衞生防護中心
Centre for Health Protection

Scientific Committee on Vector-borne Diseases

Epidemiology, Prevention and Control of Dengue Fever in Hong Kong

Purpose

The purpose of this document is to update the epidemiology, preventive and control measures of dengue fever (DF) and provide recommendations on combating the disease in Hong Kong.

Background

2. DF is known as one of the most important arthropod-borne viral diseases affecting humans. Over the past several decades, major outbreaks of DF have occurred in many countries, causing significant morbidity and mortality. The magnitude of the DF issue remains alarming. Frequent travelling over the world can cause further spread of DF from the endemic areas to many previously unaffected areas.[1, 2] Scientific Committee on Vector-borne Diseases (SCVBD) published "A Three-year Strategic Plan for the Prevention and Control of Dengue Fever in Hong Kong" in 2005. In view of the latest local cluster of DF in 2010, we have further reviewed the global and local epidemiology of DF and summarised the preventive and control measures of DF in the following sections.

The vector and virus

3. DF is mosquito-borne and the primary vector is *Aedes aegypti*. Breeding of *Aedes aegypti* has not been found in Hong Kong. The *Aedes albopictus*, often found in Hong Kong, is a less efficient vector. The female *Aedes* mosquitoes acquire the virus while feeding on an infected person. After a period of 8-12 days, the mosquito becomes

infective and can transmit the virus to another human through its bites throughout its life. There may be transovarial transmission from the infected female mosquitoes to their offsprings.

4. Dengue viruses are members of the genus *Flavivirus* and family *Flaviviridae*. They are single-stranded RNA virus with an icosahedral nucleocapsid surrounded by an envelope. There are four distinct serotypes: DEN-1, DEN-2, DEN-3, and DEN-4. Infection by one dengue serotype can give rise to life-long immunity to the serotype but only partial protection to other serotypes. Sequential infection by different serotypes of dengue virus has been generally accepted as the predisposing factor of dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS). DHF is more likely to occur when dengue virus affects a person with immunity to a heterologous serotype. The frequency of each serotype causing DHF/DSS is in descending order of: type 2, 3, 4, and 1.[3] All four dengue virus serotypes (DEN-1 to DEN-4) are presently circulating in different geographical areas.[4, 5]

The host and transmission of the dengue virus

5. Dengue viruses infect humans and some species of lower primates and humans are the main amplifying host of the virus. Dengue virus circulating in the blood of viraemic humans is ingested by female mosquitoes during feeding. The virus then infects the mosquito mid-gut and subsequently spreads systemically over a period of 8 to 12 days. After this extrinsic incubation period, the virus can be transmitted to other humans during subsequent probing or feeding. There are several factors which can determine virus transmission, including environmental and climate factors, host-pathogen interactions and population immunological factors.[6]

Clinical features

6. The virus may cause disease in humans after an incubation period of 3 to 14 days. Dengue viruses cause three main clinical syndromes: DF, DHF and DSS.[7] DF is an acute febrile viral disease characterised with fever, headache, myalgia, arthralgia, retro-orbital pain and maculopapular rash. The pain can be so severe that it is sometimes called “break-bone fever”. Most often, DF presents as a mild illness and rarely causes death, with case-fatality rate less than 1%. For DHF, the initial presentation is similar to DF but the patient may have bleeding and/or circulatory collapse after 2-7 days of high fever. This is due to a combination of thrombocytopenia (which is usually more severe than in DF) and plasma leakage from ‘porous’ capillaries leading to effusions such as pleural effusion, ascites and pericardial effusion.[8]

7. For DSS, the patient with DHF may develop hypovolaemic shock. In general, the period of shock is short and usually lasts only 1-2 days before the patient dies. However, the response to treatment with fluid replacement and

oxygen administration is prompt.[8] Case fatality rates of DHF/DSS vary in different countries. Expert treatment in a modern ICU reduces the mortality to less than 1%.

