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Lessons raised by the major 2010 dengue epidemics in the French West Indies

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ABSTRACT

Dengue fever has been endemo-epidemic in the whole Region of America. In 2010, Guadeloupe and Martinique experienced historical epidemics, with an estimated attack rate of 10% in two islands. When considering the temporal evolution of epidemiological indicators, an unusual increase in the number of dengue cases could be detected very early. Two main factors might have facilitated the settlement of a viral transmission despite the dry season: a low immunity of the population against the circulating serotype and particular climatic conditions, notably very high temperatures which could have improved both virus and vector efficiency. This unusual situation was considered as a warning sign, and indeed led to major outbreaks in both islands a few weeks later. This event underlines that follow-up of epidemiological indicators is necessary to detect the unusual situations as soon as possible. Furthermore, development of biological and modelling tools should be promoted, as well as integrated management strategies for dengue prevention and control.

1. Introduction

Dengue fever has been endemo-epidemic in the whole Region of America, leading to recurrent epidemics at 3–5 year intervals (San Martin et al., 2010). French West Indies (FWI), as part of the Caribbean Islands, is periodically hit by outbreaks that usually start in July–August, with arrival of the rainy season. In 2010, FWI experienced the largest dengue outbreak ever described in these territories. Many other countries of America (Puerto Rico, Dominica, Cayman Islands, Salvador, Costa-Rica, etc.) and Asia also reported unusual epidemics in terms of intensity or severity. When such an event occurs, health impact as well as economic and social burdens are considerable. Vast resources are necessary to fight against the virus and its vector, to monitor the epidemic, and to look after infected people (notably severe cases). Forecasting the occurrence of great epidemics is therefore a real challenge; on one hand to try to limit its size and extent through early preventive and control measures; and on the other hand to be prepared to its occurrence. This paper aims at describing the major epidemics that occurred in the FWI in 2010, determining whether this event was predictable, and raising some lessons for the future.

2. Methods

Epidemiological situation was monitored by the Regional Office of French Institute for Public Health surveillance Antilles-Guyane (Cire AG) through several indicators:

- Weekly number of dengue-like syndromes was estimated through data from a representative sample of voluntary general practitioners (GP). This sentinel network represents more than 20% of GPs' total activity in each island, with a weekly response rate >80%. Every week, they report their number of visits for dengue-like syndrome, which is then extrapolated to total number of cases in the island using the ratio of all GPs to participating sentinel GPs;
- Weekly number of laboratory-confirmed cases (positive RT–PCR, IgM and/or NS1) was also obtained through real-time notification of cases by all public and private laboratories.

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For these two indicators, an epidemic threshold has been built using the Serfling method (Serfling, 1963) on data from the 3 previous years, with the upper limit of the confidence interval of the expected value representing the threshold.

A surveillance of circulating serotypes was also performed among cases confirmed by RT–PCR. Daily number of emergency room visits for dengue fever was automatically collected and monitored, and severe cases were notified by hospital wards and their evolution was collected.

All these indicators were monitored to follow epidemiological situation in order to adapt vector control measures.

Furthermore, a scientific committee for surveillance of infectious and emerging diseases (Cemie) met regularly in order to assess epidemiological situation and to raise recommendations regarding control measures.

3. Results

The weekly estimated number of dengue-like syndromes started to increase in December 2009, and rapidly exceeded the maximum expected values in both islands (Fig. 1). Weekly number of biologically-confirmed cases followed the same trends. During the following months, Guadeloupe and Martinique experienced the greatest epidemics ever described in terms of both length and size. The estimated attack rate was 10% in the two islands (Table 1). Total number of cases was about twice greater than observed during previous epidemics. Hospitalization and mortality rates were not higher than usual.

In Guadeloupe, the epidemic lasted for 47 weeks and more than 44,000 estimated dengue-like syndromes were diagnosed in GP clinics. The peak was reached in August, with 4000 cases in one single week. In Martinique, the outbreak started later but had a similar evolution, with a total of 40,000 estimated cases in 35 weeks. Considering that all the infected cases do not have recourse to a doctor, the attack rate in the general population was probably much greater than 10% in both islands. As shown in Fig. 1, this episode was the greatest observed for several years in Martinique (a) as well as in Guadeloupe (b); in 2005 and 2007, the estimated number of cases was twice lower and the duration of the outbreaks were much shorter. A similar situation has been reported in many areas of the Region of America: according to data collected by the Pan American Health Organization, more than 1,600,000 people were infected; of who 48,954 had a severe form and 1194 died (Pan American Health Organization, 2010). Several territories experienced the largest dengue outbreak in their history, and some areas usually protected either by cold weather conditions or because there was a delay in the entry of the cold season, were affected.

