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Vector Biology
and Control Project

Assessment of the Epidemiology of Dengue and its Past, Present and Future Control in Fiji

January 27 to February 14, 1992

by

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Abbreviations

VBC	Vector Biology and Control Project
USAID	U.S. Agency for International Development
MOH	Ministry of Health
ELISA	Enzyme-linked immunosorbent assay
DHF	Dengue hemorrhagic fever
DSS	Dengue shock syndrome
CWM	Colonial War Memorial Hospital
WHO	World Health Organization
HI	Haemagglutination inhibition test
CHW	Community Health Worker
DMO	Divisional Medical Officer
SDMO	Subdivisional Medical Officer
MO	Medical Officer
SCC	Suva City Council
YWCA	Young Women's Christian Association
YMCA	Young Men's Christian Association
$	US dollar(s)
ADAB	Australian Development Assistance Bureau
AFRIMS	Armed Forces Research Institute of Medical Sciences
SPC	South Pacific Commission

Executive Summary

At the request of the Ministry of Health of Fiji and USAID/Suva, the Vector Biology and Control Project (VBC) organized a four-person team with professional skills in vector biology, arbovirology, medical epidemiology and sociology to work in Fiji from January 27 to February 14, 1992. The team was asked to assess the epidemiology of dengue in Fiji as well as past, present and future dengue prevention and control methods. The team also was asked to prepare a draft resource document suitable for discussion at a workshop involving the Ministry of Health (MOH), the National Dengue Task Force and interested funding agencies.

During the assessment, the team visited various urban and rural sites, including settlements and villages, on the three largest and most populated islands. Observations were made and data collected on laboratory diagnosis, clinical case management, mosquito breeding sites, mosquito densities, health education techniques, staffing patterns, and community participation as related to dengue control.

The team found that dengue epidemics had occurred periodically in Fiji since 1885 (1885, 1930, 1944, 1971). The more serious form of the disease, dengue hemorrhagic fever (DHF), first appeared in the country in 1975, with subsequent outbreaks in 1979-80 and 1989-90. More than 3,600 confirmed cases of dengue were reported in the last epidemic, with 30 reported deaths due to DHF. An unrelated mosquito-borne virus, Ross River, caused an explosive outbreak of epidemic polyarthritis in 1979. Both this epidemic and the 1989-90 dengue epidemic caused widespread human suffering throughout the three major islands, in rural as well as urban areas.

Judging from the Asian and Latin American experiences with dengue, DHF cases with severe illness will occur with increasing frequency, particularly in children, as the people of Fiji are exposed to future outbreaks. Direct costs due to treatment and control measures will increase, as will indirect costs resulting from premature death, school absenteeism, reduced productivity, and losses in tourism. Therefore, the team commends the MOH officials and the National Dengue Task Force for their evident awareness and concern about the control of dengue and other mosquito-borne viruses in Fiji.

Team members noted a number of constraints that have impeded dengue prevention and control efforts in Fiji. Lack of resources, such as trained staff, vehicles and diagnostic equipment, is the first major constraint. The second is the lack of recognition, support, and official status for a national unit devoted solely to the control of mosquito-borne diseases. Inadequate surveillance and analysis of important epidemiological data have prevented rapid, appropriately targeted responses to dengue outbreaks. Fiji also has not implemented a specific action plan for emergency control of dengue, and health education for the medical community and the population at large has not been completely successful.

The solutions to overcoming these and the other constraints listed in the report may or may not require additional funding. In some cases, such as notification of diagnosed cases to the appropriate offices, increased awareness or better communication will solve the problem. Other solutions, such as the purchase of a vehicle for the National Mosquito Control Unit, may require external funding.

The team's major recommendations are as follows:

1. Officially establish a National Mosquito Control Unit and provide it with adequate resources (e.g., trained staff, vehicle, microscopes, survey and control equipment) to carry out its national mission to prevent and control dengue and other mosquito-borne diseases in Fiji.

2. Provide the head of the National Mosquito Control Unit with sufficient status to have direct access to the appropriate decision-making bodies.

3. Develop a field-oriented training and retraining course in *Aedes* surveillance and control at the National Mosquito Control Unit for health inspectors and assistant health inspectors.

4. Focus the national dengue program on prevention rather than emergency control by emphasizing continuing community participation in the elimination of major mosquito breeding sources (tires and unprotected water drums) in industrial, residential, and public areas.

5. Increase the training of the subdivisional public health team in health education to promote dengue prevention and control.

6. Tailor health education materials on dengue prevention and control to the target audiences, ensuring that the messages are clear, simple, relevant, and in the appropriate language(s).

7. Ensure that facts on the current dengue situation and the prevention/control efforts being carried out are provided via a periodic newsletter to the relevant MOH offices and to the medical community throughout Fiji.

8. Collaborate with the Fiji Medical Association in developing a periodic training workshop for medical officers on dengue diagnosis and treatment.

9. Develop and use an action plan, specific to Fiji, for emergency dengue control, and implement it when necessary.

10. Develop complete in-country capability at the Wellcome Virus Laboratory to test acute sera for dengue IgM antibody.

1. Introduction

The Fiji islands are located in the southwest Pacific Ocean approximately 2,800 kilometers northeast of Sydney, Australia. The territorial waters of Fiji lie between 15 degrees and 22 degrees south of the equator, corresponding in latitude to Tahiti, Rio de Janeiro and Northern Queensland. Of the 710,000 square kilometers within this area, 3 percent (19,400 square kilometers) is land in the form of islands and 97 percent is water. One hundred of the 300 islands are inhabited, and 70 percent of the population lives on the largest island, Viti Levu. Suva is the largest city, main port and capital. Vanua Levu and Taveuni, the second and third largest islands, lie northeast of Viti Levu. Travel between these three islands is frequent, rapid, easy and inexpensive, which facilitates the movement of human hosts and mosquitoes infected with dengue and Ross River viruses.

Dengue is traceable historically back to 1635 in Indonesia and 1780 in Philadelphia, USA. Epidemics occurred in the newly settled lands of the Americas and Australia in the 18th and 19th centuries. During the 1950s and 1960s, dengue affected thousands of people in urban Asia, and it has subsequently moved into Latin America. Dengue-like illness was reported in Fiji during the years 1885, 1930, 1944 and 1971. The severe hemorrhagic form of the disease, dengue hemorrhagic fever (DHF), was first recognized in 1954 in the Philippines but was not seen in Fiji until 1975. Subsequent DHF outbreaks in Fiji occurred in 1979-80 and 1989-90. More than 3,600 confirmed cases of dengue were reported throughout Fiji during the last outbreak, with 30 reported deaths due to DHF or dengue shock syndrome (Table 1). In addition, an explosive outbreak of epidemic polyarthritis caused by Ross River virus (unrelated to dengue virus) took place in Fiji in 1979.

DHF is an increasingly severe threat to child survival in Latin America, Asia and the South Pacific, including Fiji. When DHF cases do not receive the appropriate intensive supportive care, 5 to 10 percent of the cases may result in death. In at least eight tropical Asian countries, DHF and dengue shock syndrome (DSS) are among the 10 leading causes of hospitalization and death.

Table 1. Dengue in Fiji, 1885-1990

Year	Serotype	No. Cases	DHF	Deaths
1885	?	thousands	?	?
1930	?	thousands	?	?
1943-44	1	thousands	?	?
1971-72	2	4,000	None	None
1974-75	1	20,000	Yes	12
1980	?	127**	?	
1981	4*	hundreds (18+)	Yes	1
1982	2	546+	?	
1983	?	237+	?	
1989-90	1	3,686	Yes	30

Source: Personal communication, Dr. J. Mataika, Wellcome Virus Laboratory, 1992

* Serologic evidence

** Reports compiled by South Pacific Commission, as reported by Fiji. (Source: WHO Report ICP/001, Preparedness against outbreaks of arbovirus disease in the Pacific, 1984.)

The need for hospitalization during DHF epidemics can put an enormous strain on a country's economy and medical service system. Half of all pediatric beds in Thailand were occupied by DHF cases during a 1988 outbreak. One-third of 344,000 DHF cases in the Cuban epidemic of 1981 were hospitalized.

In Puerto Rico during a 1977 dengue epidemic, costs due to the epidemic were estimated at $6.4 million to $16.7 million. However, this estimate does not include indirect costs resulting from premature death, school absenteeism, reduced productivity, and losses in tourism. Based on 1986 data, it was estimated that for four major tourist regions of Queensland, economic losses due to reduced tourism, manufacturing and retailing could amount to $150 million per annum. Fiji faces the prospect of serious DHF outbreaks in the future, which may result in the same sort of disastrous consequences: namely, high morbidity, some mortality (particularly in children), overloading of the health care system, and severe economic impact. Tourism is highly important to the economy of Fiji.

The Ministry of Health of Fiji revised its efforts to control dengue in response to the 1989-90 outbreak. Emergency control measures were carried out, and a National Dengue Task Force was formed in March 1990 to coordinate efforts to prevent and control dengue in Fiji. Task Force members are professional health personnel from the MOH, the World Health Organization (WHO), the Fiji School of Medicine, the Colonial War Memorial (CWM) Hospital and the Suva City Council. They quickly recognized that the prevention and control of dengue in Fiji was an extremely difficult problem, particularly with the limited resources available in urban and rural areas of the country. In fact, the epidemiology of dengue in Fiji is unique because it the only country in the world where four to six species of mosquitoes may transmit the virus. *Ae. aegypti*, *Ae. albopictus*, *Ae. polynesiensis* and *Ae. pseudoscutellaris* can be abundant in urban, periurban and rural habitats, whereas *Ae. horrescens* and *Ae. rotumae* have a more patchy distribution. Therefore, Fiji's dengue control efforts cannot be focused just on urban *Ae. aegypti*, as they can be in many other areas of the world.

In 1991, a meeting was held at the MOH with Dr. David Calder and Mr. Manoa Bale of the U.S. Agency for International Development (USAID) about the problems the ministry faced in dengue control in Fiji.

The MOH agreed to request technical assistance from USAID in developing a more comprehensive plan for dengue prevention and control to present to donors in a follow-up workshop in three to six months. USAID/Suva then asked the A.I.D. centrally-funded Vector Biology and Control Project for that technical assistance. A team with professional skills in vector biology, arbovirology, medical epidemiology and sociology was selected and began work in Fiji on January 27, 1992.

The following revised terms of reference were provided to the team during the initial meeting with the National Dengue Task Force at the MOH on January 28, 1992.

1. Formulate a plan of action for the control of dengue and DHF in Fiji.

    a. Pre-epidemic stage
    b. Epidemic stage
    c. Post-epidemic stage

2. Visit the National Vector Control Unit.

    a. Review the monitoring system and surveillance of dengue vectors.
    b. Review data and control strategies for dengue vectors.
    c. Review identification and survey techniques.
    d. Review chemical control measures.

Complimenting these terms of reference from the Ministry of Health were the following general VBC team objectives:

1. To determine the major epidemiological and ecological features that may lead to dengue outbreaks in Fiji;

2. To determine the capabilities in Fiji for dengue surveillance and control operations;

3. To determine possible community actions to prevent or control dengue in certain situations in Fiji;

4. To write a draft proposal for donor support for dengue control in Fiji.

To accomplish the above, the team visited both urban and rural sites on the three largest and most populated islands.

Observations and survey results are discussed in the following sections of the report: Medical Issues, Entomological Issues, and Community Issues. A detailed list of recommendations can be found at the end of the report. The draft proposal for the donor workshop is included as Appendix C.

2. Medical Issues

Infrastructure

The most recent figures available for medical personnel in Fiji are from the 1987/1988 MOH Annual Report. These figures obviously need updating, but the problem with vacancies in medical positions apparently has not changed and may even have grown worse. The MOH had 384 doctor/medical assistant positions in 1988 and 111 were vacant. Of 1,651 nursing/orderly positions approved in 1988, 126 were vacant. Of 251 paramedical positions, 71 were vacant. Seventy-four nursing students were in the 1988 first year class at the Fiji School of Nursing. At the Fiji School of Medicine in 1988, 14 medical degrees were awarded and 33 paramedics completed training.

There were 1,747 hospital beds in the public sector in Fiji in 1988, with an occupancy rate of 65 percent. There are three divisional hospitals, 16 subdivisional hospitals, 53 health centers and 95 nursing stations in the country. A new hospital with 80 adult beds is being built next to the CWM hospital. No new pediatric wards are being built.

Laboratories are also understaffed. For example, six of 19 hospitals in the country have no laboratory/x-ray assistant (according to an interview with a supervisor at the CWM pathology laboratory). The hematology lab at CWM has five technicians and is understaffed when any of them are on leave.

Only two of the subdivisional hospitals have microcentrifuges for hematocrit determinations.

The resources of the Wellcome Virus Laboratory are described on pp. 15 - 16.

The public health statistics unit has no full time epidemiologist or programmer. The WHO is providing some epidemiological and computer support with short-term consultants.

Intravenous fluids are easily obtained. Blood supplies are marginal under normal circumstances. The system relies on blood drive campaigns in factories and schools, and donations from family members. During the 1989-1990 dengue epidemic, basic medicines such as panadol were reported to be in short supply at at least one base hospital.

Summary of Clinical and Laboratory Data

Two draft manuscripts on the 1989-1990 dengue outbreak were available for review of clinical and laboratory features of documented and undocumented dengue cases (Fagbami, et al., on epidemiology and virology, and Adiao, et al, on clinical findings in pediatric cases). We also were able to review the charts of six fatal pediatric cases from the CWM Hospital in Suva, two hospitalized children from Savu, four adults and six children hospitalized in Labasa, and six cases in Taveuni.

Many hospitalized cases were labeled clinically as dengue or dengue hemorrhagic fever (DHF) without laboratory confirmation. Ninety-eight (51 percent) of the 192 pediatric patients admitted to CWM hospital from September 1989 to October 1990 had serologic and/or virologic tests done. Of those 98, 81 (83 percent) were confirmed by four-fold titer rises or virus isolation (Fagbami, et al.). This rate of positive laboratory confirmation is much higher than that for the 1990 data from CWM children's ward provided by Dr. Mataika, in which 20 (57 percent) of 35 paired sera were positive. The discrepancy between the two rates suggests that the data in Fagbami, et al. should be double checked.

Clinical findings in laboratory-confirmed cases are not specified in Dr. Adiao's paper. Thus, the data refer to all clinically diagnosed cases. As indicated above, the majority but not all such cases were indeed associated with dengue infection.

From September 1989 to December 1990, 199 children with dengue were admitted to CWM hospital. Cases occurred in all months except July and August 1990. The peak of (hospitalizations in) the epidemic was in February and March, when 109 (55 percent) of the cases were hospitalized. In contrast, national surveillance statistics show the peak of the epidemic in October and November 1989 (Table 2).

Table 2

Dengue Cases by Month of Report 1989-1990, Fiji

Year	Month	Number of Cases
1989	September	61
	October	808
	November	861
	December	495
1990	January	591
	February	283
	March	413
	April	93
	May	50
	June	18
	July	13
Total		3,686

Source: National surveillance statistics

National surveillance data show that 64 percent of all cases were Fijian and 31 percent were Indian, while hospitalized pediatric cases were 55 percent Indian and 41 percent Fijian. Most of the hospitalized pediatric cases (87 percent) were 5 years of age or older.

The 199 pediatric cases spent 558 days in hospital for an average of 2.8 days. Sixteen percent of patients stayed five days or more.

Twenty-nine percent of patients with dengue came into the hospital more than five days after the onset of illness. This is important to note because delays in seeking medical attention has been shown in other countries to lead to higher rates of mortality.

Six deaths occurred among the CWM pediatric patients, for a case fatality rate of 3 percent. According to the manuscript, only one of these cases was confirmed in the laboratory. A mortality rate of 3 percent is reasonable, but experience in Thailand indicates that hospitalized case mortality can be reduced even further when community awareness is high and with careful clinical monitoring and aggressive fluid therapy.

Most patients had common manifestations such as fever, headache and body ache. Among the CWM pediatric patients, 54 percent had hemorrhagic manifestations, 21 percent had rashes, 5 percent had convulsions, 5 percent had hepatomegaly and 2 percent had comas. The rate of hepatomegaly is lower than that reported in Thailand. The number of patients with shock is not detailed by Dr. Adiao, but Dr. Fagbami's paper indicates that 17 percent of the CWM pediatric hospitalizations had shock.

Seventy percent of patients had platelet counts less than 200,000. The number of patients with platelet counts less than 100,000 (one of the laboratory criteria for meeting the WHO case definition, along with hemoconcentration) was not mentioned in the reports. As has been seen in other countries, a low platelet count was not present in all cases with bleeding and not all patients with low platelet counts bled. No data on hematocrits or the proportion of patients with hemoconcentration are given.