Laboratory diagnosis

8. Diagnosis of DF is usually confirmed by demonstrating a fourfold or greater rise in antibody titre to one or more dengue virus antigens between acute and convalescent serum samples. It can also be confirmed by the detection of dengue virus genome in, serum, cerebrospinal fluid or autopsy tissues by polymerase chain reaction (PCR). However, this is limited by the timing of specimen collection as virus can be detected in clinical samples during the viraemic phase usually within five days of disease onset. PCR has the advantage of enabling differentiation between the four dengue serotypes and allows further molecular epidemiological studies by sequencing. While the isolation of virus from clinical samples is the most specific diagnostic method, the time needed to obtain results (one to two weeks) is long. Besides, culture technique and facility may not be available in routine diagnostic laboratory. Thus, virus isolation is not routinely performed.[7]

Disease management

9. Clinical management of DF involves monitoring of vital signs and laboratory parameters, and supportive therapy including bed rest, fluid replacement and antipyretics (while aspirin and NSAIDs should be avoided as these drugs may aggravate gastritis or bleeding). Management of DHF and DSS requires meticulous monitoring of haemodynamic status to detect the earliest evidence of plasma leakage with early and adequate fluid replacement when needed. Blood transfusion may be required.

10. Dengue antiviral is not available but the research in this aspect is a new endeavour in management. There are many challenges for the development of anti-dengue drugs. With respect to clinical efficacy, the drug must be active against all serotypes, reduce symptoms, and reduce the incidence of severe disease.[9]

11. No licensed vaccine against DF is available at the moment. However, the development of vaccine is in progress. The first phase III clinical trial to investigate tetravalent dengue vaccine (TDV) in children has been initiated in 2010 and preliminary results are expected by the end of 2012.[10]

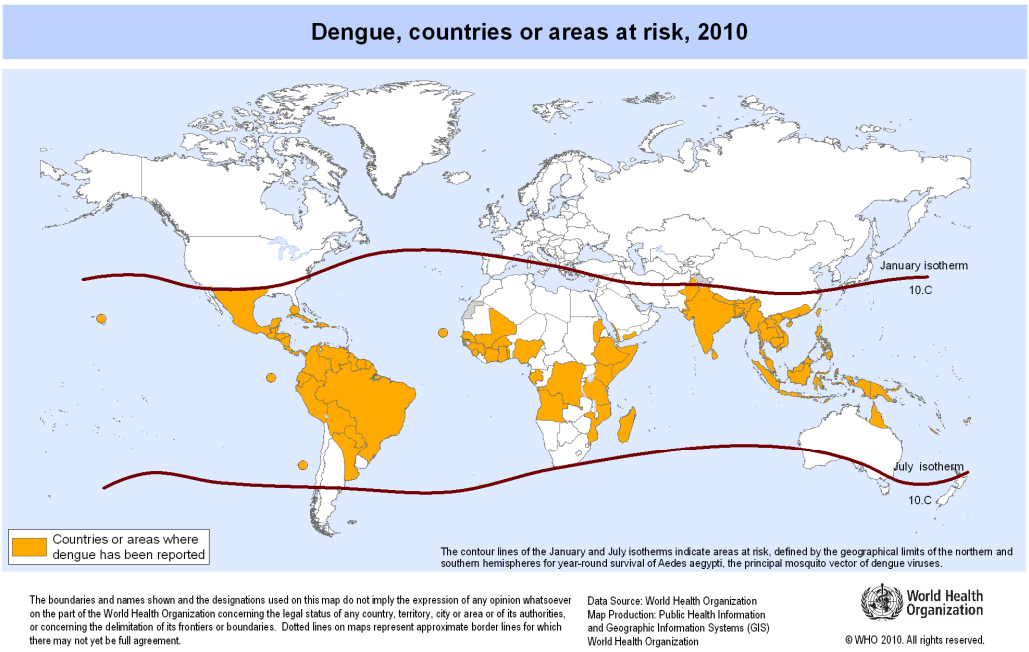
Global situation

12. According to WHO, almost half of the global population are under the risk of dengue infection (Figure 1). Reports to Western Pacific Region Office (WPRO) of WHO showed that DF continues its increasing trend

and some countries (Cambodia, Singapore and Viet Nam) have experienced a higher cumulative incidence of dengue relative to the same time period in 2010.[11] From 2001 to 2007, more than 30 countries of the Americas notified a total of 4,332,731 cases of dengue and the number of cases of DHF in the same period was 106,037.[12]

