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## Chikungunya on the move

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### Abstract

In December 2013, chikungunya virus (CHIKV) transmission was reported for the first time in the Americas. Since then it has spread quickly, with more than 1 million suspected and confirmed cases being reported in one year, where previously there were only sporadic travel-related cases. Transmission patterns suggest that the epidemic in the southern hemisphere is only beginning and that chikungunya will not go away anytime soon.

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In the early 1950s an acute disease marked by fever, joint pain, and rash was affecting the residents of the Makonde Plateau region of Tanzania [1]. Known as chikungunya for the way the joint pain ‘bent’ people, the disease manifested in intense outbreaks affecting 60–80% of people in small villages. Recognizing that spread of this disease was similar to that noted in dengue outbreaks, Ronald Ross isolated a previously unknown alphavirus, CHIKV [2].

CHIKV is transmitted between humans by *Aedes aegypti* and *Ae. albopictus* mosquitoes which are common throughout the tropical and subtropical regions of the world and that are also responsible for the transmission of the more widespread dengue viruses. The outbreak in Tanzania was not the first or last outbreak of chikungunya. Intense but sporadic outbreaks occurred in Africa and Asia throughout the latter half of the 20th century. In 2004, a large outbreak in Kenya spilled into the islands of the Indian Ocean and Asia leading to a multi-year pandemic with more than a million cases [3]. This outbreak and increased activity in South-East Asia [4,5] marked a change in the global landscape of CHIKV as transmission became much more widespread.

With more infections occurring in more locations it also became more likely that travelers would enable international spread of the virus. In the summer of 2007 an infected traveler introduced CHIKV into Italy. With local mosquitoes and warm temperatures supportive of CHIKV transmission, this introduction led to the first European outbreak of chikungunya, with at least 205 people being infected [6]. In the Americas, where dengue is widespread and infected travelers were also arriving, local transmission had yet to occur [7].

In December 2013, a local CHIKV infection was confirmed on St. Martin in the Caribbean. Within weeks this was followed by confirmed cases in other nearby islands (Figure 1). A total of 111 cases were reported in December, which rapidly increased to 2487 in January and roughly doubled in the following months (Figure 2) (<http://www.paho.org/>)

*chikungunya*). As the number of cases increased, chikungunya also expanded geographically. By late February, local CHIKV transmission had been reported from ten locations: St. Martin, St. Barthelemy, Martinique, Guadeloupe, St. Maarten, the British Virgin Islands, Dominica, Anguilla, French Guiana, and St. Kitts and Nevis. In April, three new locations reported local cases, followed by four more in May, five in June, nine in July, two in August, three in September, three in October, three in November, and one in December. As of December 12, 2014, 43 countries and territories in the Americas had reported autochthonous CHIKV transmission for the first time in 2013–2014. A total of more than 1 million suspected and confirmed chikungunya cases had been reported in areas where only sporadic travel-associated cases had previously been reported.

Several patterns in the epidemic are evident. First, human movement has been crucial for the international spread of CHIKV. Early CHIKV isolates from St. Martin indicated that the virus was the Asian genotype, with a closely related isolate from the Philippines also in 2013 [8]. Exactly how the virus arrived will likely never be known, but clearly one or more infected travelers enabled it to move halfway around the world within a matter of months. Spread within the American continents was also extremely rapid. Models highlight how human mobility at small and large scales contributes to the speed of spread [9,10]. As with previous outbreaks in the Indian Ocean epidemic, it is increasingly evident that globalization facilitates movement of pathogens at unprecedented speed.

Second, the incidence of chikungunya is following seasonal patterns. Martinique and Guadeloupe first reported local chikungunya cases in December, but incidence did not peak until July (Figure 2). Meanwhile, in the Dominican Republic, where cases were first reported in April, the peak also occurred in July. While CHIKV was introduced at different times across the Caribbean, a seasonal pattern is apparent across the region. This seasonality is very similar to dengue; hot and wet conditions favor the transmission of mosquito-borne viruses. The first chikungunya cases occurred during the relatively cool and dry winter months when dengue cases are also generally low, but transmission across the region took off with the warmer and wetter summer weather. This pattern is also evident in the southern hemisphere where the peak dengue season is reversed. Despite the previous arrival of infected travelers, no local chikungunya cases were reported until September. Unfortunately, this portends increased chikungunya in these regions in the coming months because CHIKV is now present and the dengue season is beginning.

Third, similarly to chikungunya epidemics in other areas with little pre-existing immunity, transmission has been intense. In the current epidemic the number of cases reported by surveillance systems has already topped 10% of the population in several locations. However, the true incidence of infection is certainly several times higher. In a large outbreak in La Réunion, for example, there were an estimated 67 symptomatic chikungunya cases for each case reported by the surveillance system [11]. Retrospective investigations of other CHIKV outbreaks in naïve populations have shown attack rates on the order of 30–75% [12–14].

Together, these patterns portend a public health problem that is only beginning. Approximately 500 million people live in areas of the Americas where dengue is endemic.

Incidence in some locations, such as El Salvador, increased later in the year than in others, and numerous large dengue-endemic countries such as Brazil, Mexico, Peru, Ecuador, and Bolivia have so far reported limited local transmission if any (as of December 12, 2014). If historic attack rates of 30–75% are any indication, there could be several hundred million infections in the region within the first year or two of introduction. The number of cases reported will be much lower; a proportion of infections are asymptomatic and, as noted above, many symptomatic cases are not reported. Nonetheless, hospital emergency departments throughout the Americas are likely to be filled with chikungunya patients. While chikungunya has very low mortality, the morbidity is substantial, and some patients may experience persistent and potentially debilitating joint pain for months after the initial illness [3].

