DF/DHF and Its Control in Fiji

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Abstract

Dengue haemorrhagic fever (DHF) first appeared in Fiji in 1975, with subsequent outbreaks in 1979-80, 1989-90 and 1997-98. The 1997-98 outbreak of DF/DHF was explosive with 24,000 cases and 13 deaths when the disease also spread to rural areas.

The epidemiology of DF in Fiji is unique, as urban and rural transmissions occur through different sets of species. *Aedes aegypti, Aedes albopictus, Aedes polynesiensis and Aedes pseudoscutellaris* are abundant in urban, peri-urban and rural habitats, whereas *Aedes horrescens* and *Aedes rotumae* have a more patchy distribution.

Therefore, Fiji's dengue control efforts cannot be focused just on urban *Aedes aegypti* as elsewhere in the world. In Fiji, integrated methods of vector control placing particular emphasis on source reduction through strategically developed health promotion campaigns and community participation backed up by law enforcement are in place. Chemical control is not used as a routine measure in Fiji except during DF/DHF outbreaks.

An active surveillance system for early warning and detection of potential DF/DHF outbreak has been established following the 1997-98 epidemic (clinical, laboratory-based surveillance and entomological). For the first time these surveillance systems have coordinated well to address dengue control in Fiji and to activate appropriate public health response from communities.

Keywords: DF/DHF, *Aedes spp*., integrated control, surveillance systems, law enforcement, Fiji.

Introduction

Fiji, comprising about 300 islands, located in the southwest of the Pacific Ocean, lies between 15^{o} and 22^{o} south of the Equator. One-third of the islands are inhabited, and 70% of the population lives on the largest island, Viti Levu. Suva is the largest city, the main port and the Capital. Vanua Levu and Taveuni, the second and third largest islands, lie in the northeast of Viti Levu. Travel between these three islands is frequent,

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rapid, easy and inexpensive, which facilitates the movement of human hosts and mosquitoes infected with dengue viruses.

History of dengue

DHF was first recognized in 1954 in the Philippines but was not seen in Fiji until 1975[1]. Subsequent DHF outbreaks in Fiji occurred in 1979-80, 1989-90 and 1997-98. During the last explosive outbreak of DF/DHF in 1997-98 there were more than 24,000 reported cases with 13 deaths due to DHF or DSS. Table 1 depicts the morbidity and mortality recorded between 1885-1989/1999[1,2].

Table 1. *Dengue epidemics in Fiji from 1885-1998/1999*

Year	Serotype	Number of cases	DHF-DSS	Deaths
1885	Not known	Thousands	Not known	Not reported
1930	Not known	Thousands	Not known	Not reported
1943-1944	Not known	Thousands	Not known	None
1971-1972	DEN-2	4,000	None	None
1974-1975	DEN-1	20,000	Yes	12
1980	Not known	127	Not known	Not reported
1981	DEN-4	Hundreds	Yes	1
1982	DEN-2	546 +	Not known	Not reported
1983	Not known	237 +	Not known	Not reported
1989-1990	DEN-1	3,686	Yes	30
1997-1998	DEN-2	24,000	Yes	13
1998-1999	Not known	300 +	Not known	None

Serotypes identified in Fiji

Table 1 also highlights the circulation of different serotypes in different years. DEN-2 has been in circulation since the 1971-72 outbreak. DEN-1 was detected during the 1974-75 epidemic. This was followed by DEN-4 during 1981. In subsequent epidemics DEN-1 and DEN-2 were prevalent. DEN-3 has not been isolated so far.

Vectors of dengue and DHF

In Fiji there are 26 known species of mosquitoes. The epidemiology of dengue in Fiji is unique because it is the only country in the world where four to six species of mosquitoes may transmit the viruses. The most effective vector is *Aedes aegypti* because of its close association with man. Other known vectors are *Aedes albopictus*, *Aedes polynesiensis, Aedes pseudoscutellaris,* and *Aedes rotumae* (in Rotuma only). *Aedes horrescens* may also transmit the virus[2]. The breeding habitats of these vectors are given in Table 2.

Table 2. *Vectors and their breeding habitats in Fiji*

(1) ***Aedes aegypti*** **(primary vector)** - used tyres, water storage containers, tins, pot plants, flower vases and man-made containers
(2) ***Aedes albopictus*** **-** same as above including natural breeding habitats like tree holes and plant leaf axils
(3) ***Aedes pseudoscutellaris*** **-** miscellaneous and artificial containers
(4) ***Aedes polynesiensis*** - crab holes, coconut and sea shells, tree holes, tins along coastal areas
(5) ***Aedes rotumae*** (in Rotuma only) - tree holes, coconut shells and tins
(6) ***Aedes horrescens*** - tree holes

Although *Aedes aegypti* is known to be the major vector of dengue, the Breteau index of *Aedes aegypti* during epidemics on Suva island ranged from 35.7 (1977) to 109.8 (1979) as indicated in Table 3. *Aedes albopictus* and *Aedes pseudoscutellaris* have also been recognized as dengue vectors in Fiji (Vector-Borne Disease Working Committee 1997:3-4). *Aedes albopictus* was first recognized in Fiji in 1988 and appears to be replacing *Aedes aegypti* in some places and displacing *Aedes pseudoscutellaris* in most areas. It was evident that by 1988, *Aedes albopictus* already was well established and distributed in all the three major islands of the country.