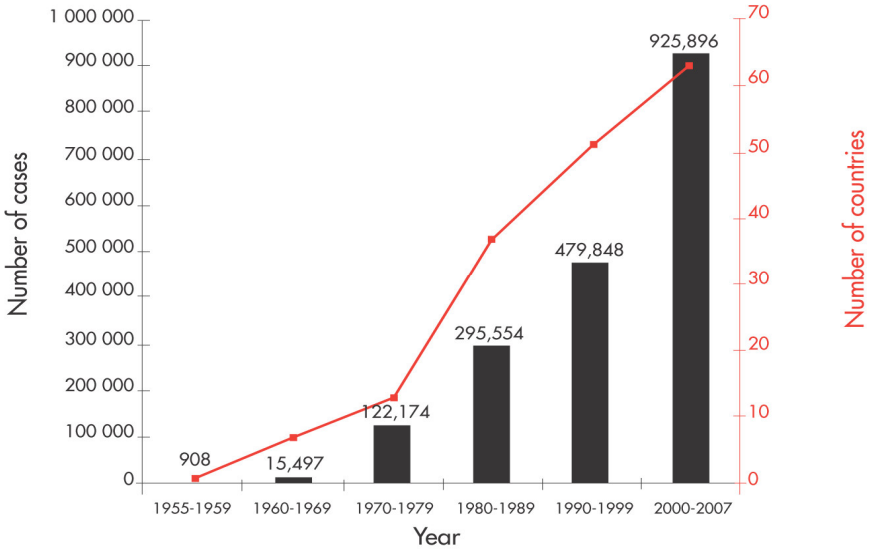
13. The global annual dengue infection ranges about 50 to 100 million. The majority of 500,000 hospitalisations for DHF are children and there are about 20,000 deaths each year.[1, 7] In recent years, recorded average annual number of DF/DHF cases from WHO increases significantly (Figure 2). The number reported to WHO for the period 2000-2007 almost doubled that for the period 1990-1999.[1, 7] Outbreaks dengue fever have been reported to WHO from different countries and a recent large outbreak was documented in the Cape Verde islands in 2009, where more than 17,000 cases recorded.[13]

Figure 1 Countries/areas at risk of dengue transmission, 2010 (with permission from the World Health Organization)



(source:http://gamapserver.who.int/mapLibrary/Files/Maps/Global_DengueTransmission_ITHRiskMap.png

Figure 2 Average annual number of dengue fever (DF) and dengue haemorrhagic fever (DHF) cases reported to WHO, and of countries reporting dengue, 1955–2007[7] (with permission from the World Health Organization)



(source: Dengue: Guidelines for Diagnosis, Treatment, Prevention and Control 2009, p4; http://whqlibdoc.who.int/publications/2009/9789241547871_eng.pdf

Local situation

14. DF has become a statutorily notifiable disease in Hong Kong since March 1994. From 2001 to June 2011, there were a total of 438 cases of DF. The annual number of cases ranged from 17 to 83 (Figure 3 and 4). Patients aged from 5 to 76 years old (median: 37 years old) and male to female ratio was 1.3 to 1. Majority (94.3%) were imported from other countries and only 25 cases (5.7%) were local cases in the past decade. More cases were observed in summer months (from August to October). There have been 5 DHF in the past decade and all have recovered. No DSS or fatal case was reported so far.

Figure 3 Dengue fever cases in Hong Kong, by year (2001 – June 2011)