The charts of the six fatal cases at the CWM children's ward showed that the ages of the pediatric patients were 4 months, 5 months, 5 years (two children), 8 years and 12 years. Three were Fijian, two were Indian and the race of one was unclear from the chart. All had significant bleeding, most with coffee ground emesis. At least three cases had shock and three had documented platelet counts of less than 100,000. Of interest is the fact that one patient was diagnosed as having dengue encephalopathy and three others suffered seizures during their hospital course. Hemoconcentration was not documented in any patient. Two patients had hemoglobins of 7.5 or less.

Dr. Fagbami's paper indicates that 30 deaths occurred among the 3,686 cases reported (case fatality 0.8 percent) in all age groups. One hundred seventy adult patients were hospitalized during 1989, 22 percent of whom had hemorrhagic manifestations. Of 12 fatal cases for whom details are available, nine were children 15 years of age or younger and three were adults. A table describing 10 of the fatal cases indicates that 8 (80 percent) were Indian. All of these fatal cases had significant bleeding. What proportion of the 10 fatal cases was laboratory-confirmed is not indicated, but the table states that three of the 10, including two children, probably had primary dengue infections.

Of 28 hospitalized dengue cases from the hospital register in Savu Subdivisional Hospital, two were labeled as DHF. Six of the patients (21%) were younger than 15 years of age. The two cases called DHF were in a 9-year-old and an 11-year-old. The dengue hospitalization rate in Savu Subdivision was 88 per 100,000 population. Undoubtedly, many more dengue hospitalizations occurred but were not recorded as such because hospitalizations in January and February 1990 were increased by about a third, with most of these excess hospitalizations due to "nonspecific viral illness." Both of the patients identified as "DHF" cases had bleeding manifestations (epistaxis and hematemesis) but platelet counts were normal. No blood pressures were recorded.

Diagnosis

Clinical diagnosis

These observations are based on interviews with medical officers and laboratory personnel at the CWM hospital in Suva, at six subdivisional hospitals in Viti Levu, Vanua Levu, Taveuni, and at Labasa base hospitals.

Most physicians in Fiji are quite aware of dengue and DHF and feel comfortable diagnosing and treating the various manifestations of dengue virus infection. Awareness has certainly been heightened by the 1989-90 epidemic. However, almost all the clinicians interviewed felt that continuing medical education workshops on DHF diagnosis and management would be useful. Doctors at the CWM hospital seemed quite knowledgeable about DHF, although the internist had not seen the WHO Guide to Diagnosis, Treatment and Control of DHF. Since Dr. Adiao, who was chief of the CWM children's ward during the epidemic, had extensive experience with DHF during the 1960s epidemics in the Philippines, the familiarity of the CWM physicians with DHF is not surprising.

Of the eight hospitals visited, only three had copies of the WHO guide on DHF. The base hospital at Labasa was without a copy, and the two subdivisional hospitals with copies had received them only recently. Some mention was made of a pamphlet the Ministry had put out on DHF, but no one had a copy of anything other than health education material. In at least three hospitals, tourniquet (Hess) tests have not been routinely done to screen suspect DHF cases. Hematocrits and platelet counts are not routinely done, partly because of difficulty in getting these tests done by the clinical laboratories. Pediatric size blood pressure cuffs were not available at any of the subdivisional hospitals visited nor at the Labasa base hospital. Such cuffs should probably be available at health centers.

There seems to be confusion among some medical officers about the WHO diagnostic criteria for DHF, which are evidence of "leaky capillary syndrome" with hemoconcentration and platelet concentration less than 100,000, as well as a positive tourniquet test or other bleeding manifestations. Physicians all over the world frequently view any dengue infection with bleeding manifestations as DHF, which is not the case.

This confusion emphasizes the need for clarification of the case definition for severe illness in which hemorrhage rather than shock syndrome with hemoconcentration predominates. Whatever the case definition, physicians in Fiji should receive more information on the syndrome of shock without significant hemorrhage.

Inadequate clinical laboratory support seems to be a common problem in Fiji. At least three of the subdivisional hospitals we visited had no microcentrifuges to do hematocrits. An equal number were unable to do platelet counts because of lack of reagents or a hemocytometer, or because technicians had been only partially trained. The base hospital in Labasa occasionally runs out of reagents for platelet counts because the Biomedical Department in Suva cannot provide them. The CWM pathology laboratory, however, thought that the reagents were continually available. The laboratory staff at CWM hospital was unable to keep up with the needed tests during the 1989-1990 outbreak. This could very well have compromised patient care. The children's ward should have its own microcentrifuge and hematocrit reader so that registrars and nurses can perform this test without having to send specimens to the laboratory.

Virus Laboratory diagnosis

The Wellcome Virus Laboratory has been an important resource for arbovirus diagnosis in Fiji and the Western Pacific for at least two decades under the able professional direction of Dr. Jona Mataika. The laboratory performs serologic testing for dengue by hemagglutination inhibition (HI) and, occasionally, complement fixation. Virus is isolated by inoculation of *Toxorhynchites* adult mosquitoes and identified by direct fluorescent monoclonal antibody tests. C6/36 *Ae. albopictus* cell culture has been used for virus isolation, but the cell line is not currently in stock. The laboratory has one biosafety hood, a fluorescent microscope, and two -70^0 C Revco freezers. *Toxorhynchites* mosquitoes are raised in an insectary within the laboratory building. A computer is available for word processing but laboratory results and specimen storage are not computerized.

The Virus Laboratory has occasional problems maintaining stocks of antigens and monoclonal antibodies. It relies on the Queensland State Health Laboratory, Queensland University of Technology and the U.S. Centers for Disease Control for these reagents. HI testing is usually performed with a single dengue antigen. The laboratory processed 2,500 blood specimens last year and is capable of doing twice as many tests, or about 100 a week. Dr. Mataika has foregone retirement to keep the laboratory functioning. Dr. Josefa Koroivueta has recently returned to Fiji after training in virology at Dunedin, New Zealand, and will probably eventually take over running the laboratory. The laboratory has only one full-time technician, but two staff members are in training to support the Virus Laboratory and the CWM Hospital pathology laboratory.

The most important need of the Virus Laboratory is to develop expertise to do routine ELISA serologic testing for dengue IgG and IgM antibodies. This will permit the processing of many single blood samples for dengue diagnosis. The laboratory also needs a new incubator for mosquito tissue culture, training in antigen production, training and software for data management, and a laser printer.

Medical officers are well aware of the availability of serologic testing at the Wellcome Virus Laboratory. Blood is typically drawn in sterile tubes on suspect dengue cases and sent to the laboratory via the CWM pathology lab. Obtaining second specimens for convalescent serology is frequently difficult.

Treatment

As mentioned, medical officers in Fiji seem quite knowledgeable about the possibility of shock and hemorrhage with DHF and the need for vigorous fluid treatment, and perhaps transfusion. The laboratory tools to manage patients carefully, though, are frequently lacking. Ideally, hematocrit measurements, platelet counts and electrolytes should be evaluated frequently in hospitalized DHF patients. At the subdivisional and even the divisional level, these tests are sometimes not available at all.

The CWM hospital children's ward handbook includes a four-page section on dengue and DHF with guidelines for diagnosis and management. A good part of the material is taken directly from the WHO guide and contains accurate, useful information for clinicians. We suggest that the CWM statistics on dengue be updated. Also, the WHO case definition and grading of severity should be included to clarify the distinction between classic dengue with hemorrhage and DHF/DSS. The CWM handbook contains an incorrect statement that severe manifestations of dengue such as encephalopathy and hemorrhagic manifestations per se are "usually the result of a second dengue viral infection." This association has been shown only for DHF/DSS. A flow chart for outpatients from the WHO guide is included in the handbook. The WHO inpatient flow chart could also be incorporated. Similar material or perhaps just the WHO flow charts should be provided to medical officers throughout the country. The flow charts could be posted in hospitals, especially in urgent care areas.

Illness Surveillance

Clinical

Every week medical officers fill out a certificate of notifiable diseases, which is forwarded to Suva. Usually just the number of suspect dengue cases is indicated along with the name of the reporting site. The National Task Force on Dengue Control met March 1990 and agreed upon a case definition that was distributed March 27, 1990, to all medical officers and health inspectors. Both classical dengue fever and DHF were defined. The memo acknowledged the well-known difficulty in differentiating dengue fever from other viral infections such as influenza. However, the classical dengue case definition was not precise, which defeats the purpose of a case definition. The definition did not indicate which non-specific symptoms should be included and was more of a description of the clinical spectrum of classical dengue. The DHF case definition was the same as that of WHO. A reasonable clinical case definition of classical dengue fever would be fever of 38°C for three days and headache plus at least one of the following: myalgia, retro-orbital pain, rash or altered taste.

A proposal to make dengue cases reportable by telephone with age, sex and race data is currently under consideration in Fiji. We agree that telephone reporting of dengue would be helpful. At the very least, outbreaks of dengue should be reportable. Although outbreaks of dengue are currently reportable by telephone, all medical officers do not understand this requirement. As it is, notifiable disease certificates are frequently not filled out promptly and they often arrive at the Ministry one to three months late. It would be advisable to include the addresses of the cases in these these reports to help monitor disease patterns and target control measures. Further, every attempt should be made to collect specimens for laboratory confirmation on suspect cases of DHF and fatal dengue-like or DHF-like illness.

As indicated above, the Wellcome Virus Laboratory has the capacity to test 100 paired sera a week and is currently underutilized. Between epidemics, it would be advisable to send specimens each week from designated sentinel surveillance sites rather than only when clinicians think they are seeing classical dengue or DHF. For example, the CWM, Labasa base hospital and a number of subdivisional hospitals could send five samples a week. In this way early warning surveillance could be developed to detect the introduction of new viruses, the beginning of an epidemic, and the appearance of dengue associated with severe illness. Any patient with a febrile virus-like illness would be a candidate for a dengue blood sample. During epidemics, when it is less important to confirm every case, more specific case definitions could be used. Still, any hospitalized suspect case should have a blood sample taken.

Transport of blood samples to the laboratory is a problem. Many samples arrive late and in poor condition because too few cold containers or vehicles are available.

The Ministry's Statistics Section has a personal computer and software to process notifiable disease reports. The data entry is accomplished rapidly. Monthly reports are circulated within the Ministry of Health at Tamavua Hospital but have not been provided to the outlying medical officers and health inspectors routinely. All medical officers interviewed by the team indicated that they would find these reports useful. The Ministry has no computer programmer, which limits its flexibility in putting out reports. For example, dengue reports are not sorted by reporting station, which, again, would be useful for control efforts.

Emergency Measures

Background

The need for an emergency plan to deal with medical aspects of a large DHF epidemic is underscored by the events of the 1981 DHF epidemic in Cuba. About 1 percent of the population was hospitalized and 20 percent of all hospitalized cases needed plasma expanders to treat shock.

A similar outbreak in Fiji would lead to 7,500 hospitalizations compared to the several hundred hospitalizations that occurred during the 1989-1990 outbreaks. Medical resources would probably be taxed beyond existing capacity unless an emergency plan had been implemented. Such an outbreak in Fiji could require additional temporary hospital beds to accommodate a roughly 50 to 100 percent increase in daily hospital admissions, 22,500 liters of normal saline, 1,500 liters of volume expanders such as Plasmanate, and 750 units of whole blood, as well as additional medicines such as panadol, oral rehydration solution, oxygen, sedatives and diuretics. The cost of an epidemic of this size, assuming an average hospital stay of three days and $50 per day hospitalization cost, would be greater than $1 million.

A contingency plan should have preparatory, alert, and emergency phases.

Preparatory Phase

The National Dengue Task Force should meet and establish a timetable and responsibilities for various activities. The Task Force should include a representative from the MOH familiar with national disaster procedures. A key task force member should be given time and support to follow up and ensure that these activities are being carried out expeditiously. This person should also compile appropriate literature and educational material on DHF. An early warning laboratory-based sentinel surveillance system should be established as described above. Training workshops for medical, paramedical and nursing personnel should be conducted and materials developed as described above. With appropriate supervision, each division should work with the medical community to develop a local plan for triage of patients and procurement of supplies. Divisional experts in the diagnosis and management of DHF should be identified. An important aspect of this phase would be developing appropriate media messages and mechanisms for rapid dissemination of information. Donor agencies might be contacted to determine possible sources of support in the event of an epidemic.

Alert Phase

Surveillance data criteria should be established for triggering the alert and emergency phases. A suggestion for criteria for going on alert in Fiji would be 100 or more cases of dengue reported in a month, coupled with a serologic confirmation rate of 50 percent or the introduction of a new dengue serotype. The Minister of Health might be notified and efforts begun to obtain resources and strengthen preparedness. The medical community should be notified and surveillance procedure should be tightened. Local hospitalization plans should be reviewed. Initial contacts should be made to facilitate procurement of intravenous fluids, volume expanders, blood, medicines and other supplies. Community-based and other control efforts should be stepped up and regular contact maintained with the National Mosquito Control Unit. Contacts with potential donor agencies might be renewed.

Emergency Phase

A suggested surveillance threshold in Fiji for declaration of a dengue emergency could be 100 reported cases in a one-week period with serologic confirmation of 60 percent. The National Dengue Task Force Chairman would issue a recommendation to the Minister of Health, who might then declare an emergency. A media campaign could be conducted to alert the public. An epidemic control center could be established, staffed by key members of the National Dengue Task Force. Information should be gathered, evaluated, and rapidly fed back to the community. Emergency hospitalization planning should be implemented. Hospitalizations, deaths, and the need for medical supplies should be carefully monitored. International assistance might be requested.

Recommendations

Surveillance

- Make dengue a notifiable disease by telephone at least for clusters of identified cases.

- Include locality information in reports as well as age, race and onset date.

- Provide feedback to the medical, vector control and public health/environmental health community on dengue surveillance data, perhaps through a newsletter that gives information about dengue epidemiology. Such a newsletter could be produced by the health education division of the Ministry of Health.

- Conduct virologic/serologic surveillance in sentinel sites during interepidemic periods as well during as during threats. Key hospitals should submit at least five to 15 blood samples per week to the Wellcome Virus Laboratory.

- The MOH should consider establishing a full-time computer programmer and/or epidemiologist position. One function of this position would be to monitor, analyze and disseminate surveillance data.

- Consider establishing positions for an infection control/epidemiology nurse in each base hospital to facilitate timely reporting of notifiable diseases.

- Public health (zone) nurses could be trained to draw convalescent blood specimens for dengue serology.

Diagnosis and treatment

- The MOH could approach the Fiji Medical Association about conducting a training workshop in DHF diagnosis, treatment and control in the near future, with updates at least every two years.

- Microcentrifuges for hematocrit determinations should be purchased and placed in all subdivisional hospitals and the children's wards at CWM and Lautoka Hospitals.

- The WHO Guide to Diagnosis, Treatment and Control of DHF should be kept at each subdivisional hospital and on the pediatric wards of each base hospital.

- Posters with flow charts on the diagnosis and management of DHF should be placed in all hospitals.

- Pediatric blood pressure cuffs should be purchased and placed in all health centers and subdivisional hospitals.

- At least two new technicians should be hired in the CWM hematology laboratory.

- Laboratory/x-ray technicians should be trained and hired for each subdivision hospital.

- Place hospitalized suspect dengue cases in the same area and use mosquito nets for patients hospitalized during the first five days after fever onset to prevent dengue transmission in the hospital.

- Conduct weekly cleanup of potential *Aedes* breeding sites around hospitals.

Virology

- The Wellcome Virus Laboratory should develop the capability to test sera for dengue IgM and IgG antibody by ELISA

- Appropriate computer software should be obtained to monitor serologic and virologic data, and laboratory staff should be trained in use of this software.

3. Entomological Issues

Vector Control Capabilities and Infrastructure

There is no doubt that the vector control program in Fiji historically has been a reasonable one, and even a leading program in the region. However, stresses and strains of various kinds on the system have mounted since perhaps the mid-1980s, and especially since 1987. Among the leadership of the Ministry of Health, knowledge and awareness of the issues and techniques of dengue control has been and remains high, but resource limitations have caused problems, compromising the ministry's ability to do what was desired.

In reviewing the 1989-90 dengue epidemic throughout Fiji and current control activities, the following points are evident:

1. Mr. G. Prakash, Mosquito Control Officer, is the only person recognized competent in Fiji in identifying dengue mosquitoes and advising on surveillance and control. This is an extremely fragile situation because his leaving this position would result in the MOH having minimal personnel with entomological skill and program experience in averting dengue (and Ross River virus) outbreaks. It is notable that local authority staff have little competence in mosquito identification and rely largely on Mr. Prakash. It is desirable that this shortage of expertise should be rectified through national entomological training programs and development of a manual on mosquito identification, surveillance and control specific to Fiji.

