northeast Brazil (Musso, Cao-Lormeau, & Gubler, 2015). Nonetheless, nine member states in the Americas (Brazil, Chile, Colombia, El Salvador, Guatemala, Mexico, Paraguay, Suriname and Venezuela) confirmed the autochthonous transmission of ZIKV as of December 1, 2015 (Musso, 2015). The confirmation regarding the widespread of ZIKV indicates the possibility of this virus to spread globally, as was the case of chikungunya (CHIKV) and dengue (DENV) viruses (Cao-Lormeau et al., 2014).

As such, it is imperative to develop innovative public health interventions to control and manage the possible spread ZIKV.

Zika virus constitutes an emerging arbovirus (arthropodborne virus) related to DENV and CHIKV considering that they have similar transmission cycle and epidemiology. An infected mosquito from the *Aedes genus* (notably *Aedes aegypti*) found in tropical areas is responsible for the transmission of ZIKV. The same mosquito species also transmits CHIKV and DENV viruses, as well as yellow fever (Duffy et al., 2009). Epidemiologists believed that ZIKV causes only mild disease prior to the French Polynesian epidemic. ZIKV does not have specific clinical manifestations. According to Cao-Lormeau et al. (2014), the signs and symptoms of ZIKV are similar to those of other diseases, particularly DENV and CHIKV. However, countries that have experienced ZIKV outbreak have also reported severe neurological complications, especially Guillain-Barre syndrome. The relationship between ZIKV and neurological complications cannot be discarded even though epidemiologists are yet to establish a causal effect (Musso, 2015).

The increase in neurological symptoms is a particularly worrying concern for public health. For instance, Guillain-Barre syndrome was confirmed during the French Polynesia outbreak (Cao-Lormeau et al., 2014). In the same vein, Brazil has reported 76 neurological symptoms among patients with a history of ZIKV. Guillain-Barre syndrome accounted for 55% (42/76 cases) of these cases. Additionally, 62% of patients with Guillain-Barre syndrome (26/42) manifested symptoms consistent with ZIKV based on clinical history (Musso, 2015). Non-vector borne transmission ZIKV is also increasingly evolving as a significant public health problem. For instance, the Brazil Ministry of Health has established a plausible correlation between ZIKV infection and the increasing occurrence of microcephaly (Victora et al., 2016). The findings of a preliminary investigations conducted in Brazil have shown that the ZIKV infection during the first trimester of pregnancy presents the greatest risk of developing microcephaly and other congenital abnormalities (Samarasekera & Triunfol, 2016; Victora et al., 2016).

The resemblance of ZIKV transmission to the history of CHIKV is of the essence to public health. The first isolation of ZIKV from a monkey occurred in the Uganda's Zika forest in 1947 with subsequent, sporadic human infections occurring in Asia and Africa. Yap State in the Federate States of Micronesia reported the first, major ZIKV outbreak in 2007 (Duffy et al., 2009). The Pacific region did not document further transmission until October 2013, when French Polynesia identified the first cases. French Polynesia reported a subsequent, explosive ZIKV outbreak with approximately 11% of the affected population (28,000) of cases seeking medical care (Cao-Lormeau et al., 2014). On the other hand, CHIKV was reported first in Africa in 1952 prior to emerging in Asia. The virus caused major epidemics in Southeast Asia and India between the 1950s and 1980s. CHIKV disappeared epidemiologically after the Asian outbreak but reemerged in 2004 in East Africa before spreading to Asia again and worldwide subsequently (Musso et al., 2015).

The outbreak in French Polynesia highlighted the proliferation of the ZIKV Asian lineage. Similarly, the transmission cycle of CHIKV exemplifies the fact that ZIKV has the potential of spreading to global populations living outside the tropical regions (Cao-Lormeau et al., 2014). Twenty-eight countries and territories in the Americas were reporting the active transmission of ZIKV as of February 1, 2016. PAHO attributed the rapid transmission of ZIKV to two factors: epidemiological naivety of the populations to the virus and the ubiquitous presence of the *Aedes* mosquitoes (Musso, 2015). WHO projected in February 2016 that the Americas would record three to four million cases of ZIKV infection in the next 12 months. The WHO generated this figure from mathematic modelling based on Zika infections in Brazil and dengue dynamics in the region (Musso et al., 2015).