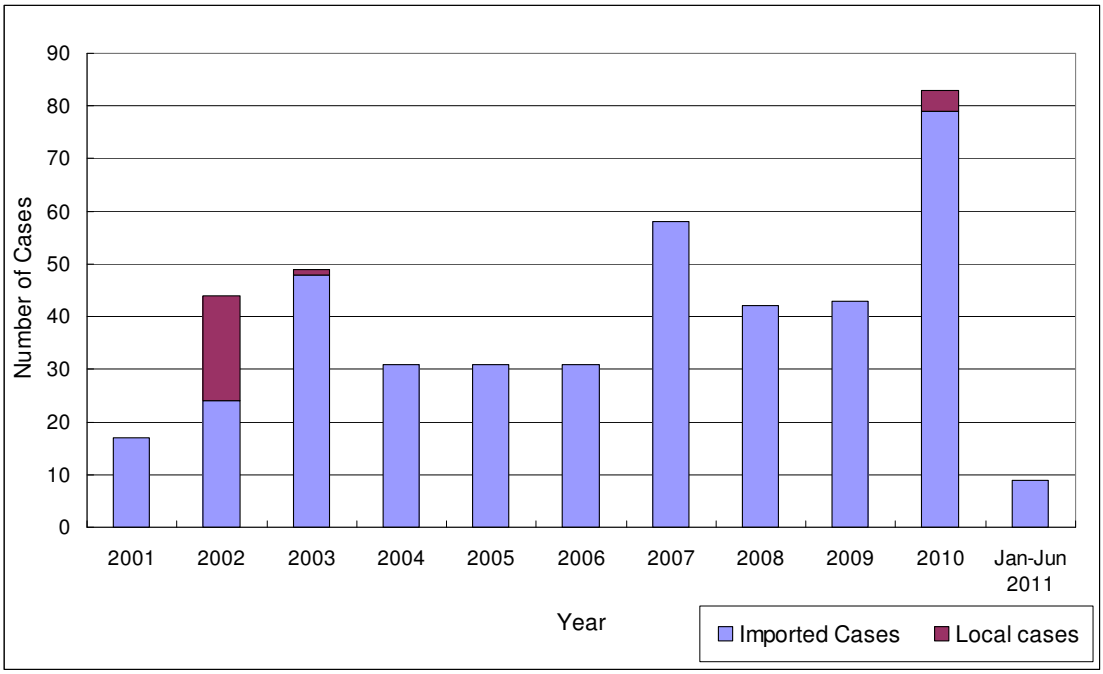
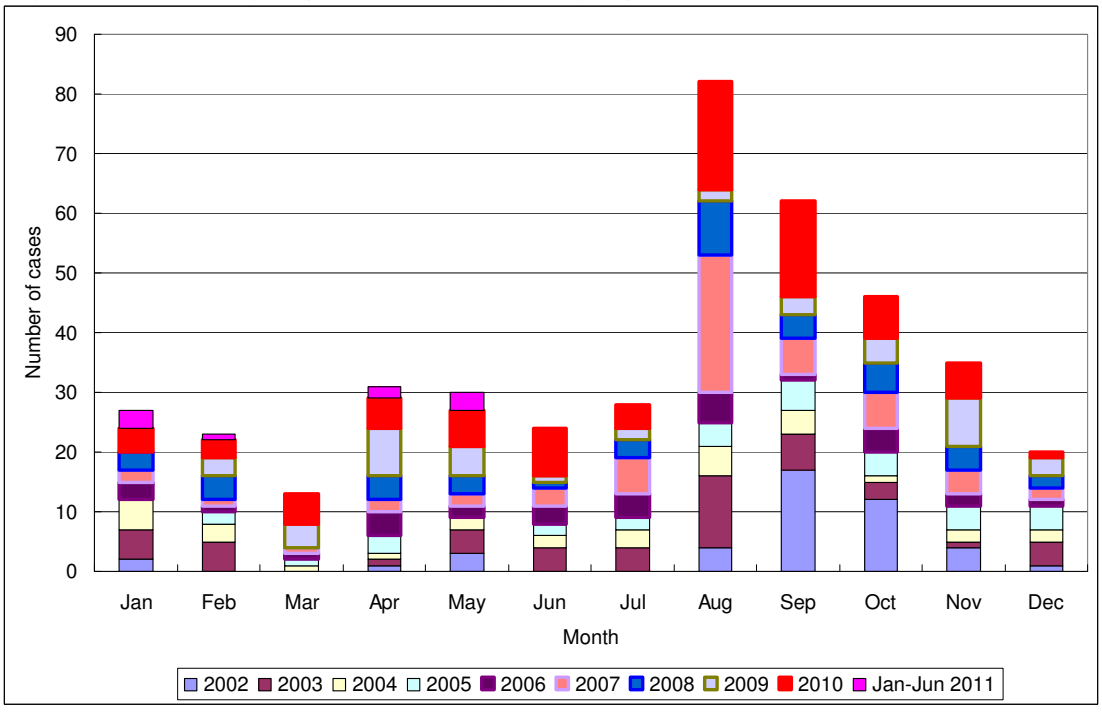


Figure 4 Dengue fever in Hong Kong, by month (2002 – June 2011)