Table 3. *Breteau index of Aedes aegypti during the years of dengue epidemics (in Suva)*

Year	Breteau Index
1972	51.0
1974	78.0
1975	48.2
1976	48.5
1977	35.7
1979	109.8
1989	79.0

Key containers

The entomological studies undertaken in Suva between 1978-1979 revealed that *Aedes aegypti* and *Aedes pseudoscutellaris* bred in flower vases, drums, plant containers and tyres, but preferentially in miscellaneous containers such as tin cans, plastic food-containers and, to a lesser degree, in coconut shells, old motor parts and, least of all, in ground pools. However, these measurements take no account of the relative productivity of each larval habitat. Drums and tyres can produce far more adult mosquitoes than other containers and thus attention should be focused initially on these 'key containers'[3]. Recent research in Fiji has shown that tyres and drums comprising 10-20% of the total containers found positive for *Aedes* larvae are responsible for 83-99% of the adult *Aedes* produced.

National dengue control plans

Sentinel vector surveillance system

Three sentinel sites (Suva, Lautoka and Labasa) have been selected as they are regarded as high-risk areas of dengue transmission. The National Vector Control Unit and the area health staff survey these sites at quarterly intervals. The Unit is responsible for identification, data processing and feedback. The Centre is also responsible for the overall coordination of public health responses to curb any potential outbreaks of DF/DHF. In 1998 the Pacific Regional Vector-Borne Disease Project (PRVBDP) of The Secretariat of the Pacific Community (SPC) facilitated the Ministry of Health with professional skills and resources in training the health inspectorate staff which led to the establishment of mini vector identification laboratories at divisional stations. All vector identification work in Fiji has been decentralized since September 1998.

(1) **Monthly *Aedes larval* surveillance**: A countrywide monthly *Aedes* larval monitoring programme is carried out by the health inspectorate staff of all the urban

and rural local authorities on a monthly basis. This survey includes inspection of at least 100 premises per month, covering residential, commercial and industrial zones. In Fiji, the sample size comprises 10 larvae (including pupae) per container from all water-holding containers in a premises. In Fiji the Breteau Index is classified as follows:

(a) <5 – No risk of transmission

(b) 5–35–significant risk of transmission

(c) >35 should be considered as high risk of transmission.

(2) **Adult mosquito surveillance**: The surveillance of *Aedes* adults as for most other mosquitoes currently involve the collection of adults (mainly females) at bait, nets and traps. Mosquito nets and suction tubes are used for the collection of *Aedes aegypti* adults resting indoors and other *Aedes* species resting in vegetation or biting man outdoors. Ovitraps to trap eggs are used to reflect adult densities as a useful tool for surveillance of *Aedes* vectors. Presently, human baits are not used because of the potential risk of infection. In Fiji the *Aedes* landing/biting rate of more than 2 per man-hour should be considered as high risk of transmission.

Integrated vector control measures

The Central Board of Health is the regulatory body that overlooks the urban and rural local authorities, which implement public health legislation. The Health Inspectorate personnel of all local authorities carry out monthly mosquito surveillance and control activities.

(A) Control strategies

(1) **Source reduction** (elimination of breeding sources).

(2) **Chemical spraying**. Malathion ULV for focal spraying during epidemics only to reduce adult density. Aqua Resigen for peri-focal sprays of case locations and area within 400 metres of case location.

(3) **Chemical larviciding**. Temephos (Abate) for ground pools and water storage receptacles.

(4) **Health promotion**. Dengue control demands household-level interventions and behavioural modifications that require high levels of community participation and support to remove refuse or carefully protect essential water containers and other household items that can provide ideal breeding sites for *Aedes* aegypti. During dengue outbreaks, control programmes must convince people of the need to reduce their own, and particularly their children's, chances of being bitten by day-biting mosquitoes. Inter-island and inter-country travel also needs to be reduced during outbreaks.

Dengue education messages are generally based on biomedical explanations of the disease and scientific observations of dengue

mosquitoes, but these are often too abstract for people to be able to relate them to their own knowledge and immediate surroundings. Continued anti-dengue campaigns with community participation and involvement are essential to prevent outbreaks.

(5) **Law enforcement (backing for effective implementation of the programme).** The penalty for offences related to mosquito breeding is very minimal. The Public Health Act of Fiji is under review to address this issue.

