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Volume 2015 *2015* Article 19

2015

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Recommended Citation

Todorovich, S., Ugarte, C., John-Baptiste, A., Terry A. (2015). Chikungunya in the Americas: Estimating the Burden of Disease and Cost of Illness. in: Speechley, M., & Terry, A.L. [eds] Western Public Health Casebook 2015. London, ON: Public Health Casebook Publishing.

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CASE 13

Chikungunya in the Americas: Estimating the Burden of Disease and the Cost of Illness[1]

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INTRODUCTION

Emily Lucas was a new intern at the Pan American Health Organization (PAHO) Headquarters in Washington, D.C. and her supervisor had given her the task of conducting a preliminary socio-economic impact assessment on Jamaica for the chikungunya epidemic that had been spreading through the Caribbean for the past few months. Emily had done extensive background research on Jamaica to learn about the economy and dynamics of the country. She had also researched chikungunya to get a better understanding of the disease and why it was such a big public health concern. By reading reports and talking to PAHO employees, Emily came to appreciate why the Americas as a region was so vulnerable to a chikungunya epidemic, as well as how the events leading up to this first outbreak had unfolded.

Upon looking for a methodological outline she could follow to complete the analysis, Emily came to realize that no such outline existed for determining the complete socio-economic impact of chikungunya outbreaks. She quickly came to the conclusion that in order to produce a holistic analysis of the impact she would have to pull knowledge from all the classes she had taken in her Master of Public Health degree and create a methodological framework herself before she could calculate an estimated cost for such an epidemic.

CHIKUNGUNYA

Chikungunya translates from Makonde to mean “that which bends up”, describing the posture assumed by those who suffer from severe joint pain as a result of this disease (Caglioti et. al., 2013; Her, Kam, Lin, & Ng, 2009). Chikungunya is a viral infection that is transmitted through *Aedes* mosquitoes, the same mosquitoes that transmit dengue (Caglioti et. al., 2013; Her et al.,

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2009; Thiberville et. al., 2013). The attack rate (percentage of population infected) is between 38-63% during an epidemic (PAHO, 2011). Acute illness caused by the chikungunya virus has the potential to be followed by a chronic state of illness; however, between 4-28% of infections in individuals are asymptomatic (Thiberville et. al., 2013). In those who are affected by the disease, acute symptoms start to appear around 3-7 days after being bitten by an infected mosquito (also known as the incubation time). The most prominent symptom is incapacitating joint pain (arthralgia), which is reported in 87-98% of cases, and can be accompanied by other symptoms including high fever, headache, back pain, and fatigue (Caglioti et. al., 2013; Thiberville et. al., 2013). Generally, symptoms resolve within 3-10 days; however, 30-40% of symptomatic cases become chronic with infected persons experiencing recurrent joint pain that persists for months to years (European Centre for Disease Prevention and Control, 2014). The timeframe during which an infected person is most likely to transmit the disease to a biting mosquito or through blood is from approximately 0-6 days post-infection (Staples, Hills, & Powers, 2014).

As of yet there is no specific treatment for chikungunya, and management of the disease has been limited to treating the symptoms of the disease through non-steroidal anti-inflammatory drugs and paracetamol/acetaminophen (Thiberville et. al., 2013). Also, despite the development of a few vaccines none have been licensed for use (Caglioti et. al., 2013). The best means of defense against contracting chikungunya when living in or visiting an affected area is through preventive measures, such as vector control strategies (fumigation), wearing long clothing, and the proper use of bed nets. A vector is an organism that is capable of transmitting a disease from one animal to another (for example, *Aedes* mosquitoes are the vector for chikungunya and humans are the affected animals).

Chikungunya was first isolated in Tanzania in 1952 before being detected in other African countries. The first documented Asian epidemic was in Bangkok in 1958, and since then chikungunya outbreaks have occurred intermittently throughout Africa and Asia (Thiberville et. al., 2013). Due to the low mortality rate and its occurrence in poorer tropical areas, chikungunya was generally neglected until 2005 (Her et. al., 2013). A massive outbreak of chikungunya in countries and territories in the Indian Ocean region during 2004-2005 increased concern about chikungunya among the global community. This outbreak was much larger than previous outbreaks, it affected areas where people had access to a competent health system (the French territory of La Réunion), and had a huge socio-economic impact (Caglioti et. al., 2013). Previously, most areas affected by chikungunya were medically impoverished with inefficient public prevention/control measures, and thus, outbreaks of the disease in these areas were not surprising. See Exhibit 1 for recorded global chikungunya outbreaks.