Local cases

15. In 2002, Hong Kong registered the first local cluster of dengue fever in September. The epidemiological investigation revealed an outbreak in a construction site in Ma Wan affecting 16 workers and residents nearby. One of them had further spread to a transfusion recipient through blood donation. Subsequent to the 2002 outbreak, another 3 local cases in 2002 and one in 2003 were recorded. As no linkage was identified after thorough epidemiological investigation, these were classified as sporadic cases. Afterwards, there has been no local case reported until 2010, when a cluster of local DF cases were confirmed in September. A male patient with no travel history outside Hong Kong during the incubation period was confirmed with dengue virus serotype 4. Further epidemiological investigations revealed that his wife and two sons, who also had no travel history during incubation period, had symptoms compatible with DF. Their diagnoses of DF were substantiated with positive serological testing results. All of them recovered subsequently. After implementation of intensive control measures, no more related case was reported. Over 800 mosquito and larva samples were collected that time and all of them were tested negative for dengue virus by RT-PCR (Reverse Transcription Polymerase Chain Reaction).

Imported cases

16. Among imported cases, the source of countries and the serotypes of the dengue virus were summarised below (Table 1). Among the 293 imported cases from 2005 to June 2011, 240 of them had their dengue serotype available by PCR.

Table 1 Imported dengue fever cases by imported country and serotype (2005 – June 2011)

Country	DEN-1	DEN-2	DEN-3	DEN-4	Unknown serotype	*Total*
Aruba Island	1					**1**
Bangladesh		2	3		5	**10**
Cambodia	1		1		6	**8**
China	2				1	**3**
Dominican Republic				1		**1**
Ghana					1	**1**
India	6	3	6	1	5	**21**
Indonesia	27	19	34*	3	11	**94**
Jamaica				1		**1**
Laos	1					**1**
Macao		4				**4**
Malaysia	3	4	4	5		**16**

Maldives	1		4			**5**
Myanmar	1				1	**2**
Nepal	1					**1**
Pakistan			1			**1**
Philippines	10	9	12	2	9	**42**
Singapore	2	1			2	**5**
Sri Lanka		1	1		1	**3**
Suriname	1					**1**
Thailand	22	8	13	1	8	**52**
Vietnam	7	1			2	**10**
Undetermined	4	2	2	1	1	**10**
Total	**90**	**54**	**81**	**15**	**53**	**293**

*one case from Indonesia had both type 3 and type 4 serotype and the case was included in DEN-3 serotype only

Prevention and control for DF in Hong Kong

17. Dengue infection is of great public health significance because of the potential in causing rapid and extensive epidemics and resultant stress to healthcare services. Although DF is endemic in many nearby countries, it has been well under control in Hong Kong. There have been many existing preventive and control measures applied locally.

Surveillance and investigation of human cases

18. The availability of effective mechanisms for early case detection so as to prevent further spreading of virus to local mosquito population is critical. In Hong Kong, DF is statutorily notifiable and all medical professionals are required to report suspected and confirmed cases to the Centre for Health Protection (CHP) of Department of Health (DH).

19. Case investigation is initiated immediately when a notification is received. Detailed history of the patient, such as the onset date, travel history, residential/ workplace addresses, local movement, symptomatology of travel collaterals and contacts is taken. Health advice will be given to both travel collaterals and contacts. They are also put under medical surveillance. The Food and Environmental Hygiene Department (FEHD) is also notified for vector control and prevention at relevant sites as appropriate.

20. The febrile patients are required to be hospitalised in mosquito-proofed facilities to prevent subsequent mosquito bites which may be prone to further spread to local mosquito populations. The hospital concerned should adopt practical guideline to prevent transmission of the disease. Close observation of the patient is necessary to guard against DHF and DSS.

21. Should a local source be suspected, CHP will conduct field investigation, perform active case finding, enhance surveillance and set up telephone hotlines. Staff of FEHD would conduct entomological survey and vector control and preventive measures covering the area beyond the average flight range of the *Aedes albopictus*.