Of particular interest and concern to global public health is the adaptation of ZIKV to a suburban or urban cycle. This cycle involves human as the amplifying host and *Aedes aegypti* and other mosquitoes of the *Stegomyia* subgenus as vectors. The current trends in globalization and urbanization (especially the increased frequency of global travel) constitute the principal mode of transmitting the vectors (Samarasekera & Triunfol, 2016). For example, the United States, Europe and other countries have reported cases of ZIKV infection among travelers returning from Latin America and the Caribbean (Musso, 2015). More than 50% of the world's human population resides in areas infested with these mosquitoes. Accordingly, the potential for a major ZIKV epidemic in urban areas is overwhelming (Samarasekera & Triunfol, 2016). The preceding concern brings to the forefront the importance of developing feasible public health intervention to prevent the transmission of ZIKV, as well as manage outbreaks effectively.

Innovative Intervention

The proposed public health intervention will entail using electronic health records (EHRs) to share accurate and timely information about at-risk patients. This approach will focus largely on tracking imported cases of ZIKV from travelers who have recently visited a region where ZIKV is circulating. The rapid transmission and expansion of ZIKV throughout the Americans has prompted both PAHO and WHO to update the recommendations on surveillance. These organizations have encouraged public health authorities to report cases of Zika virus using the international health regulations (IHR) framework. The health bodies also oblige member states to provide information regarding any increase of neurological and autoimmune syndromes in children and adults, or congenital malformations in newborns that have unknown cases (PAHO, 2015; WHO, 2016). The realization of the preceding goal will require the utilization of EHRs to ensure timely and accurate flow of information.

The foregoing discussions have highlighted the high probability of ZIKV infection spreading rapidly in per-urban and urban areas. The critical concern is the risk posed by travelers from areas where ZIKV is circulating currently (Musso, 2015). CDC has indicated that infected travelers from high-risk areas will influence the future outbreaks of ZIKV in the United States. However, there is a paucity of guidelines to identify infected travelers with certainty. The labeling of ZIKV a “nationally notifiable disease” is a critical step to effectual tracking and surveillance (Samarasekera & Triunfol, 2016). Accordingly, it is crucial to identify and track these patients once they present the signs and symptoms common to ZIKV infection. Health professionals carry the mandate of identifying patients who have the clinical manifestations of ZIKV and have travelled to regions with circulating ZIKV infection (Central and South America and the Caribbean).

The assimilation of EHRs into ZIKV surveillance systems will play a fundamental role in identifying and managing patients with unprecedented speed to minimize the risk of possible outbreak (primary prevention). The achievement of this objective mandates the development of an integrated system where health facilities record patients’ demographic and medical data (including the date and region of travel). The health information managers (HIMs) will then analyze this information to identify trends in transmission. In practice, the HIMs will know precisely the residence of people with ZIKV, as well as areas where local outbreaks will likely occur. This process is complex considering the costs of establishing the necessary EHR infrastructure. Despite these challenges, the experiences from similar initiatives provide valuable lessons regarding the integration of ZIKV surveillance with EHR.

The response to previous pandemics and other debilitating health conditions has underscored the importance of sharing information in a timely manner. The proliferation of technology in clinical practice is supporting public health professionals to identify health concerns promptly, act faster and manage them effectively. For example, health officials in Wisconsin responded to the 2009 H1N1 pandemic by transmitting test results electronically to the established case management system. The disseminated information was useful in alerting public health nurses about the possibility of an outbreak (Barrios, Koonin, Kohl, & Cetron, 2012). Healthcare organizations in the U.S are yet to recommend the use of EHRs to report cases of ZIKV infection. In fact, the recent outbreaks of both Zika and Ebola viruses exemplify the limitations inherent in the modern EHR systems, specifically their inability to enhance clinical decision support.

Implications for Healthcare Policy

The proposed public health intervention emphasizes the use of EHRs to disseminate timely and accurate information regarding the location of populations with an increased risk of ZIKV infection. In contrast, it is essential to highlight that most health care facilities are yet to adopt EHRs despite the federal government's incentives (Baker, 2013). The purpose of these incentives is to facilitate the realization of the Meaningful Use (MU) objective. However, meeting the MU milestones and deadlines is resource intensive, burdensome and time-consuming. Consequently, the majority of hospitals are using a hybrid system, which involves switching between the paper record and EHR (Bero & Lee, 2010). Bredfeldt et al. (2013) have asserted that the hybrid system is deficient does not eliminate the redundancies associated with unnecessary delays, as well as the complexities of producing longitudinal reports. The preceding limitations provide the rationale for transitioning to the EHRs exclusively.