There are three main genotypes of the chikungunya virus, meaning there are three slightly different genetic compositions of the virus. They are named West African, Asian, and East/Center/South African (ECSA) and tend to be present in different regions of the globe (Vazeille et. al., 2007). The emergence of the ECSA genotype during the Indian Ocean epidemic in 2005 enabled *Aedes albopictus* to become a vector for viral transmission, in addition to the predominant vector species, *Aedes aegypti* (Caglioti et. al., 2013; Vazeille et. al., 2007).

Initially, the disease was spread through the *Aedes aegypti* species, which inhabits only tropical and subtropical climates, thereby restricting its geographic reach (Caglioti et. al., 2013; Her et. al., 2013). This mosquito is mostly found around human dwellings, which makes it easier to implement control and eradication measures in response to an outbreak of chikungunya. On the other hand, *Aedes albopictus* can be found in both wooded areas and human inhabited settings

making it near impossible to control the population (Caglioti et. al., 2013; Her et. al., 2013). *Aedes albopictus* inhabits both tropical and subtropical regions, but is also found in more temperate climates such as Europe and the northeastern United States (Parola et. al., 2006; Rochlin, Ninivaggi, Hutchinson, & Farajollahi, 2013).

VULNERABILITY IN THE AMERICAS

Before December 2013, the Americas did not have autochthonous transmission of chikungunya, meaning the disease was not naturally found in the Americas, and cases that were reported were from people who had traveled to areas where chikungunya was endemic. However, there were many factors that put the Americas, specifically the sub-region of the Caribbean, at high risk for developing a chikungunya outbreak. One of these factors is that *Aedes aegypti* mosquitoes, the primary vector of chikungunya, are present in almost all countries in the Americas and their population has been increasing in recent years due to failed eradication programs throughout the region (Brathwaite et al., 2012). *Aedes albopictus* is also present in most of South America, in all of Central America and the Caribbean, in Mexico, and at least 25 US states (Moore & Mitchell, 1997; Centre for Agricultural Biosciences International, 2013). It must also be noted that mosquito density, which tends to increase after heavy rainfalls during the rainy season, plays an important part in the likelihood of chikungunya outbreaks (Her et. al., 2013). Therefore, the time of year in which a chikungunya outbreak occurs in a previously non-endemic area may have significant consequences on the outbreak in the following months.

A factor that puts the Caribbean at particularly high risk is the travel between these countries and areas in the world that are already chikungunya endemic, such as India and other Asian countries (PAHO, 2012). Travel from these areas could be for vacation purposes or for business and trade reasons (for example, amongst French territories in both the Indian Ocean and in the Caribbean), and thus, increases the risk of transmission of chikungunya between endemic and non-endemic areas (Weber et. al., 2013).

The fact that autochthonous transmission of chikungunya had not occurred in the Americas prior to December 2013 indicates that very few people have had the infection before and therefore, do not have an acquired immunity against chikungunya. This means that there is no herd-immunity to chikungunya in this region, putting the population at a high risk of having a very large outbreak of the disease (Her et. al., 2013). Unlike dengue, previous infection with and recovery from chikungunya confers long-term immunity preventing the individual from getting the disease a second time (Her et. al., 2013).

INTRODUCTION INTO THE AMERICAS

In 2012, PAHO headed a meeting in Jamaica with international experts and health professionals from 22 countries to discuss the potential of a chikungunya outbreak and to create a preparedness and response plan for the potential introduction of autochthonous transmission of chikungunya virus in the Caribbean sub-region (PAHO, 2012). A year and a half later, the first chikungunya cases in the Americas were reported.

On the 16th and 18th of November, 2013, five people in the French territory of Saint Martin presented with symptoms consistent with dengue, but also had incapacitating joint pain (Cassadou et. al., 2014). There were a total of eight suspected cases that tested negative for dengue and were subsequently sent to the French National Reference Centre for Arboviruses in Marseille, France for further testing. The samples tested positive for chikungunya on December 2nd, and because none of these individuals had recently traveled to chikungunya endemic countries, this signaled the first autochthonous transmission of chikungunya in the Americas. Following this discovery, Saint Martin enhanced its chikungunya surveillance program and

increased communications with the Dutch side of the island in an effort to prevent the spread of the disease (Cassadou et. al., 2014).

Despite the recognition that an outbreak in an island nation should theoretically be easier to contain, autochthonous chikungunya infections have since been reported in 17 countries/territories and could eventually affect every country in the Americas where *Aedes aegypti or Aedes albopictus* mosquitoes can be found (Weber et. al., 2013; PAHO, 2014).