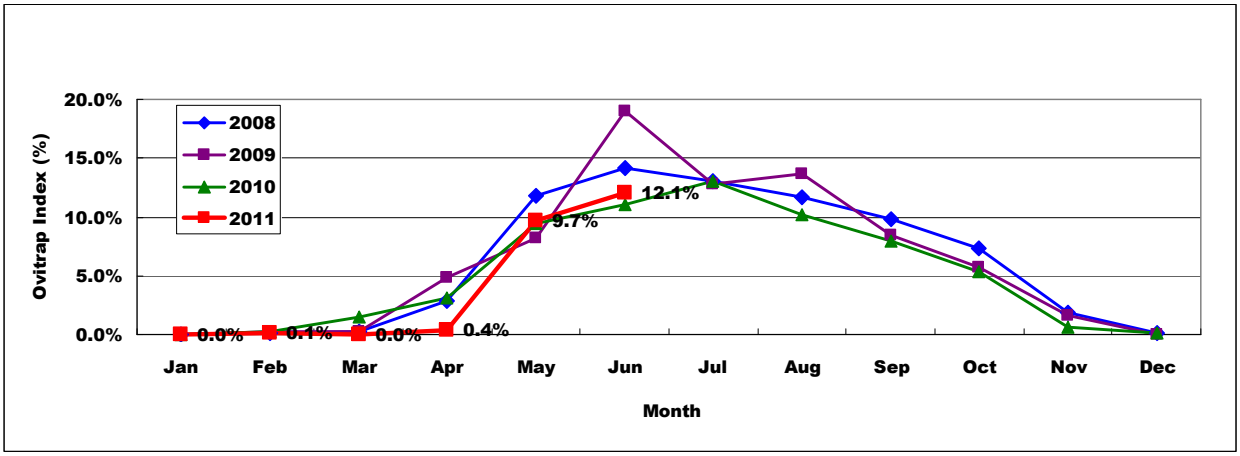
Vector management and control

22. The FEHD is the government department taking the lead in vector surveillance and control. It has been conducting a dengue vector surveillance programme since 2000 using oviposition trap (ovitrap). This programme monitors the adult aedine mosquitoes including *Aedes albopictus*.

23. Two different indices, namely Area Ovitrap Index (AOI) and Monthly Ovitrap Index (MOI), are enumerated. AOI indicates the extensiveness of the distribution of aedine mosquitoes in that particular area surveyed while the MOI is the average of all AOIs within the same month, which reflects the territory-wide situation of *Aedes albopictus*.

24. Prior to 2011, the dengue vector surveillance programme has 38 survey areas. Among the 38 survey areas, two were in outlying islands, eight in Hong Kong island, 11 in Kowloon and 17 in the New Territories. The areas were mainly areas where previous local dengue fever cases were reported as well as areas with high human concentrations such as residential areas, schools and hospitals. This was in line with the recommendations of the WHO for dengue vector surveillance. Six more survey areas had been added since January 2011, in response to the local outbreak of DF in September 2010, resulting in a total of 44 survey areas currently. Figure 5 shows the Monthly Ovitrap Indices between 2008 and 2011 (as of June 2011).[14]

Figure 5 Monthly Average Ovitrap Index (2008 – June 2011)



25. Survey of *Aedes albopictus* has been carrying out in Hong Kong International Airport since 1998. Since 2004, dengue vector surveillance work has been extended to other port areas, such as cross boundary sea ports, land ports, cargo working areas and container terminals. Two different indices, namely Port Ovitrap Index (POI) and Port Monthly Ovitrap Index (PMOI), were enumerated. POI indicates the extensiveness of the distribution of aedine mosquitoes in particular group of surveyed port areas while the PMOI is the average of all POIs within the same month, which reflects the overall situation of *Aedes albopictus* in port areas.

26. Results of these surveys are distributed to partner departments and the public. Specific preventive and control measures will be initiated according to the level of the Ovitrap Index. The AOI, MOI, POI, and PMOI results are also available on the website of FEHD.

27. FEHD also carries out regular vector control at hotspots. Source reduction is the fundamental method adopted to eliminate mosquito breeding. The AOIs are categorised into four action levels, each of which requires the initiation of different control actions and health education work. The management of properties and the public are also advised to take corresponding preventive or remedial actions at different action levels.