4. Discussion

4.1. Were the 2010 major outbreaks predictable?

Regarding the evolution of surveillance indicators, the unusual side of the epidemiological situation was discernible very early, much before the epidemic became major. Indeed, both numbers of biologically confirmed- and clinical cases started to increase in December 2009. They rapidly exceeded the maximum expected values, and kept increasing during the whole dry season, showing an active viral transmission which is totally unusual at this period.

The first question was: how to explain this unusual increase? Two factors were identified as having probably played a role. First, the involved serotype (DENV-1) had not been circulating actively for many years in the FWI, since the last outbreak clearly attributable to DENV-1 in the FWI occurred in Martinique and lasted from 1997–98. The level of immunity of the population was therefore probably low, especially among children. This could have facilitated the settlement of a viral transmission despite the dry season. Second, early 2010 have been characterized by a remarkable heat wave, since average temperatures exceeded the climate norm by 2–3 °C. The months of February and March were notably the warmest ever described in both islands. Although usual entomological indices were collected, these extreme temperature could have improved virus and *Aedes aegypti* efficiency by: (i) decreasing time of virus replication and extrinsic incubation (Bangs et al., 2006; Koopman et al., 1991), (ii) shortening vector's gonotrophic cycle (Bangs et al., 2006; Jetten and Focks, 1997) and development time to adulthood (Alto and Juliano, 2001; Bangs et al., 2006); and (iii) decreasing vector's size and time for digestion, leading to more frequent meals (Jetten and Focks, 1997; Patz et al., 1998). Last, during warm and drought condition, people tend to store water in indoor containers, increasing the risk of exposure to mosquitoes (Bangs et al., 2006). High temperatures were previously found to be associated with the occurrence of large dengue epidemic (Bangs et al., 2006).

The second-and main question was: does this situation constitute a forewarning of an increased risk of an unusually-large epidemic? In the literature, little information was available in order to answer that question. However, two studies on predictive models for dengue epidemics suggested that the risk was real: first, it was shown that early outbreaks are likely to produce large epidemics because they have a longer time to spread before the winter extinction of vectors (Otero and Solari, 2010); second, the high number of previous cases was suggested to be associated with an increased risk of dengue hemorrhagic fever epidemic through an association with the reproductive number of the virus (Halide and Ridd, 2008).

In view of these elements, the Cire AG, in agreement with the local expert committees on infectious diseases, considered as high the risk of large-scale epidemic during the following months. Health authorities, medical professionals and general population were informed of this potential risk in order to reinforce individual and collective preventive measures and to prepare for a potential increase in hospitalized cases. A few weeks later, the expected increase did happen, but fortunately children were not particularly affected although their probably low level of immunity.

4.2. What lessons for the future?

Regarding this episode, health authorities should keep in mind that in endemic areas, a high number of dengue cases during dry season could be a warning sign for a following large outbreak.

However, a continuous collect of entomologic and epidemiologic indicators is essential in order to dispose of a warning system capable of detecting as soon as possible this increased risk. Several complex models including many parameters have been developed in that view, but these methods require significant financial and human resources (Racloz et al., 2012) that are not available in all countries. Our experience shows that monitoring temporal trends of simple epidemiological indicators can also be of interest to detect unusual situations when modelling is not realisable due to lack of data and/or resources. However, this requires continuous collection and monitoring of reliable and robust indicators. In the DFA, data from the sentinel network represent more than 20% of total GPs' activity and are geographically representative, which gives a reliable overview of the epidemiologic situation. Furthermore, the laboratory network provides reliable and exhaustive data on confirmed cases. Contrary to recommendations from other testing algorithms (World Health Organization, 2009), patients with a single IgM positive test are considered as confirmed cases, leading to a possible overestimation due to false positives. However, this bias might be limited due to the absence of circulation of