2. The National Vector Control Unit has only *ad hoc* status and lacks funds and transport. During the early 1980s, two vehicles were assigned to this unit, but no vehicles have been assigned since the events of 1987. It may be unreasonable to expect comprehensive performance from this unit without appropriate adjustment of other job responsibilities (e.g., pollution control, supervision of eight laborers building pour-flush latrines), and provision of

adequate transport and staff. Furthermore, as the word "vector" means little to the public, perhaps it might be useful to consider another name for the unit, such as "National Mosquito Control Unit."

3. The National Mosquito Control Unit should begin with a staff of 10. In addition to the head of the unit, there should be one technician and two mosquito collectors at each of the three proposed surveillance centers in Suva, Lautoka and Labasa. In addition to a vehicle, which is absolutely necessary, the unit needs up-to-date entomological texts, dissecting and compound microscopes, sampling nets, pipettes, trays, preserving fluid, bottles, forceps, store boxes, entomological pins, mounting media, clearing fluid, glass slides, cover slips, and a properly stored reference collection.

4. In carrying out surveys with health inspectors from both the Ministry of Health and the local authorities, we were impressed with the willingness and enthusiasm of those assisting. But they will require adequate training, equipment and transport to fulfill their potential output.

5. The communication system from the Mosquito Control Officer to the appropriate decision makers may benefit from review. For example, letters of August and October 1989 advising of a pending epidemic of dengue may not have been channeled to the decision makers until shortly before action was taken in approximately March 1990. One could foresee a future situation in which such delays in moving information up the chain of command could result in emergency spraying being conducted too late in an epidemic peak. Therefore, it seems important that the Officer in Charge of vector control be given sufficient seniority, or other access, to the Permanent Secretary to assure rapid response when such occasions arise.

6. Furthermore, as considerable reliance is placed on local authority staff for emergency, surveillance and control activities, some participation from a representative of the local authorities in surveillance and control management might be useful.

7. Success also depends on adequate legislative and enforcement authorities. It is hoped that the MOH will be successful in its efforts to have penalties for non-compliance with vector control regulations increased to at least $200, and to ensure enforcement.

Vector Bionomics

With the discovery of the second most important dengue vector, *Ae. albopictus*, in Fiji in October 1988, previously projected scenarios may no longer be relevant. It was evident that by 1988, *Ae. albopictus* already was well distributed and established in at least Viti Levu and Vanua Levu. This suggests that local surveillance and quarantine procedures had broken down earlier.

To avoid future introductions of additional dengue vectors, as well as mosquito vectors of other diseases (e.g. *Anopheles* vectors of malaria from hyperendemic areas such as the Solomon Islands), quarantine procedures might merit reexamination. At the port area of Suva, procedures may be deficient, given that they appear to be mainly directed towards agricultural pest introductions and there appears to be uncertainty as to mutual responsibilities for health surveillance between the Suva City Council and the Dept. of Health. Perhaps a discussion in a meeting of all of those involved, including health and agricultural personnel, could fully resolve this issue. Particularly important are the issues applicable to containers of imported used vehicle tires from countries with *Ae. albopictus*.

Fiji is now the only country with four known dengue vectors (or possibly even more if *Ae. rotumae* and *Ae. horrescens* are proved). The known vectors are *Ae. aegypti*, *Ae. albopictus*, *Ae. polynesiensis* and *Ae. pseudoscutellaris*. As these species often share or compete for the same breeding sites, it is not possible at the moment to accurately predict future prevalence and, therefore, the new degrees of risk for various localities. There is evidence to suggest that *Ae. albopictus* may be displacing *Ae. pseudoscutellaris*. In the USA, the arrival of *Ae. albopictus* in 1985 saw the displacement of *Ae. aegypti* from New Orleans and other cities.

It is notable that Fiji does not possess definitive vector competence data for all four serotypes of dengue with the four major (*Stegomyia*) species involved in transmission. Nor is there sufficient information on vector behaviors and habits.

Field Survey of Dengue Vectors

Previous field surveillance data for immature dengue vectors shows the limited geographic coverage of surveillance (only Suva and Lautoka provide regular samples), the restricted sample size, and a reliance on weak indices (Breteau, Container and Premise). As these indices record prevalence rather than abundance per se, they often are not very useful for predicting the need for control.

We conducted house-to-house surveys for immature *Aedes* during January 30 - February 7, 1992, on Viti Levu, Vanua Levu and Taveuni (Table 3). A total of 1,370 containers were inspected (Table 4), and the absolute numbers of immatures were estimated/counted directly for all positive containers (Table 5). From this, it was possible to estimate the relative productivity of different container categories and, therefore, their importance for control. A total of 16,366 immatures were sampled and then destroyed.

Because of the large inherent error in house-to-house survey methodology, it is important that at least 50-100 premises be inspected in order to gain some precision. For example, if a key premise with three positive containers is missed in a survey of 40 houses, the error will be 7.5. Hence, for our survey results we have grouped small numbers of, for example, rural properties together for analysis to increase sample size. It is recognized that there may be individual differences within these groups.

Nevertheless, the Breteau values of 105 (Suva), 31 (Nagali), 205 (Labasa), 76 (Savusavu), 38 (Vanua Levu rural) and 32 (Taveuni) indicate that the prevalence of containers containing *Aedes* (*Stegomyia*) mosquito immatures is very high, representing high dengue risk status for Suva, Labasa and Savusavu.

From Table 5, it is evident that tires pose the greatest problem. We found 68 tires positive for *Aedes* containing a total of 10,667 immatures. Tires are a particularly important source of mosquito breeding in towns with industrial complexes, such as Suva, Labasa, Savusavu, although this finding is not irrelevant to villages and settlements. Taking the high prevalence of wet tires (approximately 50 percent; Table 4) and their productivity (approximately 177 immatures per tire), it can be calculated that the majority of immatures collected were found in tires: 56 percent at Suva, 88.1 percent at Labasa, 62.1 percent at Savusavu, and 85.6 percent at the rural villages and settlements of Vanua Levu (Table 5). Positive action directed specifically at removal or proper storage of tires would have a major impact on reducing risk.

Second, although drums for water storage are not universal throughout Fiji, they also produce the same order of immatures (approximately 157/drum) as tires, are frequently wet, and contain *Ae.* (*Stegomyia*). Three of the four positive containers at Nagali village were drums representing 75 percent of production (Table 5). At Savusavu water drums represented 37 percent of *Aedes* production.

Collectively, therefore, 82.6, 99.8 and 99.1 percent of *Aedes* at Suva, Labasa and Savu were being produced by 20, 15 and 10 percent of potential breeding sites inspected. Focusing on this principle of "key containers" for routine and even emergency control would ensure that limited manpower was used most cost-effectively.

As this survey was conducted prior to expected wet season rainfall, only 40 percent of bottles and tins found were wet (mainly soft drink and beer bottles), and of these, only about 11 percent contained immatures. Almost 50 percent of all containers inspected were bottles and tins, representing a significant labor expenditure. The lack of *Aedes* breeding in bottles can probably be related to the high temperatures of the bottles in full sunlight. Because of the relatively low numbers of immatures found inside wet tins and bottles (average 22 per container), that most prevalent container category only constituted up to 2.3 percent of *Aedes* production. Hence, during a wet season with moderate rainfall like the one in 1992, clean-up campaigns directed at bottles and tins may have only minimal value. This situation would probably be different during a more typical wet season with heavy rainfall.

Table 3. Survey Areas and Dates

Viti Levu

Suva area

Buraka St. settlement	January 30
Nanuka settlement	January 30
Nadera	February 6
Suva Port (Kings Wharf)	February 7
Samabula	February 7
Edinburgh Drive	February 7

Nausori area

Nagali village	January 31
Korotogo	
Cuvu	Visual inspection only, no sampling
Nadi	February 1-2
Lautoka	

Vanua Levu

Nagigi village	February 3
Naivita	February 3
St.Bedes College, Savarekareka	February 5 (all grouped as rural in Table 1)
Labasa	February 4
Savusavu	February 5

Table 3. Survey Areas and Dates (cont.)

Taveuni

Somosomo village	February 5
Lamini village	February 5
Matei Lagoon Resort	February 6
Bibi's Hideaway	February 6
Garden Island Resort	February 6
Government Station, Taveuni	February 6
Lovonivonu village,	February 7
Bucalevu Government School	February 7
Vuniuto settlement	February 7

Table 4
Premise inspection for immature *Aedes (Stegomyia)* mosquitoes in Fiji
January 31 - February 7, 1992

	Viti Levu						Vanua Levu									Taveuni		
	Suva			Negali			Labasa			Savusavu			Rural					
Container Category	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**
Water Storage																		
Drums	29	14	9	6	3	3	5	5	3	9	7	4	3	3	1	5	4	0
Tanks										4	1	0	1	1	0	2	1	0
Wells	2	2	0							2	2	0						
Others	1	1	1	1	1	0				2	2	2						
Rubbish																		
Tires	46	31	19	1	1	1	95	35	29	36	14	8	14	8	5	33	17	7
Bottles, tins	66	14	3				108	32	1	118	33	0	69	10	5	297	175	6
Coconut shells	12	0	0							27	0	0	26	—	1	34	2	0
Disused Household/ Industrial																		
Sinks, baths, dishes	17	12	4				1	0	0	22	6	1	4	1	0	9	3	2
Iron parts	9	5	1				2	1	1							1	1	1

Table 4 (cont.)
Premise inspection for immature *Aedes (Stegomyia)* mosquitoes in Fiji
January 31 - February 7, 1992

	Viti Levu						Vanua Levu									Taveuni		
	Suva			Negali			Labasa			Savusavu			Rural					
Container Category	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**	**Tot**	**Wet**	**Pos**
Garden Receptacles																		
Flower pots	26	1	1				1	1	1	1	0	0	4	3	1	6	2	2
Ornamental tire/shells	3	1	0										10	—	0	54	1	0
Vases																10	7	2
Natural																		
Tree holes	3	3	3										1	1	0	2	1	1
Crab holes*	4	—	—										28	—	—	88	—	—
Axils																10	10	1**
Recreational													1	1	1			
No premises inspected		39			13			17			17			37			75	

* Crab holes not sampled.
** Mixed *Aedes (Finlaya)* and *(Stegomyia)* pooled; 1 *Ae. albopictus* found.

Table 5
Absolute numbers of immature *Aedes* (*Stegomyia*) mosquitoes collected per container type

Container Category	Viti Levu		Vanua Levu			Taveuni
	Suva	Nagali	Labasa	Savusavu	Rural	
Water Storage						
Drums						
200 liter	1,598(9)*	533(3)	437(3)	978(4)	6(1)	72(2)
20 liter	36(1)					
Rubbish						
Tires	3,362(19)	177(1)	3,301(29)	1,642(8)	1,587(5)	598(6)
Bottles/tins	143(3)		1(1)		84(5)	139(4)
Coconut shells					14(1)	
Disused household/ industrial						
Sinks, buckets	624(4)			23(1)		278(2)
Iron parts	156(1)		1(1)			

Table 5 (cont.)
Absolute numbers of immature *Aedes* (*Stegomyia*) mosquitoes collected per container type

	Viti Levu		Vanua Levu			Taveuni
Container Category	**Suva**	**Nagali**	**Labasa**	**Savusavu**	**Rural**	
Garden Receptacles						
Flower pots	17(1)		9(1)		160(1)	189(2)
Ornamental vases						108(2)
Natural						
Tree holes	64(3)				2(1)	27(1)
Recreational						
Total	6,000(41)	710(4)	3,749(35)	2,643(13)	1,853(14)	1,411(19)

* The number of positive containers sampled is shown in parenthesis.

Other breeding sites, such as the bases of flower pots, vases and buckets for striking plants, constituted production of up to 13.4 percent (at Taveuni). Both indoor and outdoor inspections are necessary for these breeding containers.

Although the vector competence of the four species has not been fully investigated, it is probably safe to assume that *Ae. aegypti* poses the greatest risk in Fiji.

Surveillance

As indicated under Vector Biology, the current *Aedes* indices have limited value. The practice of using a ladle (or dipper), especially in water storage, is preempted by visual inspection and therefore gives a biased sample. Dipping procedures relate poorly to actual immature numbers present.

Furthermore, visual inspection of the inside of discarded tires, or use of a small pipette, is inefficient and can result in underestimates of positive containers.

In view of the above, it is suggested that gauze nets be introduced for general sampling. The net we recommend, which was used for our surveys during this assessment, is 20 cm long x 10 cm wide on an aluminum frame. The bag fitted to the frame is 25 cm deep of fine 100 μ gauze and is roundly tapered. After approaching a drum with minimum disturbance of the water surface, a collector can capture approximately 25 percent of the total immatures in a drum by making one complete sweep around the top 20 cm of the water column. Counts of 4th instar larvae are the most reliable index of likely adult productivity, and larvae of this instar are the most easily counted and identified.

For tires, a semicircular frame with fine gauze netting will fit conveniently within the inside walls of a tire casing. One sweep will collect most immatures. As 4th instars are most reliably collected, and because they are larger, the netting can be of coarser mesh to allow mud and organic debris to filter through easily. Alternatively, water can be siphoned with a flexible hose and filtered through gauze netting or a domestic strainer. In view of the likelihood of regular epidemics of dengue and possibly DHF/DSS causing fatalities, it is strongly suggested that priority be given to developing a surveillance system that considers not only the prevalence of positive containers but also their relative potential for producing adult mosquitoes.

Once the productivity of container types has been established, correction factors can be routinely applied without the necessity of laborious counting procedures. For example, during this survey the average number of larvae in tires and tins, respectively, was 177 and 22, so mosquito control in one tire becomes eight times more important than control in one tin. The assessment team began collecting the information needed for this approach (see Table 5), but further research and verification around Fiji are needed. For predictive purposes, these sampling methods should be checked against resting adult numbers collected by vacuum aspirator and, against human antibody conversion to dengue serotypes.

Current practices for submitting *Aedes* samples for surveillance to the National Vector Control Unit should be re-examined. The number of premises inspected prior to submission is often too small to give meaningful indices (Breteau, House and Container). It is suggested that selection of high risk "indicator areas" may provide better estimates of risk. On the basis of dengue cases that occurred during the 1989-90 epidemic, key towns and cities, such as Suva, Lautoka and Labasa, should be selected for developing the "indicator area" principle. Should one of these indicators become positive for dengue vector risk, control action should be applied nationally.

In order to increase the precision of the Breteau, Container and House Indices, it is suggested that at least 100 premises be inspected. It is recognized that industrial premises are larger than residential properties, especially rural ones. This introduces further bias into the calculated indices because the large industrial areas have more containers and therefore more positives per premise.

As these indices are used as a basis for making decisions on emergency control, it is suggested that larger surveys be conducted, but only four or five times per year, at the following times:

1. the end of the dry season (October), to gauge what is likely to happen when wet season rains increase transmission risk;

2. the beginning of the wet season (December) to confirm necessary action;

3. mid-wet season (February) to measure the effect of any control actions;

4. the end of the wet season (March - April).

5. mid-dry season (August) to gauge the potential state of the next wet season's *Aedes* populations and to begin preparation, e.g. intensifying education programs, checking equipment and stores for operational readiness.

Note that these times will vary somewhat with the onset of wet season rainfall, and that there is some variability in the timing of epidemic onset. The survey times are therefore provided as a guide but require further consideration. Each survey should contain a similar proportion of industrial/residential properties, "indicator areas," or likely problem areas. This is not to suggest that other areas of lesser risk are forgotten completely.

At the level of actual inspection procedures, it was evident to the consultants that the larval searching techniques of some of those assisting could be upgraded. This could be accomplished by training at the assistant and health inspector levels.

As stated earlier, the mosquito identification system is extremely fragile. It is recommended that a simple pictorial key be developed for *Ae.* (*Stegomyia*) first, and subsequently for all Fijian vector species. Instruction on using the key could be incorporated into suggested training programs that would be run by the National Vector Control Unit. The key should be for both larval and adult identification. Current practices for adult surveillance are labor-intensive and consequently do not monitor large enough areas to be generally meaningful, particularly for *Ae.* (*Stegomyia*) species, which have limited flight ranges.

Since adults are measured directly, however, the number of adults from biting catches is probably the most accurate indicator of epidemic risk. It is noted that a one-hour collection on November 25, 1991, returned 48 *Stegomyia* mosquitoes in the Suva City Council area. Numbers of this order are rare. For example, in Colombo, Sri Lanka, an average biting catch of 0.2 *Stegomyia*/hour is the density at which control is implemented! In view of the multiplicity of *Stegomyia* species in Fiji, some understanding of adult thresholds predisposing transmission is needed, as is research on adult surveillance.