Building partnerships and interdepartmental collaboration

28. It is crucial to involve the community and private sector to maintain public alertness to the importance of sustained anti-mosquito efforts. The Anti-Mosquito Steering Committee (AMSC) was established by the Government to oversee strategy and direction setting in mosquito control and to promote the involvement of the community and private sector. The Committee comprises members from different government bureaux and departments. Each party is tasked to carry out mosquito prevention and control work under their respective purview.

29. Different departments have been participating in the regular territory-wide anti-mosquito campaigns. These campaigns aim to heighten the public awareness on potential risk of mosquitoes and dengue fever; encourage community participation and close collaboration between government departments; and intensify elimination of breeding sites for mosquitoes.

Health education

30. As almost all DF cases notified in Hong Kong are imported cases, it is important to provide relevant health advice to travellers before they start the journey. The Travel Health Service of DH maintains a website (www.travelhealth.gov.hk) to provide the areas at risk of DF, the latest outbreak news, background information of DF and effective preventive measures against

mosquito bites. Health education materials and announcements are also available at borders to raise the awareness of the travellers before leaving Hong Kong. Travellers visiting dengue endemic countries are advised to seek early medical consultation if they were sick.

31. On the other hand, the public are reminded of the necessity for elimination of mosquito breeding places and precautions against mosquito bites through various channels including Announcement of Public Interests (API) in radio and television, health education hotlines, website information, health talks, pamphlets and posters.

32. The ultimate goal of health education is to modify the public's behaviours in relation to vector control. Dengue vector control is effective, particularly when interventions are community-based educational programmes to enhance public knowledge and understanding.[15] Health promotion programmes aiming at sustainable behavioural changes should target at the individual, household, and institution levels. It is crucial to involve the community and private sector to enhance public alertness to the importance of sustained anti-mosquito efforts. The FEHD has been actively disseminating the messages to the community and the private sector through various channels. By weekly removing accumulated waste water, the life cycle of dengue vectors can be interrupted. A "Guidebook on Control and Prevention of Mosquito Breeding" has been prepared by the FEHD to provide the public with the practical tips to achieve the goal.

Emergency preparedness

33. Response for DF outbreak involves early warning of epidemic transmission and rapid response to contain outbreaks, thereby decelerating ongoing transmission. It includes the instigation of measures to reduce the number of infective mosquitoes over the transmission area. The Government has developed a contingency plan for local dengue fever cases is in place which contains essential elements such as protocols for stepped-up surveillance, active case finding and case investigation, emergency vector control, media and risk communication plans.

Conclusions and recommendations

34. Majority of DF cases reported in Hong Kong are imported cases from endemic countries. A series of effective public health measures have been in place to prevent local occurrence of DF. In the past decade, only a few local cases (25 cases) were reported. With prompt and intensive investigation and implementation of control measures, the situation had been well controlled locally.

35. For vector control, despite that the breeding of primary vector for DF has not been found in Hong Kong, we should maintain vigilant since *Aedes albopictus*, a less efficient vector for DF, is available in Hong Kong. In this regard, vector management and control play a vital role in the prevention and control of DF in Hong Kong.

36. Against this background, specific recommendations for enhancing our current prevention and control measures against DF are listed as follows:

(a) Surveillance and case investigation:
(i) Clinicians should maintain a high index of suspicion for dengue fever and arrange diagnostic tests as appropriate.
(ii) Case of dengue fever should be notified to CHP immediately for investigation and implementation of necessary public health measures.
(iii) The patients should be hospitalised in mosquito-proofed facilities during the febrile periods to prevent subsequent mosquito bites.

(b) Vector management and control:
(i) The locations selected for vector surveillance should be reviewed periodically to meet the latest need.
(ii) Control of the vector in populated areas should be maintained with regular updating of the design in vector control programme.

(c) Building partnerships and intersectoral collaboration:
(i) Government departments and the community should continue to cooperate to sustain the work of mosquito prevention and control.

(d) Health education:
(i) Travellers to DF endemic areas should be reminded of the risk, take necessary preventive measures and seek medical consultation earlier should symptoms develop.
(ii) Simple and practical messages should be provided to the public for elimination of mosquito breeding places and precautions against mosquito bites.
(iii) Anti-mosquito campaign should be implemented regularly to sustain community vigilance on vector prevention.

(e) Emergency preparedness:
(i) The contingency plan should be kept updated in response to the latest disease situation and science development.

Centre for Health Protection
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