(6) **Biological control.**

(a) Fish *Poecelia reticulata* (Guppy) Tilapia - Control in pools, drains rice fields, etc.

(b) *Toxorhynchites amboinensis* (A predatory mosquito) - Control in tree holes, tyres, drums, etc.

(c) *Bacillus thuringiensis var. Israelensis* (Bacterium) - Control in ground pools with brackish water - coastal areas.

(d) *Tolypocladium cylindrosporum* (Fungus) lab trials and field trials - Nukui, Rewa.

(7) **Strategies for sustainability.**

The goal of the strategy for anti-dengue vector preventive and control work in Fiji is to prevent the recurrence of dengue epidemic as a public health problem. It has nine components as key areas of concentration:

- Develop diagnostic procedures to enable confirmatory tests of dengue fever cases.
- Develop clinical management of dengue cases both for use by the general public in rudimentary early case management and importantly at clinics, hospitals, and for outpatients and also for inpatients.
- Vector surveillance and control: This includes consistent mosquito surveillance and anti-mosquito work focusing first in cities, towns, neighbouring settlements and villages. It also includes designs and management of control programme that are practical and economical.
- Mobilization of communities for source reduction from church groups, women and youth groups, scouts and girl guides, schools, villages and similar types of groups. To be effective in source reduction, any attempts to address mosquito-breeding sites must include a strong and effective mobilization programme.
- Development and wide distribution of effective health promotion IEC materials to the general public and government and non-government institutions. Evaluation of these IEC materials must be an ongoing exercise to be responsive to public attitudes and behavioural patterns.
- Capacity-building and training in the entomological, surveillance and vector control aspects of the programme of divisional, district and area health inspectors, including those who are employed in city and town councils.

- Periodical exercises to alert key workers of the importance of emergency preparedness and coordination in vector mosquito surveillance and control work.
- Information and management training of key environmental health officers and other cadres of key health workers who are involved in surveillance and control work, source reduction, resource management and health promotion.
- Develop an improved anti-mosquito surveillance and control programme in each of the major cities, towns and each rural local authority. The plan will include zoning of each area to facilitate proper coverage and consistence in mosquito surveillance and control work.

Preparedness against outbreaks of arboviral diseases

(1) Main objective

The programme's main objective is to strengthen active and quick response for the control of epidemics of arboviral diseases in Fiji.

(2) Immediate objectives

In order to develop preparedness against arboviral diseases, the following objectives are to be attained:

(1) To discover and report outbreaks of arboviral diseases as early as possible. Surveillance activities shall be conducted by means of monitoring the requests for serological tests of suspected patients and mosquito inoculation studies as well as by the results of vector surveillance.

(2) To train medical and paramedical staff on early diagnosis and treatment, and prevention and control measures of arboviral diseases. They shall also be trained in the use and maintenance of insecticide-spraying machines.

(3) To keep vehicle-mounted spraying machines in the main urban centres and portable spraying machines in other centres.

(4) To keep sufficient reserve of insecticides and spare parts for spraying machines in other centres.

(3) Outputs

The outputs of this programme will consist of the following:

(1) Stocking of insecticides and spraying equipment at national Vector Control Unit and at all other centres so that these are available immediately for emergency use during outbreak of arboviral disease.

(2) Long-range programme to control the larval population of vectors of arboviral diseases will be undertaken by the health inspectorate staff of each district.

(3) Establishment within each district of a group of trained personnel capable of carrying out both emergency and long-range programmes of arboviral disease control.

(4) The Wellcome Virus Laboratory to carry out regular serological tests of blood samples from all districts.

(5) The national Vector Control Unit, divisional vector control units, Suva and Lautoka City Council vector control units to carry out the identification of mosquito larval and adult specimens from all districts.

Conclusion

The main strategy for controlling dengue and other mosquito-borne diseases in Fiji is through reduction of the vector population. Most methods of attack are aimed at the breeding habitats, which can be divided into two basic areas: artificial and natural.

To control mosquitoes in artificial containers, environmental sanitation in conjunction with education of the public and constant surveillance by health authorities appears to be the key factor in lowering the population of dengue vectors[4]. Natural habitats such as tree holes, crab holes, ground pools, leaf axils and hoof prints occur mainly in the rural and coastal areas. Because the range of habitats are so diverse, the application of insecticides would not only be very difficult but economically impracticable and ecologically unsafe. Environmental management or source reduction would also not be economical or logical as many of these natural breeding habitats are extensively used by the people of the region. The use of bio-control agents like pathogens, parasites and predators, which already exist in nature, are best suited to control mosquitoes in these natural habitats. Biological control in the South Pacific has been actively pursued and Fiji, in particular, has had outstanding success as against various agricultural pests. Fiji, in general, is well suited for bio-control programmes because of its isolation and small size.

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