Furthermore, the practice of collecting *Stegomyia* off human bait should be discouraged due to obvious potential risk given the high number of bites. Please note that pre-existing antibody in human collectors does not confer protection from dengue; in fact, it may cause severe dengue disease if the second infection is of a different serotype.

Control

The prevalence of breeding sites in Tables 4 and 5 is categorized according to purpose as follows to help assess the contribution of each category and focus on appropriate control strategies:

1. Water Storage

Drums may be fitted with cloth or gauze invertible covers tied around the rim of the drum. The bag section sits in the water, allowing residents to draw water from the drum. At night the bag is pulled out of the water, thus killing any immatures present between the bag and the water surface. Immatures that have passed through the gauze into the lower part of the drum will be trapped, and enclosed adult mosquitoes will not be able to escape.

Covers of iron or wood are generally of little value because of surface irregularities between the cover and the rim.

Although fish can be introduced, microcrustacean predators called copepods (genus *Mesocyclops*) could be studied in Fiji and evaluated as a reasonably permanent, low-cost and environmentally sound means of biological control. *Mesocyclops* are particularly appropriate for tanks, wells, and other storage containers.

2. Rubbish

Tins, bottles, coconut shells, and other discarded containers should be disposed of by rubbish collections.

Tires are kept for several purposes; industrial premises may keep them for retreading. All industrial premises must store tires properly, either indoors or with a waterproof cover outdoors. In residential areas, tires may be categorized as garden receptacles. They are used to form borders around trees and plants. All in the latter category should be kept filled with soil and maintained in that state.

Because of the obvious importance of tires to *Aedes* production in Fiji, legal proceedings should be applied to offenders. In Tahiti, Brisbane and New Orleans, *Mesocyclops* have been used successfully for long-term control. However, disposal is a simple, maintenance-free solution.

Our inspection of dumps suggested that tires may rise to the surface after being buried or may lie around the periphery. Perhaps it could be considered that in Fiji, with its abundance of islands, discarded tires could be used to construct artificial reefs. After a few years, such artificial reefs can become encrusted with coral and blend into the environment. (Of course we don't pretend to be experts on artificial reefs, but we have heard of such use elsewhere.)

3. Disused household/industrial items

Many of these items can be disposed of as rubbish. Other items, such as old cars, iron parts, baths and sinks, require proper storage or disposal. Large parts could be used for artificial reefs.

4. Building fixtures

Roof gutters are often undersampled in surveillance because it is difficult to reach them. Gutters should be kept free of leaves and items that may cause blockages and breeding sites.

5. Gardening receptacles

The saucers under potted plants can be a significant breeding source, indoors and outdoors, especially in urban areas. Removal of bases outdoors will provide a simple solution, but a solution for indoors is not evident. Washing with boiling water every five to six days is time consuming and difficult to sustain. Placing sand around the saucer with stones on the top may be easier and more decorative.

Playground items, pot plant holders, and tires used for ornamentation should be punctured so they drain easily and completely.

Other items, such as wheel barrows and buckets, require proper storage. Ornamental ponds should be properly maintained with fish.

6. Natural containers

Tree holes can be filled with soil and planted with orchids. Plant growth will compensate for the expansion of the tree hole over time.

There has been limited success elsewhere in dealing with Gecardine crab burrows, which breed prolific numbers of *Ae. polynesiensis*. In French Polynesia, *Mesocyclops* gave effective control of *Ae. polynesiensis* larvae in selected zones for up to four years. Use of *Mesocyclops* in crab holes could be explored further in Fiji.

During our survey, the abundance of crab burrow breeding was not determined but the number of burrows was counted. They constituted about 9 percent of the total sites inspected. Obviously, they will be of greater importance in coastal areas.

7. Recreational items

Correct storage of boats and other items is important. Swimming pools should be properly chlorinated.

In summary, therefore, the thrust for routine control should be preventive, aiming specifically at the most important breeding habitats in each particular area. This should be initiated and supervised by MOH and local authority staff, with specifically targeted information (see chapter 4) directed at stimulating community action. However, these programs will not be sustainable if health professionals discontinue visitation. It is important to maintain legislative backup to deal with uncooperative residents.

Reporting

Currently report forms are submitted weekly from surveys of about 10 premises, for a total of 40 premises inspected per month. Both industrial and residential areas are inspected by Suva and Lautoka Councils.

In view of the need to do larger surveys, the mosquito larval survey forms should be modified to facilitate examination of a greater number of premises per page and inclusion of a column for dry containers. Monitoring the average number of disposable containers per premise (wet, dry and positive) will provide an indication of public motivation that can be used to measure the success of health education.

Emergency Measures

In view of the lack of resources to carry out an effective vehicle-mounted ultra-low-volume (ULV) adulticide operation, it is recommended that less reliance be placed on this method. During the 1989-90 dengue epidemic, only two Leco ULV machines were available and vehicles suitable for carrying such equipment had to be borrowed.

As only four hours operation is possible per day, (approx. 0600-0800 and 1600-1800 hr, when temperature inversions keep the layer of insecticide on the ground), two such vehicles can cover only 64 km of spraying along roads. Clearly, for effective coverage of all affected areas in Fiji, the cost of equipment acquisition would be prohibitive. Furthermore, the effectiveness of such vehicle-mounted operations is currently under review. This reassessment may be particularly relevant to Fiji, where dengue transmission often occurs in isolated villages, settlements and plantations. Many of these premises are far apart and are not close to roads. However, we realize that in urban areas with good roads, fewer people can cover greater distances in vehicles than with backpack sprayers.

During May 1979 in the Toorak Ward of Suva, evaluations of vehicle-mounted ULV malathion spraying seemed to show some control of *Ae. pseudoscutellaris* for one week, but the effect on *Ae. aegypti* was doubtful (Goettel et al. 1980, J. Trop. Med. Hyg. 83: 165-171).

Backpack adulticiding equipment is less expensive than vehicle-mounted, does not rely on the availability of specialized transport, and can be carried out indoors and in harborage areas throughout the day. It is suggested that this alternative be followed as a cost-effective and practical means of focal adulticiding. This implies expenditures for adequate, locally based stocks of malathion EC, at least 50 sprayers, safety equipment, and training of staff designated to use such equipment. It is noted that insecticide resistance testing is not being carried out. If insecticides are to be used as a part of any program, then the temporal susceptibilities of target mosquitoes must be monitored to ensure that resistance to the chosen insecticide has not developed.

Cost estimates of a total program using backpack sprayers as part of an emergency plan have not been done because of its magnitude. Obvious considerations include:

- the number of premises treatable/day/person and total premises to be treated in localities of risk;
- insecticide quantity required to cover the treated areas twice;
- transport costs;

- insecticide susceptibility kit costs;
- safety equipment;
- costs of training programs; and
- the time available for such treatments during an epidemic (or, better, when pre-outbreak surveillance has indicated sufficient vector densities or indicator cases have occurred to necessitate action). Generally two applications within the seven-to-10 day immature development period over two generations are desirable.

It should be noted that such insecticides cannot be carried by regular air services because of their flammability. Hence, stockpiling in key centers is necessary.

These considerations, plus less than optimal communication procedures, have prompted us to advocate preventive strategies, with limited focal adulticiding only where clusters of clinical cases occur. However, it is noted that clinical diagnostic information rarely is reported by address and is seldom timely. Such improvements would facilitate specific control action in foci of dengue infection.

Supplies and Equipment

Because the problem of *Aedes* and dengue is both urban and rural in Fiji, lack of transport is a major impediment to comprehensive action. Provision of motorcycles, in addition to larger vehicles, could be considered.

Dependence on central core facilities will only be overcome if field units are provided with entomological equipment (sampling nets, pipettes, trays, bottles, preserving fluid, forceps, store boxes, entomological pins, mounting media, clearing fluid, glass slides and cover slips) plus microscopes (both dissecting and compound).

It is suggested that MOH staff consider the extent of desirable decentralization and estimate costs of supply.

Emergency Control

According to WHO records, in 1983 Fiji had 28 Fontan backpack sprayers for adulticiding purposes. As we are recommending that backpack adulticiding equipment be the major means for focal adulticiding, the MOH, with the assistance of WHO, might consider the following: placing such machines in areas of major risk; the areas to be covered for focal rather than widespread application; the number of trained personnel needed for such operations; and the number of houses that can be covered per person. Costs can be calculated with this information.

4. Community Issues

The nature of Fiji's multiracial society is such that the potential impact of community participation in primary health care, and in particular dengue control, is tremendous. The following key findings reflect current trends:

1. Generally speaking, public awareness and perceptions of dengue vary widely among different ethnic groups in the community. It is quite common to hear interpretations of dengue symptoms linked to a prolonged common cold with some debilitating effects. Ethnic Fijians often term this as *mate taka*.

2. Most health personnel acknowledge and actively support the current practice of a community-based approach to primary health care. Despite the shortage of resources, medical staff recognize the potential that this approach can have in promoting and strengthening community awareness and participation, and they display commitment to getting things done with whatever is available.

3. The community health worker (CHW) is seen as an important link between health personnel and the community, but the whole nature of the CHW scheme faces severe problems of sustainability and support.

4. Due to size, locality and cultural homogeneity, it is easier to define organized groups operating in rural communities. The growing metropolitan nature of urban communities means that organized groups have more diverse memberships, cater to specific interests of different target groups, and vary in area and scope of activity. The common focal point for both rural and urban communities, however, is the family or household.

5. It is not uncommon for people to turn to herbal medicine as a first referral point for treatment of dengue symptoms.

6. Health education material on dengue is fairly insignificant and there is scope for improvement in this area.

7. Local government bodies often coordinate activities requiring community participation with other public sector agencies that have established community networks.

8. Perceptions of community participation vary among health personnel and community members themselves.

Infrastructure

Community participation varies in practice from a mere passive participatory approach to a more active participatory stance. The activities of the following people and groups working in primary health care will be examined:

- Community health workers
- Local government bodies
- Interest groups

Community health workers (CHWs)

In the late 1970s, the community-based approach to primary health care and preventive services was introduced as a pilot scheme in the Rewa medical subdivision. Its initial success and acceptance by MOH as an integral part of health care delivery is reflected in its adoption as a national operational strategy by the health sector.

The main contacts for health personnel in each respective community are the community leaders. In Fijian villages, these leaders are the *turaga-ni-koro* (village headmen), whose position would be endorsed by the *bose va koro* (village councils). In other communities the leaders would be those holding some prominent position or those perceived by others as playing an active role in community affairs.

Selection of CHWs

Although health personnel inform the communities about some of the criteria to be considered in the selection of CHWs, the final decision is entirely up to community members. The high turnover rates of CHWs remain a constant problem. Health personnel advise communities that CHWs should be females, married or widowed. A married woman must have the consent of her male spouse and be willing to take on the role of a CHW. However, despite these criteria, there is still a high rate of inactive CHWs.

Training program

Once potential trainees have been selected, health sisters at the sub-divisional level draw up their respective training programs and put trainees through six weeks of basic clinical training covering a wide agenda (see Appendix D). Vector-borne diseases are indirectly covered in the sections on environmental health and sanitation, which are often taught by a health inspector. Specialists from different public sector agencies help cover different aspects of the course.

Training materials

Health sisters prepare their own teaching materials, sometimes at their own expense. They also use material from the Health Education Unit of the Ministry and from other agencies, such as the South Pacific Commission, WHO, the United Nations Fund for Population Activities, the National Food and Nutrition Committee and World Vision.

Training methods

Classroom lectures, role play, practicals, group work and discussions are used in training sessions. The context is often semi-formal.

Training venue

All CHWs are trained at either a health center or subdivisional hospital. Trainees travel daily or stay with relatives nearby, and daily sessions take about six hours. This is the only training most CHWs receive. Shortages of resources do not allow for in-service or even one-day seminars for updates on current health concerns. It is hardly surprising, therefore, that CHWs have only heard of dengue through the media and know little about its causes and symptoms.

Recognition of training

On completion of training, CHWs are given a certificate. When funding is available, they sometimes receive name tags too. Even though communities are encouraged to provide a separate facility from which a CHW may dispense his or her services, general community support does not seem to be forthcoming. CHWs interviewed expressed a feeling of being in limbo in their own communities.

Local government bodies

Health services provided by city and town councils and rural local authorities are incorporated under the Public Health Act. Such services in turn are regulated, supervised and controlled by the Central Board of Health, an advisory body chaired by the Permanent Secretary of Health and supervised by the Chief Health Inspector.

These local government bodies have statutory powers that enable them to impose fines for violation of litter and sanitation bylaws and to prosecute offenders. However, experience has shown this process to be fairly time-consuming and an ineffective deterrent as it is applied currently.

Community participation in combatting all forms of pollution, especially littering, has continued to be a problem. One means of raising awareness that has been used somewhat successfully by the councils and rural local authorities has been the launching of various week-long theme programs, such as: Anti-Mosquito Week, Hospital Week and Health Week. Councils provide free disposal of garden and other refuse during these weeks, in addition to the scheduled rubbish disposal days. The public is notified through the radio and newspapers about this free service.

There is an absence of activities that raise awareness of vector-borne diseases during these clean-up campaigns. It would seem that such exercises provide opportune times for a more integrated effort by all interested parties to use this week in raising awareness of dengue.

Health inspectors in local government bodies also use the community networks of other established public sector agencies when conducting educational and informational campaigns related to health and environmental issues.

Interest groups

There is a range of organized groups operating in Fiji. They vary in size, membership, structure, interests, scope of activity, area of coverage, and effectiveness. Membership is often determined by any one or a combination of the following: ethnic background, physical proximity, gender, professional interests, religion, ideology, class, age, recreational pursuits, income and kinship.

Field experience has shown that health-related concerns often attract women and women's groups. Women informants in Savu, Nagigi and Somosomo villages expressed eagerness and support when dengue surveillance and control measures were discussed. Caring for the young, the elderly, the sick, and the household are traditional women's roles. As such, moves that aim to reduce women's drudgery and improve the standards of households are seen in a positive light.

Reservations expressed about the status quo of organized groups in communities underline the importance of establishing effective systems of communication with other organizations also involved in community development. Agencies like the Fiji Council of Social Services (FCOSS), National Council of Women (NCW), YMCA, YWCA and the Ministry of Women and Culture have good knowledge of active organized groups in the community that could spearhead community participation in dengue surveillance and control.

There is no doubt that the infrastructure for community participation is already in place, but strategies for strengthening it must be developed so that it can be sustained.

Description of Communities

Rural communities

The communities visited in rural Viti Levu, Vanua Levu and Taveuni were villages and settlements identified as locations of dengue outbreaks in 1989-1990.

Savu, Nagigi and Somosomo are predominantly Fijian villages that share common attitudes about community affairs.

Village governance is administered through a village council that is directly linked to the provincial administration under the Ministry of Fijian Affairs. Churches play an important role in village affairs and all three villages have church-based groups in the form of a women's fellowship, men's fellowship, laity council, youth fellowship and the circuit council. School mothers' clubs and traditional women's groups are also present.

Scheduled clean-up days are organized separately for the men and women. The men tend to focus on general cleaning and weeding around the village perimeter, public buildings, and areas like the church, the school, the community hall and the village green. Cleaning in and around the main dwelling houses is primarily the domain of women.

Villagers share common values of seniority, male dominance, female subservience, gender division of labor, and distinctions between public and private life.

Rural settlements are of two types. The first type is a farm-based settlement, such as Siberia settlement outside of Labasa town, which features more individualized homesteads separated by crop farms. The second refers to small pocket localities that consist of families living on either leased or freehold land. Naivita settlement near Savusavu airport and Cuvu settlement along the western coast of Viti Levu are examples of such localities.

Religious groups, farming associations, school clubs and kinship groups are common organized units in these settlements.

Urban communities

Suva has approximately 9,000 rate payers, but its services and facilities are also used by about 60,000 people who commute daily into the city.

The wide-ranging socio-economic levels in the urban centers are reflected in the various types of residential areas. High-cost housing, or residential A types, are found in and around the central business districts, whereas low-cost housing estates are more prevalent in the outer city areas. Squatter settlements spring up indiscriminately in various places.

The range of organized groups within urban communities is vast and varied in objectives and interests. Religious groups, ethnic groups, and parents' and teachers' associations (PTAs) are some of the active groups in the urban setting.

The socioeconomic status of households should be a serious consideration in the design of health education to promote community participation for dengue surveillance and control in both rural and urban areas. The message and methods chosen should be tailored to specific audiences.

Dengue Knowledge, Attitudes and Practices (KAP)

Generally, knowledge of dengue's causes and symptoms is often obtained through the media or by word of mouth when someone in a community is hospitalized.

Informants in the squatter settlements and villages visited indicated that they had heard the word dengue but were not too familiar with the details of the disease. When the symptoms were described, they had little difficulty understanding them, but more or less linked them to the common cold rather than dengue.