There are several potential contributing factors to the spread of chikungunya across the Caribbean. At the time the first few cases of chikungunya emerged, Saint Martin was already experiencing a dengue epidemic, thereby making the epidemiological situation complex to begin with (Weber et. al., 2013). Due to the similar symptomatology of dengue, a diagnosis of chikungunya can be easily mistaken for dengue, especially in an area where dengue is already endemic (Laoprasopwattana, Kaewjungwad, Jarumanokul, & Geater, 2012). Also, the fact that chikungunya was not a common disease created the potential for the public and health care providers alike to be unfamiliar with chikungunya or its symptoms, resulting in a lack of action. For those who had heard of chikungunya, they may have been aware that it is rarely fatal and thus viewed it with less concern than the dengue epidemic and as less of a threat to public health. Again, an important means for viral travel to other islands and countries is the common travel between territories of the same country (in this case France) (Weber et. al., 2013). Another factor that hampered the ability of Saint Martin to act more quickly to increase surveillance and control measures was the inability to test for chikungunya directly. The samples taken from the suspected cases were initially laboratory tested for dengue in Saint Martin, but when they produced negative test results they had to be sent for further testing at the French National Reference Centre for Arboviruses in Marseille, France (Cassadou et. al., 2013).

JAMAICA

Jamaica is the largest English speaking country in the Caribbean and is situated near Cuba and Haiti (the island of Hispanola). It has a population of approximately 2,930,050 people with a literacy rate of 87% (Central Intelligence Agency, 2014). Roughly 6.1% of Jamaica's gross domestic product (GDP) is spent on education compared to 5.2% of the GDP being spent on the health sector (CIA, 2014). In 1988, Jamaica's reported poverty rate was 30.5%, which officials have since been working hard to reduce; as of 2010 the rate had dropped to 17.6% (PAHO, 2013). The unemployment rate in Jamaica is 16.3%; however, the rate more than doubles for youth ages 15-24, averaging 34% (PAHO, 2013).

The Jamaican GDP in 2012 was estimated at US$14.76 billion (The World Bank, 2014). The services sector (including tourism and insurance) is an important driver of the Jamaican economy and accounts for nearly 80% of GDP, with tourism alone accounting for 30% (CIA, 2014).

Jamaica has both public and private health care systems. The public system includes primary, secondary, and tertiary services and in an attempt to make services more accessible, patients are not required to pay user fees (PAHO, 2013). However, many people still prefer to use private services as quality of care in the public system is generally considered to be poorer (PAHO, 2013). There is an overall shortage of health care professionals in the country, specifically in nursing and midwifery positions (PAHO, 2013).

In order to obtain clean water, 13.7% of Jamaicans rely on rainwater collection, which serves as a potential breeding ground for mosquitoes (PAHO, 2013). Jamaica is particularly vulnerable to

natural hazards such as hurricanes, tropical storms, and floods, and if the climate change trends continue, rising temperatures and increased rainfall/flooding will increase the risk of transmission of communicable diseases like chikungunya and dengue (PAHO, 2013).

Reasons for Selecting Jamaica

Although Jamaica had not yet reported any cases of chikungunya, Emily decided that it was an appropriate country to create a preliminary impact assessment because the results could be reasonably extrapolated to other countries in the Americas. Jamaica has a large population for an island nation, which makes it a country that can relate to both larger mainland countries as well as smaller island nations. Her supervisor also assured her that it would be fairly easy to get supplemental and consistent information from Jamaica itself compared with other nations within the Americas, should she require it.