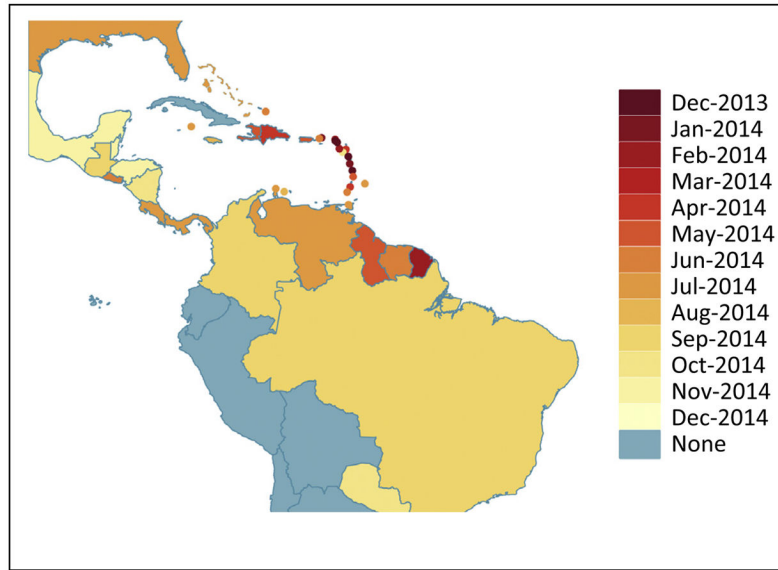
The impact of chikungunya on human health has vastly increased over the past two decades. Chikungunya presents challenges to nearly all aspects of public health: CHIKV has shown an ability to evolve, increasing its transmissibility [15]; clinical diagnosis and management of cases is complicated by co-circulation with dengue viruses and other pathogens that cause similar disease [3], and effective large-scale interventions (e.g., vaccines, vector control) are not available [3]. Ongoing research aims to improve diagnostics, clinical management, and prevention tools including therapeutics, vaccines, personal protection measures, and vector control.

At the same time, it will be essential to establish surveillance systems to monitor chikungunya activity in the Americas. It is possible that CHIKV will become endemic in the Americas. High attack rates lead to herd immunity at the population level, making future outbreaks less likely. However, the heterogeneous landscape of that immunity will still leave many locations susceptible to outbreaks, and human movement throughout the region, especially linking northern, southern, and tropical climates, will facilitate reintroduction. Chikungunya is likely here to stay.

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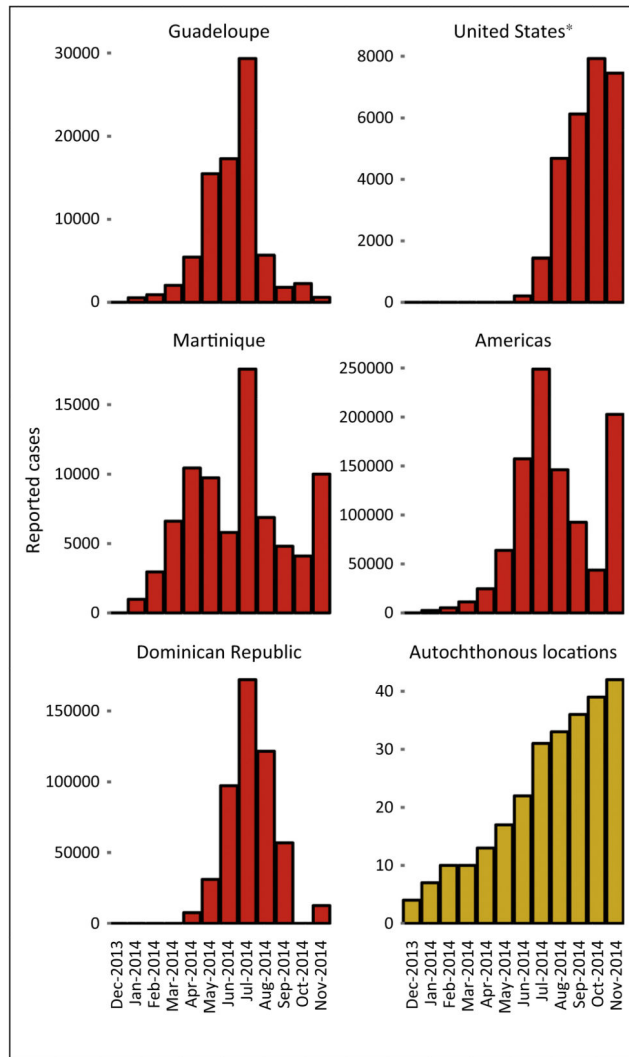
**Figure 1.** The geographical pattern of chikungunya spread in the Americas by month of first reported autochthonous case.

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**Figure 2.** Chikungunya cases reported by month. Red bars indicate the number of cases reported each month including suspected and confirmed, imported and autochthonous cases. Orange bars indicate the cumulative number of countries or territories reporting autochthonous cases. Data were compiled from Pan American Health Organization reports (<http://www.paho.org/chikungunya>) using cumulative reports published closest to the end of each month. \*The US includes cases in Puerto Rico and the US Virgin Islands where large outbreaks are ongoing.