Practices related to promoting dengue surveillance and control are synonymous with keeping a mosquito-free environment. Information relating dengue to mosquito breeding in man-made containers and tree holes, and especially in drums and tires, was received with a sense of quiet alarm. Such containers are commonly used in and around houses for ornamental and recreational purposes, as well as for storing water.

Routine Actions

Resorting to herbal and alternative medicine is quite common in the treatment of dengue symptoms. Access to medical services and drugs is influenced by a family's socio-economic status.

Health personnel usually assume the duration of illness to have been already two to five days by the time patients arrive at the hospital or clinic. In some communities the CHW is perceived as unqualified to administer drugs such as panadol.

Communication and Health Education

There is obviously a need to strengthen communication links between the Ministry and the public to provide timely information on dengue.

Common focal points in communities, such as community halls, village shops, village dispensaries, schools, social clubhouses, or bill-boards in prominent locations are potentially useful for directing attention to dengue. At present, health personnel often pass on media reports to the community, Unfortunately, these reports are sometimes unreliable sources of accurate information.

The health education unit of the MOH has faced staff shortages and this has influenced production of material. The unit recently acquired equipment and additional staff and should be in a position to produce materials in the two main languages besides English, Fijian and Hindi.

As part of the health education efforts of the Suva City Council, simple dengue informational material has been translated into Hindi.

The absence of refresher courses means that CHWs have not been able to perform an optimally effective role in educating the community on dengue.

Emergency Measures

During a dengue outbreak, community participation can be mobilized very rapidly if accurate and practical information is disseminated quickly through the media.

Our informants referred to the absence of any clear existing guidelines for community action on dengue. It would seem appropriate that the National Dengue Task Force lay down some guidelines for the community in the event of a dengue outbreak.

Health Education

It is obvious that one of the main means of strengthening the role of community participation is through health education. The following suggestions are offered:

Health Educators

- An officer in the Health Education Unit could be assigned specific duties to draw up a plan of action that would include: production schedules, types of literature to be produced, a distribution network, expertise required and costs.

- A workshop could be organized with health educators from the MOH on participatory approaches to dengue reduction. Zone nurses, health sisters and health inspectors would participate.

- Special attention should be given to the following in the production of health education literature about to DHF:

  - use of simple and relevant language,
  - use of simple pictorial illustrations,
  - targeting specific audiences, and
  - relevant imagery.

Community health care workers

- Separate workshops could be conducted for CHWs in urban, periurban and rural communities to help evaluate and strengthen their role in dengue surveillance and control.

- Communities could receive help in establishing or activating local health committees to support the CHWs.

- Organized groups in the community could be identified and used as bases for promoting community awareness of dengue.

Operational Research

It is suggested that research be applied to the subject of mobilizing community participation in dengue surveillance and control. Field experience has shown that multidisciplinary research projects have a far wider impact and greater relevance to host communities.

5. Recommendations

The team recommends that the Ministry of Health consider the following suggestions aimed at improving dengue prevention and control in Fiji, hoping thereby to further reduce morbidity, mortality and health care costs directly attributable to this disease.

1. Officially establish a National Mosquito Control Unit and provide it with adequate resources (e.g., trained staff, vehicle, microscopes, survey and control equipment) to carry out its national mission to prevent and control dengue and other mosquito-borne diseases in Fiji (see p. 24).

2. Provide the head of the National Mosquito Control Unit with sufficient status to have direct access to appropriate decision-making officials and bodies.

3. Develop field-oriented training (and retraining) courses in *Aedes* surveillance and control at the National Mosquito Control Unit for health inspectors and assistant health inspectors.

4. Enhance national dengue preventive programs emphasizing continuing community participation in the elimination of major mosquito breeding sources in industrial, residential, and public areas, particularly tires and unprotected water drums.

5. Increase the training of the subdivisional public health team in health education on dengue prevention and control.

6. Tailor health education materials on dengue prevention and control to the target audiences, ensuring that the messages are clear, simple, relevant, and in the appropriate language(s).

7. Ensure that facts on the current dengue situation and the prevention/control efforts being carried out are provided via a periodic newsletter to the relevant offices in the MOH and to the medical community throughout Fiji.

8. Collaborate with the Fiji Medical Association in the development of a periodic training workshop on dengue diagnosis and treatment for medical officers.

9. Develop and carry out an action plan, specific to Fiji, for emergency dengue control.

10. Obtain and place hematocrit centrifuges in all subdivisional hospitals in Fiji.

11. Obtain and place pediatric blood pressure cuffs in all health centers in Fiji.

12. Develop complete in-country capability at the Wellcome Virus Laboratory to test single sera for dengue IgM antibody by the ELISA.

13. Make dengue a telephone-notifiable disease, including locality information, and send a summary of test results back to the submitting office.

14. Provide subdivisional medical staff with the necessary resources (e.g., supplies, transportation costs) to carry out intensified community-based activities in dengue control.

15. Review the role of the community health worker to help incorporate them to a greater degree into dengue prevention and control activities.

16. Take an active role in the dissemination of relevant, factual information on dengue to the general population through various communication channels.

17. Present a comprehensive plan at a donor workshop to request funding for applied research in Fiji and the necessary resources to focus and deliver a sustainable national dengue prevention/control program.

18. Promote short- and long-term training and education in medical entomology, clinical practice, epidemiology, statistics, the social sciences, and dengue virology to ensure continuing availability of staff trained in these fields in Fiji's national progarm.

6. References

1. Aaskov et al. 1981. An Epidemic of Ross River Virus Infection in Fiji, 1979, 1981. **Am J Trop Med Hyg** 30:1053-1059.

2. Adiao, A C. 1990. Dengue fever in Fiji. **Fiji Medical Journal.**

3. Editorial on dengue epidemic. 1975. **Fiji Medical Journal** 3:51.

4. Fagbami et al. 1991. Dengue type 1 with haemorrhagic manifestations in Fiji, 1989-1990. **Virus Information Exchange Newsletter** 8:176.

5. Kuberski et al. 1977. Clinical and laboratory observations on patients with primary and secondary dengue type 1 infections with haemorrhagic manifestations in Fiji. **Am J Trop Med Hyg** 26:775-783.

6. Maguire et al. 1971. Mosquito-borne infections in Fiji II. Arthropod-borne virus infections. **J Hyg (Camb)** 69: 287-296.

7. Mataika, J U. 1977. Dengue fever in Fiji. **Fiji Medical Journal** 5:259-63.

8. Mataika, J U and Miles, J A R. 1982. Epidemiology of dengue in Fiji. **Fiji Medical Journal** May/June:91-92.

9. Miles et al. 1964. Evidence of arbovirus infections in Fiji. **Am J Trop Med Hyg** 13:327-330.

10. Palmer, A S and Ram, P. 1976. Dengue Fever in Fiji, 1975. **Fiji Medical Journal** 4:441-446.

11. Reed et al. 1977. Type 1 dengue with haemorrhagic disease in Fiji: epidemiologic fundings. **Am J Trop Med Hyg** 26: 784-791.

7. Itinerary and People Visited

January 27 - February 14, 1992

January

27-28 Dr. David Calder, Chief, Office of Health and Population, USAID, Suva

27 Dr. Salik Ram Govind, Epidemiologist, Assistant Director for Primary & Preventive Health Services
Manoa Bale, Advisor, Office of Health & Population, USAID, Suva
Pat Lowry, Advisor, Office of Health & Population, USAID, Suva
Gyan Prakash, Actg. Health Inspector, National Vector Control Unit, Suva
Jaswant Singh, In-service Student, Dip. in Env. Health, Suva

28 Ilitomasi Verenakadavu, Senior Health Inspector, Suva City Council
Prem Sushil, Health Education Office, SCC
Dr. Jona Mataika, Consultant Virologist, Wellcome Virus Laboratory, Suva
Dr. Josefa Koroivueta, Diagnostic Virologist, Wellcome Virus Laboratory, Suva
Dr. Shabnam Prakash, Pediatrician, CWM, Suva

January

28 Dr. Isikeli Leweniqila, Acting DMO Central/Eastern, Suva
Solomone Naivalu, Head Health Education Unit
Suva Uraia Lesu, Chief Health Inspector, Suva

29 Asenaca Nayacakalou, Senior Health Sister, Suva Health Office
Alumita Bera, Senior Health Sister, Raiwaqa
Seini Ravea, Health Sister, Nuffield Clinic, Suva
Mereadani Serukalou, Acting Senior Health Sister, Valelevu

30 David Chandra, Director, Health Services, SCC
Temalesi Koka, Staff Nurse, Samabula Health Center
Dr. Kopedsky, Epidemiologist, WHO, Suva
Dr. Allen, Environmental Scientist, WHO, Suva

31 Dr. Sainivalati Veitogavi, SDMO, Naitasiri
Ranjit Singh, Medical Assistant, Naqali Health Center
Niumaia Gucake, Assistant Technician, Vunidawa Hospital
Jope Davetanivalu, Assistant Health Inspector (In-service), Vunidawa Hospital
Nemani Cakausese, Representative of village headman, Savu Village, Naitasiri
Women of Bureta Street Squatter Settlement, Suva
Women of Savu Village, Viria, Naitasiri Province
Dr. Narayan, SDMO Rewa, Nausori
Mohammed Kadir, Health Inspector, Nausori
Dr. Hubert Elliot, MO, Korovou Hospital

February

1 Dr. Shiva Nand, Sigatoka Subdivisional Hospital

3 Noa Tokavou, Health Inspector, Cakaudrove
Mereani Saumi, Actg. Health Sister, Savusavu
Josefa Ganikau, Turaga ni Koro, Nagigi

February

3 Miliana Lawedrau, Dorcas Society, Nagigi
Eka Sereacagi, elderly woman, Nagigi
Dr. Tin Maung Maung, Actg. SDMO, Savusavu
Milio Toganivalu, Village elder, Nagigi
Mere Lili, CHW, Nagigi

4 Dr. Bijend Ram, DMO Northern, Labasa
Simione Radakua, Divisional Health Inspector, Labasa
Kalisito Naduva, Mayor, Labasa Town Council
Mrs. Bale Korovakaturaga, Dep. Mayor & Councillor
Mrs. Diana Billings, Councillor, Labasa Town Council
Sharma Nand, Labasa Town Clerk
Vinod Gupta, Health Inspector, Labasa Town Council
Nisha Ali, Assistant Health Inspector, Labasa Town Council
Saurara Naitini, Women's Interest Assistant, Macuata
Mr. Lingam, Hospital Administrator, Labasa Base Hospital
Dr. Krishnan, Consultant Physician, Labasa Base Hospital

5 Dr. Kyi Wann, Taveuni Subdivisional Hospital
Dr. Naceba, SDMO, Taveuni
Filo Mitchell, Health Sister, Taveuni
Olivia Kete, Zone Nurse, Taveuni
Ratu Isikeli Kubuabola, Roko Tui Cakaudrove, Provincial Office, Somosomo
Solomone Maiqovu, CHW, Somosomo

6 Senimili Kikau, Coordinator, Soqosoqo Vakamarama, Suva

February

6 Mr. Hassan Khan, Director, Fiji Council of Social Services, Suva
Amelia Rokotuivuna, General Secretary, YWCA, Suva

7 Mr. Azmat Khan, Divisional Health Inspector Central, Suva
Mr. Keshwa Nand, Senior Assistant Health Inspector, Suva Rural Local Authority

11 Kevin Barrie Mutton, Chief Executive, Fiji Hotel Association, and President, Suva North Rotary Club

A. Medical Appendices

Appendix A-1. Fiji Clinician Questionnaire

Please read the following case history:

A 15-year old Fijian-Indian female presented to CWM Hospital with a 2-day history of fever, headache, photophobia, dry cough and extreme lethargy. She had recently returned from a brief visit to Malaysia. On admission she was alert and oriented. She had a temperature of 40.1°C, blood pressure was normal. There were no other abnormal physical findings. Initial investigations revealed a hemoglobin of 11.8 gm/100 ml, a white cell count of 3,500 with a mild reduction of neutrophils to 1,900. The platelet count was 163,000. Serum creatine and liver function tests were normal apart from an elevated ALT of 72 U/L.

Over the next 4 days her condition deteriorated with a persistent high fever, diarrhea and vomiting associated with hematemesis. She became jaundiced and delirious. Her hemoglobin had increased to 13.2 gm/100 ml, while the platelet count fell to 90,000. Liver function tests were markedly abnormal, with ALT of 2,940 U/L.

Please List Your First Five Differential Diagnoses for This Case in Order of Likelihood.

1) ______________________________
2) ______________________________
3) ______________________________
4) ______________________________
5) ______________________________

Please Indicate Your Lever of Training and Specialty, If Applicable.

Medical student_____
Intern_____
Registrar_____
Medical officer_____
Consultant_____ Specialty____________
Base Hospital_____ Subdivisional Hospital__________________

Thank you for your cooperation. A list of possible diagnoses and the actual diagnosis will be provided to you after turning in this form.

Dr. Shabnam Prakash and Dr. Pagat Ram
Fiji School of Medicine

Fiji Clinical Questionnaire - Addendum

Possible diagnostic considerations:

Bacterial sepsis
Viral hepatitis
Malaria
Dengue hemorrhagic fever
Typhoid
Leptospirosis
Scrub typhus

Actual diagnosis: Dengue hemorrhagic fever
Dengue virus serotype 3 was isolated form a blood sample taken on the second day of admission and hemagglutination inhibition serology confirmed a rising tire of antibody to flavivirus group antigen.

Appendix A-2. Fiji Dengue Fever Serosurvey Form

February 1992

Fiji Dengue Fever Serosurvey Form

Date:______________________

1. School:________________________________

2. Address:______________City/Village/Settlement___________

3. Name of Child:_________________________________
First\Last

4. Race: Fijian___ Indian___ European___ Other___

5. Birthdate:______________________
Day\Month\Year

FOR LABORATORY USE ONLY

S1 Date:________________
Day\Month\Year

Laboratory number:___________

Results:______________ ___________________________

HI ______________
ELISA ______________
IgG ______________
IgM ______________
Neutralization ___________________

S1 Lab Number:________________

Staple filter paper above.

Appendix A-3. Surveillance Form

APPENDIX (MEDICAL) I

Surveillance Form

Certificate of Notifiable Diseases

Week ending Saturday morn the   day of   19

Name (and father's name)	Birthdate (Age) day/mos/year	Sex	Race	Address (as detailed as possible)	Disease	Onset date day/mos/year	Other Information

Doctor Notifying________________ Signature ________________ Address ____________ Telphone________

Appendix A-4
Special Surveillance Form for Dengue Emergencies

Dengue Hemorrhagic Fever
Hospitalized Case Reporting Form

Covering period from ________________ to ______________

Hospital ___________________________

With shock				Without Shock					
Number of presumptive cases		Number of deaths		Number of presumptive cases		Number of deaths			
< 15 yrs.	15+ yrs.	< 15 yrs.	+ 15 yrs.	< 15 yrs.	+ 15 yrs.	< 15 yrs.	+ 15 yrs.	Total cases	Total deaths

Appendix A-5
Diagnostic Equipment Inventory Checklist

Equipment	In Stock (Yes/No)	Number
Hematocrit		
Microcentrifuge		
Reader		
Capillary Tubes		
Lancets		
Platelet Counts		
Compound Microscope		
Hemocytometer		
Pipettes		
Reagents		
Blood Drawing		
Needles		
Syringes		
Sterile redtop tubes		
Refrigerator		
- 20^0 C freezer		
Centrifuge		
Specimen Shipping		
Cold Boxes		
Ice Packs		

Hospital__________ Date___________ Signature____________

Designation___________

Appendix A-6

Inventory of Supplies for Management of Dengue and Dengue Hemorrhagic Fever Patients

Supplies

Inventory of Supplies for Management of Dengue and Dengue Hemorrhagic Fever Patients

Number

Hospital beds

WHO Oral Rehydration Solution*

Intravenous fluids
- Normal saline
- Ringers lactate or Hartmans
- 7.5% sodium bicarbonate for injection
- Tubing and needles

Colloidal fluids (one or more of the following)
- Fresh frozen plasma
- Plasma
- Plasmanate
- Dextran - 40
- Whole blood
- Platelet concentrate