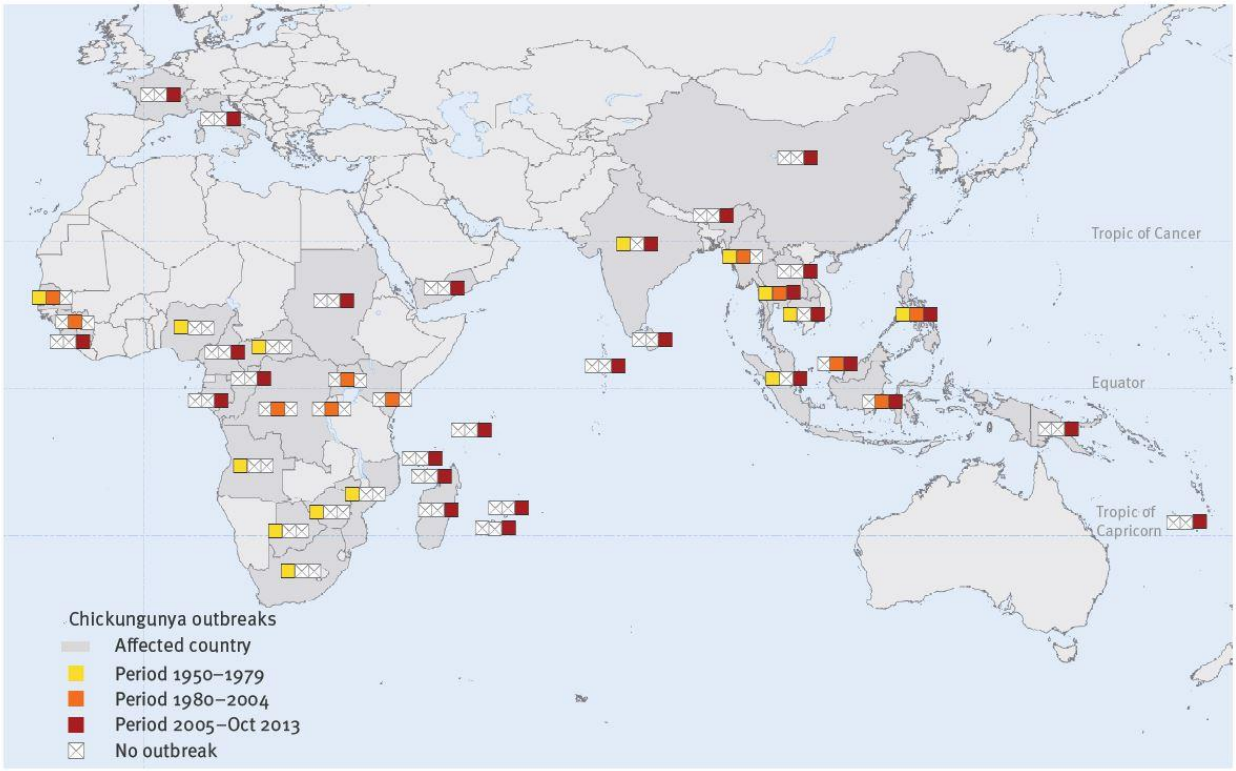
Why is this important?

Forecasting the impact of a chikungunya outbreak for a country in the Americas is important for demonstrating the potential cost to the country involved and what it would mean for its economy. This would assist with getting government officials on board to implement prevention measures. Without having countries actively engaged in these measures it would be extremely difficult to stem the spread of chikungunya throughout the entire region of the Americas, which would negatively impact millions of people directly through illness and indirectly through economic losses. Prevention and control techniques, such as educational campaigns about decreasing mosquito breeding grounds or the use of bed nets, are not prohibitively expensive. However, if governments do not think that such an outbreak would have adverse effects worth avoiding, especially in areas where dengue (a disease with similar acute symptoms but a higher fatality rate) is already common, the cost increases.

EXHIBIT 1

FIGURE 1

Historical overview of the chikungunya outbreaks prior to the emergence of the chikungunya virus in the Caribbean in December 2013



Source: Van Bortel, et. al., 2014.

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INSTRUCTOR GUIDANCE

Chikungunya in the Americas: Estimating the Burden of Disease and Cost of Illness[1]

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BACKGROUND

An intern at the Pan American Health Organization (PAHO) in Washington, DC is conducting an economic impact assessment of a Chikungunya epidemic in the Caribbean. PAHO would like to promote preparedness amongst PAHO member states and forecasting the economic impact may encourage governments to increase disease mitigation efforts. Chikungunya had been spreading through the Caribbean for several months and concerns about the impact of an epidemic in Jamaica were heightened by its reliance on tourism. The intern must incorporate information from a variety of sources to forecast the burden of disease and cost of illness of a Chikungunya outbreak in Jamaica.

OBJECTIVES

1. Define burden of illness and cost of illness and describe their roles in public health.
2. Calculate a disability adjusted life year (DALY).
3. Estimate the burden of illness associated with an infectious disease epidemic.
4. Identify and value cost items relevant to an infectious disease epidemic.
5. Identify, locate, and synthesize the information required to produce cost of illness estimates.
6. Estimate the cost of illness associated with an infectious disease epidemic.
7. Interpret cost of illness estimates and discuss the limitations associated with this measure.

DISCUSSION QUESTIONS

1. What type of information is required to develop burden of illness and cost of illness estimates?

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2. What sources provide accurate and up-to-date information for estimating burden of illness and cost of illness?
3. What sectors should you consider when estimating the cost of illness?
4. What assumptions are necessary to estimate the cost of illness?
5. How can you investigate the impact of uncertainty on cost of illness estimates?
6. What role does seasonal variation play in cost of illness estimates?

KEYWORDS
Chikungunya; infectious disease epidemic; Caribbean; Jamaica; burden of illness; cost of illness.