The review of literature has identified a myriad of factors that impede the implementation of EHRs. One of the most significant limitations of the modern EHR is the inability to adapt swiftly to the emerging public health threats (Bredfeldt et al., 2013). According to Bero and Lee (2010), vendor develop EHR tools and application primarily for enhancing best practices and the quality of care. Consequently, the current systems are slow in supporting clinical decisions, as was the case of Ebola and most recently ZIKV. For example, the proposed intervention requires clinicians to conduct a comprehensive ZIKV-focused assessment for all patients to determine those who have returned from high-risk areas. A viable EHR should remind clinicians about this task using interactive and appropriate interfaces. Unfortunately, most care facilities continue to utilize charts and other visual signs as a means of clinical communication.

The limitations of the modern EHR systems outlined above illustrate the failures of the MU objective in relation to promoting the clinical benefits of EHRs. For example, Bredfeldt et al. (2013) have asserted that the MU incentive program has failed because it makes clinicians to work harder rather than smarter. These issues necessitate the development of public health policies that will streamline the development and adoption of EHR infrastructure across health care facilities. The federal government should consider revising the current incentive program to ensure that the modern EHRs integrate the tracking and management of emerging public health issues. The current EHRs only meet baseline MU requirements, meaning that they only offer limited disease management support (Bero & Lee, 2010). Additionally, stage one MU standards provide limited ability (if any) to track and input public health epidemics. Thus, the implementation of EHRs should leverage the capabilities of modern technologies with respect to disease management (DM), as well as tracking of temporal/causal data (Baker, 2013).

The Role of DNP in the Project

The primary objective of the proposed project is to use technology as a feasible means of tracking and reporting cases of ZIKV among returning travelers. The American Association of Colleges of Nursing (AACN) has noted that the ability to employ technology/information systems differentiates DNPs from other clinicians. As such, the role of the DNP will entail the application of skills and knowledge regarding information technology/systems to manage both the aggregate and individual level information. Similarly, the DNP should also select, design and use information systems and technologies to enhance the sharing of information across multiple settings. Most importantly, the application of technological tools and systems will support the DNP in making rational and timely decisions regarding the trends of ZIKV. The latter objective is imperative to minimize the risk of a potential outbreak by augmenting public health preparedness efforts.

The Healthy People 2020 program has identified preparedness as one of the critical goals of managing major health incidences. The goal of preparedness involves improving the government's capacity to prepare for, prevent, respond to and mitigate the effects of a major public health incident. Effectual and timely communication is one of the components central to effective preparedness. Accordingly, the role of the DNP will involve using the EHRs as a means of ensuring the seamless sharing of information. Nevertheless, it will not be sufficient for the DNP to transmit information to the central unit. On the contrary, this disseminated information should describe the patterns of ZIKV among the assessed cases. Merrill (2013) has affirmed the importance of employing a systematic approach to identifying, calculating and interpreting the common indices underpinning the health statuses of populations.

The greatest challenge of managing ZIKV is its broad spectrum of differential diagnoses. The proposed project will not be effective unless the health professional develop an evidence-based protocol for diagnosing ZIKV. The role of the DNP will also include the synthesis and appraisal of research findings to inform the development of standardized diagnostic procedures. According to Merrill (2013), health professionals should have requisite skills of assessing epidemiological research critically. The utilization of research evidence will play a critical role in influencing policy. For example, the DNP should provide policy proposals regarding the use of EHRs and the diagnosis of ZIKV. AACN has opined that the involvement of DNP graduates in the development of policies is vital to creating a robust and responsive healthcare system. The DNP should prioritize the development of policies that will address the internationalization of ZIKV to avert a major global pandemic.

Conclusion

Zika virus (ZIKV) has evolved as a significant public health concern globally following its rapid and extensive spread in the Americans and across the globe. The elemental public health concern is the neurological effects of ZIKV, particularly Guillain-Barré syndrome and microcephaly. Although ZIKV is endemic in the tropics, it has a high potential of spreading globally largely because of international travel. In the same vein, the adaptation of ZIKV to a suburban or urban cycle underscores the severity of future outbreaks. Thus, the proposed intervention will entail the use of EHRs to disseminate timely and accurate information regarding the location of populations with an increased risk of ZIKV infection. The successful implementation of this novel approach requires DNP to enhance the utilization of technology and research evidence to support the development of effective policies. The DNPs also carry the responsibility of supporting the integration of EHR into clinical practices to improve the level of preparedness.

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