Pharmacy
- Paracetamol
- chloral hydrate
- Furosemide
- digoxin

Oxygen and delivery system

Blood gases

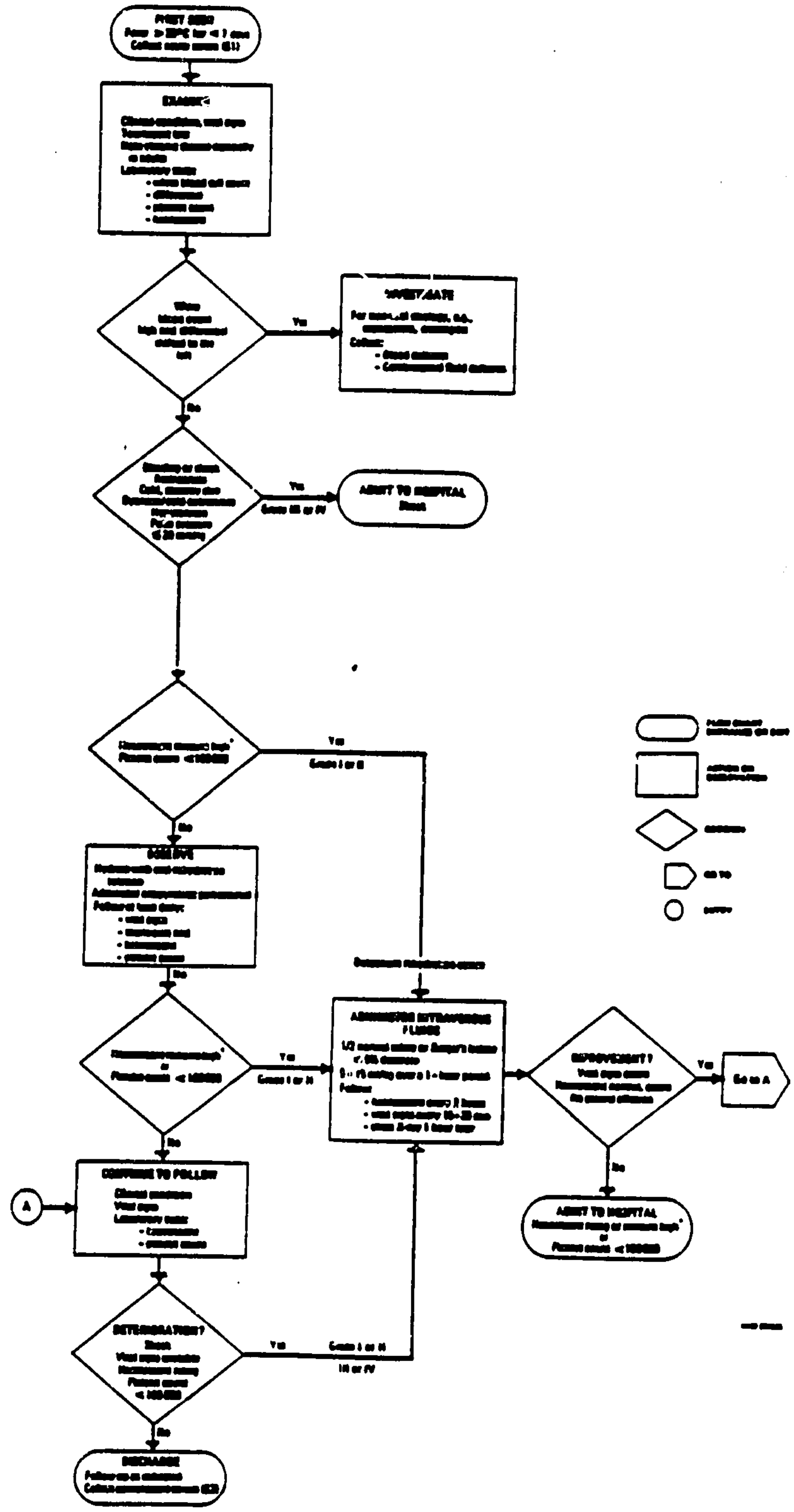
Electrolytes

Pediatric blood pressure cuffs

* Sodium chloride (table salt) 3.5g
Sodium bicarbonate (baking soda) 2.5g
Potassium chloride 1.5g
Glucose 20.0 g
Dissolved in 1 liter of potable water

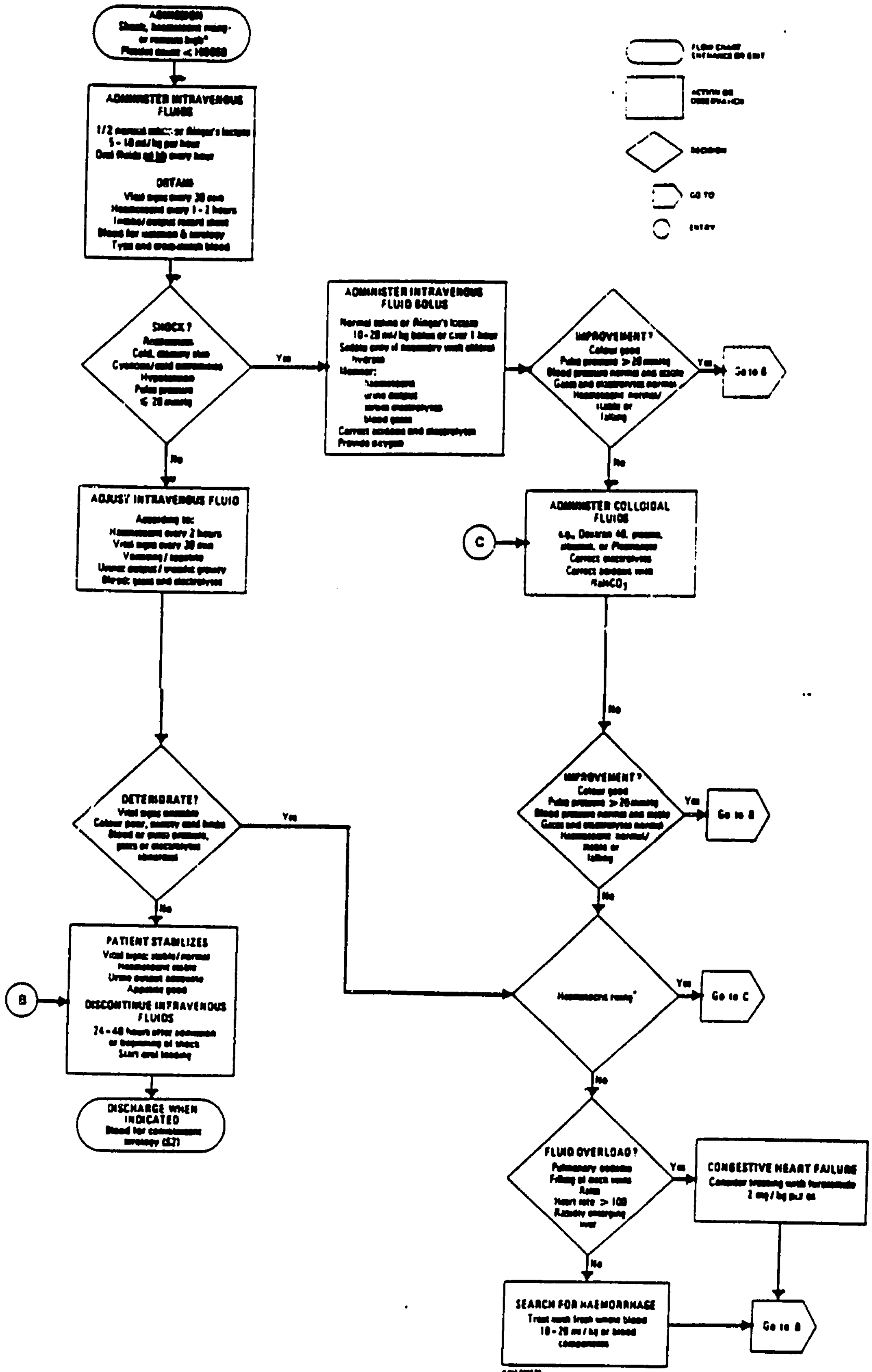
Appendix A-7. Outpatient Flow Chart

OUTPATIENT FLOW CHART



Appendix A-8. Hospital Flow Chart

HOSPITAL FLOW CHART



Appendix A-9
Summary of Dengue Emergency Measures

1. Epidemiologist (or surveillance officer) on National Dengue Task Force notes 100+ cases of dengue reported in a one-week period with a serological confirmation rate of 60+ percent and informs chairman of task force.

2. Chairman calls an emergency meeting of the National Dengue Task force and a recommendation is made to the Minister of Health.

3. The Minister of Health declares a national dengue emergency.

4. Media campaign notifies public. Messages include:

   a. symptoms of DHF and the importance of early medical attention, especially for children younger than 15 years;

   b. control of the epidemic will require community participation in elimination of *Aedes* breeding sites;

   c. basic information about day biting *Aedes* mosquitoes and the major sites of breeding, i.e., tires and drums;

   d. geographic distribution of cases;

   e. possibly a telephone hotline for the public;

   f. any government plans for focal spraying to control adult mosquitoes.

5. An epidemic control center is established with key staff from the National Dengue Task Force. Its functions include:

   a. Coordinating rapid dissemination of diagnosis and treatment guidelines for DHF;

   b. Monitoring hospitalized cases and the need for medical supplies;

c. Ensuring implementation of regional hospitalization plans and triage protocols;

d. Monitoring surveillance information and evaluating the effectiveness of control efforts;

e. Monitoring deaths, average hospital stays and costs, efficiency of distribution of supplies, and the effectiveness of hospitalization plans;

f. Coordinating requests for international assistance;

g. Providing feedback to the medical, public health and lay communities on the status of control efforts.;

h. Coordinating mosquito control efforts according to clinical foci;

i. Mobilizing community groups for control efforts;

j. Ensuring availability of national resources for control efforts through the political system; and

k. Reviewing successes and failures of the emergency campaign in a written report.

Appendix A-10. Triage

Admission Criteria

In the setting of epidemic, triage of patients with appropriate treatment will be required.

1. **Patients with classical dengue fever** and without signs of dehydration, hemorrhage or circulatory failure should be examined by blood pressure measurement, tourniquet test, and hematocrit. In the absence of clinical signs of dehydration, circulatory failure (see below) or hemorrhagic diathesis (positive tourniquet test), patients may be treated with acetimenophen and released with clear instructions to return immediately should signs of decompensation (lethargy, restlessness, cold extremities, skin congestion, hemorrhage, or severe abdominal pain) occur, usually on the 3rd or 4th day after onset.

2. **Patients with classical dengue fever and dehydration.** In patients with signs described but also manifesting severe vomiting, diarrhea, and clinical signs of dehydration, oral or parenteral fluid therapy may be given in the outpatient setting. Such patients should be followed carefully and admitted if clinical criteria are met (see below).

3. **Patients with signs of DHF/DSS.** Patients with clinical signs of circulatory failure (restlessness, lethargy, skin congestion, cool, clammy extremities, hypotension, narrowed pulse pressure [<20 mm/Hg], rapid, weak pulse), with hemorrhagic manifestations, (positive tourniquet test, thrombocytopenia), or elevated hematocrit should be immediately admitted to hospital.

   Monitoring and treatment of such patients should follow guidelines outlined in the *Technical Guide for Diagnosis, Treatment, Surveillance, Prevention and Control of DHF* (WHO 1984).

   If properly instructed, triage can be done by nurses, medical students and paramedical workers, but competent laboratory assistance is essential.

Patients with similar degrees of severity of illness should be grouped together. Those with shock require intensive 24-hour nursing and physician care. Paramedical workers or parents can assist in oral fluid therapy or in monitoring the rate of intravenous fluid administration and general status of the patient.

Appendix A-11. Operational Research Topics

1. Prospective serosurveys to evaluate dengue incidence

Prospective serosurveys among urban school children using fingerstick blood samples collected on filter paper could be done in similar socio-economic/ecologic areas with and without well-organized community mosquito breeding site elimination campaigns. Seronegative children could be re-bled at yearly intervals to establish dengue incidence. The purpose of the project would be to evaluate the effectiveness of community dengue control programs, evaluate the usefulness of various larval and adult indices for predicting dengue risk, and help assess the contribution of various *Aedes* species to transmission of dengue in Fiji.

2. Dengue KAP surveys of health care personnel

At suitable intervals after the establishment of workshops on dengue diagnosis, management, and control issues, a KAP questionnaire could be administered to a sample of medical officers, nurses and paramedics involved in primary and secondary care. This survey would evaluate the effectiveness of workshop training and the level of knowledge about dengue among medical personnel. KAP questions could cover other important areas in public health, such as heart disease and sexually transmitted diseases in order to broaden the usefulness of the surveys. Such surveys should highlight areas that need more emphasis and improve future training.

3. Evaluation of sentinel virologic surveillance for dengue

People responsible for establishing and monitoring virologic and clinical surveillance for dengue could evaluate a sentinel virologic surveillance system at yearly intervals for approximately three years. The purpose of this project would be to determine and monitor the quality and usefulness of dengue surveillance. Process indicators could be examined, such as meetings, numbers of medical officers participating and longevity of participation, as well as outcome indicators such as number of samples collected, the quality of the samples and positivity, and conformity with the dengue clinical case definition. The impact of the surveillance system could be evaluated in terms of its cost, acceptability and sensitivity. Sentinel surveillance sensitivity could be evaluated by placing sentinel sites adjacent to schools participating in serosurveys; review of clinic, hospital and mortality data; and/or household surveys.

B. Entomological Appendices

Appendix B-1 (Entomological)

Surveillance Procedures

Surveillance should be based on key towns and areas of potential risk for dengue and adequate sample sizes. It should be limited to four to five strategically chosen times of the year. The current indices used have limited value but should be retained until new ones are field tested for Fiji.

Improved and more timely information on the locations of clinical cases or foci of recent seroconversion could streamline surveillance and focal control procedures.

Surveillance Form

As there is a need to increase sample size and to include potential (dry) breeding sites, the surveillance form should be modified.

Summary of Routine Control Measures

Health education is relatively non-specific and poorly targeted. It should emphasize control in the key container categories, tires and drums, that are responsible for producing up to 99 percent of the *Aedes* mosquitoes in some areas.

Control should use targeted community campaigns and adequate legislative backup, combined with biological control of water storage containers using predacious copepods of the genus *Mesocyclops*. Tires could be disposed of in several ways. The routine program requires input from social scientists to best utilize a diverse community workforce. Such programs will always require input and feedback from the range of MOH managers and staff, who currently are hindered by serious resource deficiencies in the health sector.

Summary of Emergency Measures

Fijian demographics, as well as the potential high cost and technical and practical limitations of past ULV vehicle-mounted adulticiding campaigns, suggest that emphasis should be switched to selective, focal spraying of premises where 1) clusters of seroconversion or clinical cases occur, or 2) larval indices are extremely high. This applies in particular in localities with high numbers of tires and drums.

Operational Research Topics

The following are particularly exciting and relevant topics that might be addressed in order to assist operational programs:

1. With the introduction of the second most important global vector of dengue viruses, *Ae. albopictus*, possibly between 1986-1988, Fiji became the only nation that has to deal with four to six known carriers. There is evidence to suggest that *Ae. albopictus* is displacing *Ae. pseudoscutellaris* from breeding niches and ecological scenarios are changing. What is the prognosis and what are the implications for future control strategies and epidemic occurrence?

2. The susceptibility and transmission characteristics of all Fijian dengue mosquitoes have not been worked out for Fijian isolates. Which species is the most capable of transmitting dengue?

3. What are each species' relative propensities for blood-feeding on the human population at risk?

4. What are the relative survival characteristics of these species? If a species is short-lived, then the number of times it can blood feed and transmit will be limited.

Definitive answers to the questions posed in 1-4 are essential to decide which is the priority species for control.

5. In Fiji, quarantine procedures need improvement and cost-effective monitoring systems should be put in place to prevent a) the dissemination of *Ae. albopictus* to other South Pacific nations, and b) the introduction of malaria-carrying *Anopheles* from Melanesia. How widespread is *Ae. albopictus* in Fiji?

6. Predacious copepods, genus *Mesocyclops*, have been low-cost, permanent and environmentally compatible means of controlling *Aedes* in water storage and crab burrows in French Polynesia, China, Australia, USA and Brazil. Do they occur in Fiji and can they be integrated successfully into Fijian control programs?

7. Queensland Institute of Medical Research scientists have developed potential new methodologies for *Aedes* surveillance. Fiji presents the ideal opportunity for field development and verification against vector species that cause regular epidemics of dengue. Such testing will have global relevance for dengue/dengue hemorrhagic fever, said to be expanding at a rate comparable to AIDS (HIV).

Appendix C

Draft Proposal for Support of a Comprehensive, Integrated Dengue Prevention and Control Program in Fiji

Submitted by the Ministry of Health, Fiji

Based on material prepared by the Vector Biology and Control Project (VBC), a centrally funded U.S. Agency for International Development (A.I.D.) project, following an external assessment from January 27 to February 14, 1992 of the epidemiology of dengue and its control in Fiji. Team members were Drs. Andre, Kay, Waterman and Ms. Kikau.

Introduction

Dengue is a disease that is of great concern to man today; a few years ago, over 300,000 cases were reported in Brazil and later, more than 400,000 cases occurred in Ecuador. Hemorrhagic outbreaks with up to 10 percent mortality, especially among children with secondary infection, are reported annually from various parts of Southeast Asia.

A disease of humans, dengue is transmitted by mosquitoes. These mosquitoes are closely associated with domestic situations caused by availability of artificial containers such as tires, flower pots, tins, and water drums. Therefore, humans can prevent the disease by simple elimination of these breeding habitats. Unfortunately, many communities are not aware of the link, and mosquitoes abound. When mosquitoes feed on an infected human, they can spread the dengue virus rapidly throughout a community. Severe disease and even death may follow, depending on the immune status of the infected individuals. Part of the great significance of the dengue viruses lies in their constant disease potential. With modern global transportation, virtually any *Ae. aegypti*-infested area in the world is subject to epidemic threat.

Dengue epidemics have occurred periodically in Fiji since 1885 (1885, 1930, 1944, 1971). The more serious form of the disease, dengue hemorrhagic fever (DHF), first appeared in the country in 1975, with subsequent outbreaks taking place in 1979-80 and 1989-90. Over 3,600 confirmed cases of dengue were reported in the last epidemic, with 30 reported deaths due to DHF. An unrelated mosquito-borne virus, Ross River, caused an explosive outbreak of epidemic polyarthritis in 1979. Both this epidemic and the 1989-90 dengue epidemic caused widespread human suffering throughout Fiji's three major islands in rural as well as urban situations.

Judging from the Asian and Latin American experiences with dengue, DHF cases with severe illness, particularly in children, will occur with increasing frequency as the people of Fiji are exposed to future outbreaks. Direct costs due to treatment and control measures will increase, as will indirect costs resulting from premature death, school absenteeism, reduced productivity, and losses in tourism. Therefore, the Ministry of

Health (MOH) officials and the National Dengue Task Force are greatly concerned about the control of dengue and other mosquito-borne viruses in Fiji.

A number of constraints will continue to impede dengue prevention and control efforts in Fiji. Lack of resources, such as well-trained staff, vehicles and diagnostic equipment, is the first major constraint. The second is the lack of official recognition, support and staffing of a national unit devoted solely to the control of mosquito-borne diseases. Inadequate surveillance and analysis of important epidemiological data have prevented a rapid and appropriately targeted response to dengue outbreaks. Fiji also needs a specific action plan for the emergency control of dengue. Health education for the medical community and for the population at large has not been fully successful.

The solutions to overcoming these and the other constraints listed in the proposal may or may not require additional funding. In some cases, such as notification of diagnosed cases to the appropriate offices, increased awareness of the problem or better communication will solve the problem. Other solutions, such as the purchase of a vehicle for the National Mosquito Control Unit, may require external funding. The MOH hopes to consider the following objectives for improving dengue prevention and control in Fiji; thereby, reducing morbidity, mortality and health care costs directly attributable to this disease.

Objectives

1. Officially establish a National Mosquito Control Unit and provide it with adequate resources (e.g., trained staff, vehicle, microscopes, survey and control equipment) to carry out its national mission to prevent and control dengue and other mosquito-borne diseases in Fiji.

2. Provide the head of the National Mosquito Control Unit with sufficient status to have direct access to appropriate decision making bodies.

3. Develop field-oriented training (and retraining) courses in *Aedes* surveillance and control at the National Mosquito Control Unit for health inspectors and assistant health inspectors.

4. Focus the national dengue program on prevention rather than emergency control by emphasizing continuing community participation in the elimination of major mosquito breeding sources (tires and unprotected water drums) in industrial, residential, and public areas.

5. Increase the training of the subdivisional public health team in health education as related to dengue prevention and control.

6. Tailor health education materials on dengue prevention and control to the target audiences, ensuring that the messages are clear, simple, relevant, and in the appropriate language(s).

7. Ensure that facts on the current dengue situation and on the prevention/control efforts being carried out are provided via a periodic newsletter to the various relevant offices in the MOH and the medical community throughout Fiji.

8. Collaborate with the Fiji Medical Association in the development of a periodic training workshop for medical officers on dengue diagnosis and treatment.

9. Develop and use an action plan, specific to Fiji, for emergency dengue control.

10. Obtain and place hematocrit centrifuges in all subdivisional hospitals in Fiji.

11. Obtain and place pediatric blood pressure cuffs in all health centers in Fiji.

12. Develop complete in-country capability at the Wellcome Virus Laboratory to test single sera for dengue IgM antibody by the ELISA (Enzyme-Linked Immunosorbent Assay).

13. Make dengue a telephone-notifiable disease, include locality information in reports, and send a summary of test results back to the submitting office.

14. Provide subdivisional medical staff with the necessary resources (e.g., supplies, transportation costs) to carry out community-based, primary health care activities in dengue control.

15. Review the role of community health workers to help incorporate them to a greater degree into dengue prevention and control activities.

16. Take an active role in the dissemination of relevant, information on dengue to the general population through various communication channels.

17. Promote short- and long-term training and education in medical entomology, clinical practice, epidemiology, statistics, the social sciences and dengue virology to ensure continuing availability of specialist-trained staff in the national program of Fiji.

Background on Medical Issues

Fiji experienced its worst dengue epidemic in 1989-90. More than 3,600 cases were reported, hundreds of patients were hospitalized and 30 deaths were reported. Many of the hospitalized cases and deaths were apparently due to dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS). Dengue 1 virus was isolated. Twelve cases of dengue had been serologically confirmed in Fiji as of February 1992. A USAID team has reviewed existing entomologic data and conducted *Aedes* larval surveys in urban and rural areas of the three largest islands, Viti Levu, Vanua Levu, and Taveuni. *Aedes* indices are quite high throughout the country, especially in urban areas, even in the midst of a relative drought. Breeding was found concentrated in tires and water storage drums. The vector control program in Fiji has had resource and organizational difficulties over the last five years.

These data and observations indicate that Fiji is at high risk for continued dengue transmission, and likely will experience future epidemics of DHF with significant economic cost and mortality if the status quo persists. A renewed mosquito control program is badly needed. Because such an effort will clearly take time, dengue surveillance should be bolstered to provide "early warning" of impending outbreaks and planning to marshal the medical resources that would be needed to cope with a DHF epidemic.

Fiji's dengue situation mirrors that of other Western Pacific nations. Because Fiji has an established virology laboratory, because the political will appears to be present after the recent epidemic, and because the scope of changes needed to control dengue in Fiji, though substantial, appear feasible, it is proposed that a model dengue control program be developed in Fiji. A number of projects are suggested for funding that could strengthen the health system's ability to sustain a dengue control effort. The results of these projects could be applied to control dengue in other areas of the Western Pacific.

Objectives

1. Establish and evaluate a virologic surveillance system to provide early warning of dengue epidemics.

2. Provide epidemiologic and computer training, software and hardware to the MOH to improve management information systems for timely analysis of surveillance data and informed decision making.

3. Provide support for workshops on the diagnosis and management of DHF to medical officers and other health care personnel. Evaluate the effectiveness of this training program.

4. Support the purchase of basic medical equipment such as hematocrit microcentrifuges/readers and pediatric blood pressure cuffs to diagnose and manage DHF cases in primary and secondary care settings.

5. Support the training of Wellcome Virus Laboratory personnel and purchase of necessary equipment and reagents to develop ELISA serology capacity.

6. Support operational research to evaluate the effectiveness of community-based mosquito control programs.

7. Establish a coordinator of the National Dengue Task Force to ensure implementation and follow-up of key aspects of the dengue control program, such as surveillance, medical training, vector control, community programs and emergency planning. Support the coordinator position and the operations requirements of the Task Force.

Medical Issues

A. Development of ELISA Serology Capacity at the Wellcome Virus Laboratory

Although the Virus Laboratory capably performs HI serology, which is a classic gold standard, the ELISA (enzyme linked immunosorbent assay) has replaced the HI in most diagnostic laboratories because of its sensitivity, because the need for goose red blood cells is obviated, and because of the availability of automatic readers. Most importantly for Fiji, IgM antibody capture ELISA testing has been developed for dengue, which permits presumptive diagnosis on a single blood sample with samples collected five days or more after illness onset. Collection of paired sera for serologic diagnosis is often quite difficult because patients who have recovered are often unwilling to return to the hospital. Further, IgG/IgM ratios can be tested to determine whether dengue infections are primary or secondary, an important tool for epidemiologic evaluation of population risk for DHF, a severe and sometimes fatal form of dengue infection. ELISA methodology can be applied to serological tests for a host of other viruses, so the capacity of the laboratory for diagnostic testing would be expanded.

A supervising virologist from the Wellcome Virus Laboratory would be sent to a reference laboratory such as the Centers for Disease Control in Fort Collins, Colorado, or San Juan, Puerto Rico, for six weeks to learn ELISA methodology. ELISA reagents and a reader would be purchased. The supervising virologist would return and train local technicians.

Budget estimate

Travel and per diem	US$	6,000
Estimate Reagents		2,000
Reader		5,000
Microtiter plates		1,000
Possible Source: WHO Fellowship	US$	14,000

References

1. Innis et al. (1989). An ELISA to characterize dengue infections where dengue and Japanese encephalitis co-circulate. **Am J Trop Med Hyg** 40: 418-427.

2. Kuno et al. (1991). An ELISA procedure for the diagnosis of dengue infections. **J Virol Methods** 33: 101-113.

B. Enhancement of Management Information Systems for Disease Surveillance

Current dengue surveillance data in Fiji are entered on software provided by the WHO. The statistics unit staff does not have expertise in programming or epidemiology. The WHO software generates a monthly report that includes cases by division, age, race and sex. More specific information on site of report or crosstabs using two or more variables cannot be done. Further, the data are not always analyzed and disseminated quickly enough to be used for decision making.

Central MOH staff would receive computer and epidemiologic training from a consultant. A microcomputer, printer and additional DBASE and EPI-Info software would be purchased. Local expertise would be developed and local training courses could be developed.

Budget estimate

Travel and per diem for consultant (3 months)	US$	10,000
Micro-computer, printer and software		5,000
Total	US$	15,000

Possible Source: WHO

References

1. Anonymous, WHO Regional Office, Philippines (1991). Consultant Report to Fiji MOH on "epidemiologic support model."

C. Epidemic Dengue Emergency Planning - Medical Aspects

Fiji appears to be at increasing risk for epidemics of DHF with its increasing population, the breakdown of mosquito control efforts, and the easy introduction of new dengue serotypes through air travel. The 1989-1990 dengue epidemic was the most severe Fiji has experienced in terms of mortality (30 deaths). Emergency planning efforts are needed to cope with a massive DHF epidemic like the one that occurred in Cuba in 1981, when one percent of the population was hospitalized. Physicians in Fiji are reasonably well-informed about the diagnosis and management of DHF, but everyone agrees that knowledge and preparedness could be improved. Existing health care facilities were hard pressed to keep up with the volume of patients during the 1989-1990 epidemic, when several hundred patients were hospitalized. A Cuban-type epidemic could lead to thousands of hospitalizations over a three-month period.

Emergency planning efforts require the dedicated time of a physician or health professional. An outline of aspects of an emergency plan and approaches to developing one is presented in the USAID dengue consultant report (VBC Report 81269). Contact and follow up with a variety of agencies is necessary to create a usable and effective plan.

A medical officer would be hired to work with the National Dengue Task Force to coordinate efforts to develop a dengue control program with special emphasis on emergency planning.

Budget estimate

Medical officer (50%)	US $10,000
Meeting expenses	5,000
Materials	2,000
Computer and printer	4,000
Total	US $21,000

References

1. Gubler DJ and Casta-Velez A (1991). A program for the prevention and control of epidemic dengue and DHF in Puerto Rico and the US Virgin Islands. **Bulletin of PAHO** 25:237-247.

2. World Health Organization (1986). DHF: diagnosis, treatment, and control. Geneva, 58 pp.

3. Waterman S (1990). Medical aspects of an emergency plan for containing outbreaks of DHF in Honduras. Vector Biology and Control Project Document AR-141-5.

D. Supplies and Equipment for Medical Management of DHF Cases

Tourniquet tests and hematocrit measurements are essential to effective screening, monitoring and management of DHF patients. The equipment to perform these tests is generally not available in health centers and subdivisional hospitals in Fiji.

Equipment will be purchased to supply each health center and subdivisional hospital with a pediatric blood pressure cuff and each subdivisional hospital with microcentrifuge and hematocrit reader.

Estimated budget

70 pediatric blood pressure cuffs	US $ 7,000
15 microcentrifuges and readers	18,000
Total	US $25,000

Reference

1. WHO (1986). DHF: diagnosis, treatment, and control. Geneva, 58 pp.

E. Training Program for Health Care Personnel on Diagnosis, Treatment and Control of DHF

A half-day workshop would be presented in each Division for medical officers and other health care personnel.

Estimated budget:

Per diem (200 persons)	US $6,000
Materials	2,000
Space rental	500
Total	US $8,500

Reference

1. WHO (1986). DHF: diagnosis, treatment and control. Geneva, 58 pp.

F. Operational Research - Dengue Surveillance

Described in appendix to consultants' report on medical operational research topics.

Research assistants would be hired to work with the National Dengue Task Force Coordinator

Estimated budget

1.5 research assistants	US $10,000

References

1. CDC 1988 MMWR Supplement. Guidelines for evaluating surveillance system. 37: 5-5.

G. Operational Research - Evaluation of impact on Dengue Incidence of Community-based Control Programs

This research project is described in an appendix to the USAID consultants' report on medical operational research topics. Four elementary schools in Suva, Labasa, and Lautoka would be selected and serosurveys conducted on first graders at yearly intervals.

Phlebotomists would be hired to work with the National Dengue Task Force Coordinator.

Estimated budget

Phlebotomists (5 at 40 hours/year)	US $1,000
Per diem	500
Materials and supplies	
Filter paper	
Lancets	
Alcohol	
Forms, pens	1,000
Consultants	
Travel	
Per diem	
Fee	8,000
Serologic Testing	10,000
Total	US $20,500

H. Economic Impact of Dengue in Fiji

The costs and benefits of dengue control efforts have been incompletely studied. Although repeated dengue epidemics with significant morbidity and mortality continue to occur worldwide with undoubtedly high costs, a rigorous analysis of the economic aspects of dengue fever would probably provide impetus to government and donor agency funding of dengue control programs as well as motivating grass-roots control efforts.

Consultants in medical economics and medical epidemiology would be hired to collect pertinent data, analyze the costs and benefits, and report on this analysis.

Estimated budget

2 consultants for two months	
Travel	
Per diem	
Fee	
Miscellaneous costs	US $25,000

Entomological Issues

A. National Workshops on Vector Surveillance

Local authority and MOH personnel require basic training in mosquito collection, identification of species, data recording and analysis, and reporting.

Participants would receive lecture material and do real problem-solving practical exercises in the field. Each participant would take home a basic field kit and reporting forms for follow up.

New concepts of "key premise," "key container" and use of new sampling and biological control techniques would be also covered.

Venues:	Suva, Lautoka and Savusavu
Duration:	1 week
No participants/course:	20
Cost:	Board and lodging Transport Equipment/materials Consultant costs

Proposed personnel/institutions:

Mr. G. Prakash, National Vector Control Unit
Queensland Institute of Medical Research, Brisbane

B. A Pictorial Key and Training Manual for Surveillance and Control of Mosquitoes in Fiji

The last manual, produced in 1947, is out-of-date and generally unavailable. A comprehensive, easy to understand manual that considers dengue, Ross River virus and filariasis is required. Note that *Ae. (Stegomyia)* spp. are implicated in transmission of all three human pathogens. Project costs would include consultancy (part-time over six months) and printing and distribution costs (approx. US $30,000).

C. Education and Training

The joint University of Queensland-Queensland Institute of Medical Research (UQ-QIMR) Tropical Health Program based in Brisbane, Australia, offers short-term specialized training and formal postgraduate courses for Masters in Tropical Health (one year), Masters in Medical Science (research topic, one to two years), Masters in Community Nutrition (one year), Ph.D. (three to four years) and, from 1993, Masters in Public Health degrees.

All aspects relating to tropical health are covered. Approximately 120 staff members involved in this program. Its mandate from the Australian government is to serve the Asia-Pacific region.

For postgraduate training in the areas needed for dengue control — entomology, epidemiology, statistics, the social sciences and health administration — the Tropical Health Program is particularly strong.

Those wishing to pursue research degrees should contact the Research Coordinator, Tropical Health Research Program, QIMR, P.O. Royal Brisbane Hospital, Royal Brisbane Hospital, Brisbane 4029, Australia. For course work degrees, write to The Director, Tropical Health Education Program, University of Queensland Medical School, Herston, Australia 4006. Those doing research degrees will spend the major part of their time working in Fiji on problems relevant to Fiji.

In order to facilitate this link between the University of the South Pacific (USP), Suva, and the Australian tropical health program, formal arrangements between USP and UQ would have to be to be established for joint supervision purposes.

It is suggested that the MOH, through WHO or ADAB Fellowships, strengthen expertise in the following areas:

Entomology (short-term training)
Social Sciences (postgraduate degree, 1-3 years)
Epidemiology (postgraduate degree, 1-3 years)

Viral diagnostics - arrangements can be made but better specialist dengue laboratories are US CDC Division of Vector-borne Infectious Diseases, Fort Collins, Colorado, and San Juan Laboratories, San Juan, Puerto Rico, and at AFRIMS, Bangkok.

Medical - Ramathibodi Hospital, Bangkok. is world-recognized for dengue patient care (short-term training)

Operational Research

A. Niche Partitioning and Competition between *Ae. albopictus* and other Dengue Vectors

Hypotheses

That 1) *Ae. albopictus* will breed in a wide range of breeding sites but particularly tires; 2) it will cause greater displacement in rural areas, particularly in relation to *Ae. pseudoscutellaris*.

Objective

To determine the likely distribution of *Ae. albopictus* as a basis for assessing future control strategies.

Ae. albopictus possibly entered Fiji as early as 1986 but its presence was recognized in October 1988 at Nadi in tree holes (Fauran, pers. commun.). Recent study suggests that it may have entered via imported used car tires that were distributed throughout Fiji for second-hand sale.

Ae. aegypti (the major global vector of dengue), *Ae. polynesiensis* (recognized as a major South Pacific vector of dengue and filaria, *Wuchereria bancrofti*) and *Ae. pseudoscutellaris* (known to transmit dengue) occur widely through Fiji, often sharing the same breeding sites: drums, tires, tree holes, tins, bottles and flowerpot bases. All four species are competent Ross River virus vectors (Kay and Aaskov 1989, Mitchell and Gubler 1987).

Each species is versatile in its response to different environmental conditions. Before control strategies are developed, definitive ecological data on the abundance of immatures, their breeding sites, food partitioning and possible competition between species should be known. In Fiji, which is the only country with four major dengue vectors, the relative abundance of these species is changing.

With the advent of *Ae. albopictus* into the USA in 1985, *Ae. albopictus* has displaced *Ae. aegypti* in cities such as New Orleans. There is evidence to suggest that *Ae. albopictus* is displacing *Ae. pseudoscutellaris* in parts of Suva (Prakash, unpublished).

Localities in both dry (west) and humid (Suva) Viti Levu will be selected for ecological study of immatures and a prognosis developed for future dengue risk.

Proposed personnel

Mr. G. Prakash, National Vector Control Unit
Dr. B. H. Kay, Queensland, Institute of Medical Research, Brisbane
Quantitative ecologist (to be identified)

Duration:	3 years
Cost:	$75,000
Financing Institution:	TBD

References

1. Kay, B H and J G Aaskov (1989). Ross River virus (Epidemic Polyarthritis), pp. 92-112 in Monath, T P editor, Epidemiology of Arthropod-borne Diseases. CRC Press, Baton Rouge, FL, Vol. 4.

2. Mitchell, C J and DJ Gubler (1987). J Am Mosq Control Assoc 3:142-147.

B. The Vector Competence of *Ae.* (*Stegomyia*) Mosquitoes in Fiji

Hypothesis

Aedes aegypti has greater susceptibility to dengue serotypes 1-4 and can transmit them more effectively than *Ae. albopictus*, *Ae. polynesiensis* and *Ae. pseudoscutellaris*.

Objectives

To determine the relative roles that the above species may play in epidemics of Fijian dengue serotypes.

Outline

Ae. pseudoscutellaris from Fiji were shown to be highly susceptible after oral infection to dengue 1 and 2 but of moderate susceptibility to types 3 and 4 (Rosen et al. 1985). However, Maguire et al. (1975) could not infect *Ae. pseudoscutellaris* with a 1971 Fijian dengue 2 isolate. In contrast, *Ae. aegypti* became infected with small amounts of virus and was highly susceptible. Although the Fijian epidemic of 1971 was attributed to *Ae. aegypti* (Maguire et al. 1975), previous outbreaks suggest that *Ae. polynesiensis* and *Ae. pseudoscutellaris* were natural vectors (Maguire et al. 1971). Studies with non-Fijian strains suggest that vector competence varies with serotype and geographic strain, but in general *Ae. albopictus* and *Ae. polynesiensis* are more susceptible than *Ae. aegypti* (Rosen et al. 1985).

These data seem contradictory and do not provide an insight into what may happen in future epidemics in Fiji. Hence, it is planned to orally infect F_1 progeny of wild caught *Stegomyia* spp. from Fiji using membrane feeding, incubate blood-feds for 14 to 21 days at 25-28^0 C, and determine infection rates. Gubler has shown that transmission potential can be determined by head squash (Gubler and Rosen 1976). Virus will be assayed using dengue-specific monoclonal antibody by ELISA or immuno-fluorescence techniques.

Ae. polynesiensis has been shown to be the only species to pass all serotypes of dengue on to its progeny (Freier and Rosen 1987), although

Ae. pseudoscutellaris transmitted two serotypes vertically. In this study, vertical transmission rates for all four species will be determined to examine likely means of viral persistence once a particular serotype is introduced.

Personnel

Dr. J.U. Mataika, Wellcome Virus Research Laboratory, Suva
Dr. B.H. Kay, QIMR, Brisbane
CDC Vector-borne infectious disease staff, Fort Collins or San Juan

Duration: 3 years
Cost: approx. $75,000

References

1. Gubler, Maguire et al. (1971). **J Hyg** (Camb.) 69:287-96.
2. Maguire et al. (1975). **J Hyg** (Camb.) 73:263-70.
3. Rosen et al. (1985). **Am J Trop Med Hyg** 34:603-15.
4. Freier and Rosen (1987) **Am J Trop Med Hyg** 37:640-47.
5. Gubler and Rose (1976). **Am J Trop Med Hyg** 25: 146-150.

C. Host-feeding Patterns and Behavior of Four *Ae.* (*Stegomyia*) Species in Fiji

Hypotheses

1. *Aedes aegypti* feeds more often on human blood than *Ae. albopictus*, *Ae. polynesiensis* and *Ae. pseudoscutellaris*.

2. *Ae. aegypti* engages in more multiple blood feeding during one gonotrophic cycle than either *Ae. albopictus*, *Ae. pseudoscutellaris* or *Ae. polynesiensis*.

Outline

Fiji provides the ideal opportunity to study the relative human feeding patterns of these species in one environmental situation. Thus, comparisons will not be confounded by differing host abundance and availability in different locations.

As the transmission cycle for dengue is between humans and mosquitoes, higher human feeding will lead to greater potential for transmission.

Furthermore, Edman and Scott (unpublished) have shown that in Thailand, *Ae. aegypti* may take three human feeds for each gonotrophic cycle, thus enhancing its transmission potential considerably. Is this the same case for the other *Stegomyia* species, especially in urban situations?

Resting mosquitoes will be collected by vacuum aspirator and black resting boxes from selected urban transects and the blood source determined by precipitin reaction (Boreham 1972). Multiple blood meals even of the same host blood source will be determined histologically (Edman, pers. commun.).

Personnel

Mr. G. Prakash, National Vector Control Unit, Suva
Dr. B.H. Kay, QIMR, Brisbane
Dr. J.D. Edman, University of Massachusetts (Amherst, USA)

Duration:	3 years
Cost:	$75,000
Financial source:	TBD

Reference

1. Boreham, P F L (1972) **PANS** 18:205-209.

D. Upgrading of Quarantine Procedures to Prevent Import and Export of Mosquitoes

Objectives

1. To provide training of quarantine staff.

2. To design and implement methodologies to prevent the entry of *Anopheles* and to minimize risk of export of *Aedes albopictus* to other Pacific islands.

Outline

It is evident that quarantine was not effective when used car tires were imported in numbers into Fiji during the 1980s. Currently, there is confusion as to whose responsibility it is. Agricultural quarantine inspectors seemingly use methods conducive to mosquito escape and hatching from shipping containers. Importers are allowed to distribute tires throughout Fiji (and possibly elsewhere) without methylbromide treatment or retreading.

This confusion probably explains why *Ae. albopictus* has proliferated throughout Fiji. The possible route of entry requires investigation as does the actual distribution of this exotic mosquito to develop procedures that will prevent further import.

Since *Anopheles* and malaria are so prevalent in Melanesia (e.g., perhaps 60 percent of Honiara residents are infected with malaria each year), perhaps Fiji's quarantine methods should be re-examined.

Personnel

Dr. R.C. Russell, Medical Entomology Unit, Westmead, Australia

Duration:	3 months
Cost:	$10,000
Possible Source:	WHO or SPC

E. Location, Identification and Development of Operational Biological Control against *Aedes* in Water Storage Containers in Fiji

Hypothesis

Mesocyclops copepods occur in Fiji and can be used as low-cost, effective control agents in community-based projects.

Objectives

To provide low-cost, persistent control of *Aedes* larvae in drums, tanks and wells.

Outline

Mesocyclops copepods have been found in Australia, Western Samoa (Brown et al. 1991, Kay unpublished) and in French Polynesia (Riviere and Thirel 1981). Hence, it would seem likely that they occur in Fiji.

Freshwater water bodies will be sampled with a 100 mesh net and cyclopoid copepods >0.8 min long will be used to start small cultures in filtered water, algal and protozoan mixtures (Brown et al. 1991).

As with projects in Queensland and Brazil (Brown et al. 1991, Kay et al. in press), indigenous cyclopoids will be evaluated in the laboratory as predators of *Ae.* (*Stegomyia*) newly hatched larvae, put through a cage simulation for likely control efficacy, and released into water storages in pilot trials.

In French Polynesia (Riviere et al. 1987), researchers have used copepods successfully, and Lardeux et al. (in press) have maintained them in land crab burrows for up to four years, where they provided good control. *Mesocyclops*, therefore, are rated highly for *Aedes* control and offer an exciting new technique applicable to Fiji. Larval control will be gauged by comparing sites with and without copepods, whereas similar expected adult reductions will be measured in treated and untreated habitations.

Social scientists will assess perceptions of health, dengue and intra-community relations in habitations of different ethnic backgrounds. From this information, optimal methodologies will be developed to present through women's groups and training will be undertaken. The areas chosen for pilot control studies will be in high-risk areas for dengue. Social science methodologies will then be linked to entomological ones to assess definitively the results in terms of mosquito reduction, container reduction and lack of seroconversion.

Personnel

Ms. Eci Kikau, USP, Suva
Dr. B.H. Kay, QIMR, Brisbane
Dr. M.D. Brown, QIMR, Brisbane
Mr. G. Prakash, National Vector Control Unit

Duration:	3 years
Cost:	$150,000
Source:	ADAB, PSTC

References

Brown et al. (1991) **J Med Ent** 28:618-623.
Kay et al. (in press) **J Med Ent** 29:
Lardeux et al. (in press) **J Med Ent** 29:
Riviere et al. (1987) **J Med Ent** 24:425-430.
Riviere and Thirel (1981) **Entomophaga** 26:427-439.

F. Improved Surveillance for *Aedes* Vectors of Dengue in Fiji

Hypothesis

Alternate cost-effective immature or adult surveillance methodologies can provide more accurate means for decision making in control and prediction of dengue.

Objectives

To translate ongoing Queensland Institute of Medical Research laboratory and field studies into a background of regular dengue epidemics. To verify, field test and then apply these indices in operational programs.

Outline

It has been said by WHO (1983) that "Fiji is sitting on a (dengue) time bomb." The precision of currently used indices (i.e., Breteau, Container and Premise) can be improved by training MOH and local authority staff to upgrade their skills in breeding site detection through net sampling rather than dipper or visual inspection and by increasing the numbers inspected per sample size. These indices, however, still do not allow us to determine mosquito density because they are prevalence indices. For example, one tin with 20 larvae receives the same score as a larger container — tire, drum — with up to 596 larvae.

For immature sampling, a netting method has been developed that facilitates estimation of absolute numbers. Fourth instar larvae can be collected more reliably and accurately than any other stage of *Aedes aegypti* and in drums, samples have a good relationship ($r=0.93$) with actual numbers. It is not known whether the same is true for other dengue vectors in Fiji (*Ae. albopictus*, *Ae. pseudoscutellaris*, *Ae. polynesiensis*). This will be tested by introducing known numbers into drums and applying the netting techniques.

From our studies in Queensland (Tun-Lin et al., unpublished), it is clear that key container types contribute disproportionately to *Aedes* production. The VBC team's preliminary work in Fiji also supports this "key premise concept." For example, 99% of *Aedes* production may occur in 20% of containers (tires and drums) in Fiji.

Furthermore, from our north Queensland studies, we have found the expression $\frac{C_i X_4}{n}$, where

C_i = number of containers of type i,

X_4 = average number of fourth instar larvae in container type i, and

n = number of premises inspected,

gave an excellent correlation with adult numbers collected by power aspirator around premises. It is expected that this index will relate similarly with serological conversion rates and hence risk of disease.

Other studies in the QIMR laboratory (Muir et al. in press 2, 3) relate to the development of a disposable, low-cost lure based on visual and olfactory attractants for *Ae. aegypti*.

Therefore, we plan to compare the efficacy of these new methods by relating them to resting adult abundance and serological conversions. This should result in more cost-effective and precise methods for implementing control and predicting dengue cases.

Personnel

Dr. B.H. Kay, QIMR, Brisbane
Ms. L.E. Muir, QIMR, Brisbane
Dr. W. Tun-Lin, QIMR, Brisbane
Mr. G. Prakash, National Vector Control Unit
Dr. J.U. Mataika, Wellcome Virus Research Laboratory

Duration:	3 years
Cost:	$150,000
Possible Source:	PSTC (USAID) grant (?)

References

1. Tun-Lin, W. et al. (unpublished thesis).
2. Muir, L. et al. (in press) **J. Med. Ent.**
3. Muir, L. et al. (in press) **J. Med. Ent.**

Appendix D

Village Health Worker Training Program Schedule

VILLAGE HEALTH WORKER TRAINING PROGRAMME

1st week

Monday

10:30am - Official Opening and Welcome
Address by Chief Guest
Welcome Address by SDMO

11:30am - Morning Tea

12:30am - Introduction (participants)
Role of Health Worker - H/S

1:00pm - Lunch

2:00pm - Anatomy & Physiology
Bones, muscles, Circulation, Nerves, Senses

Tuesday

9:00am - Review/preview

9:30am - Alimentary System, Respiratory System, Reproductive System

1:00pm - Lunch

2:30pm - Common Skin Diseases

0 - Wednesday

9:00am - Review/Preview

9:30am - First Aid (Drowning; Control of Bleeding; Shock, Wound Care, Dressings)

1:00pm - Lunch

2:00pm - Fractures, Joint Injuries, Burns, Bites, Poisoning, Emergency Treatment

4:00pm - Practical - Bandaging

Thursday

9:00am - Review/Preview

9:30am - Practical - Bandaging

10:00am - Tea

10:30am - Pregnancy, Menstruation, Family Planning

1:00pm - Lunch

2:00pm - Review Morning Lecture

3:00pm - Immunization

Friday

9:00am - Growth Monitoring Chart

10:00am - Tea

10:30am - Breastfeeding

11:00am - Infant Feeding Nutrition in Pregnancy

12:00pm - ORS

1:00pm - Lunch

2:00pm - Review Morning Lecture

3:00pm - Practical - Bandaging

2nd Week

Monday

9:00am - Review/Preview
9:30am - Outpatient
10:45am - Environmental Sanitation, Worm Infestation
1:00pm - Lunch
2:00pm - Review Morning Lecture (poisoning, nutrition, etc.)
4:00pm - General Discussion

Tuesday

9:00am - Review/Preview
9:30am - Demonstration of Weighing and Charting
10:00am - Tea
10:30am - Drugs and Uses - SDMO
11:30am - Practical - OPD
1:00pm - Lunch
2:00pm - Review A.H. Practical Experience (Diarrhoea, ORS Therapy)
3:00pm - Review SDMO's Lecture

Wednesday

9:00am - MCH Clinic
1:00pm - Lunch
2:00pm - Review MCH Clinic Experience
2:30pm - Minor Infant Ailments (Fever, Boils, Rashes, Cradlecap, Basic Guidelines of Cleanliness)

Thursday

9:00pm - Review/Preview
9:30am - Herbal Medicine
10:30am - Tea
10:45am - Nutrition (3 food Groups, Food value, Supplementary feeds)
1:00pm - Lunch
2:00pm - Review A.H. Lecture
4:00pm - Making Posters

Friday

9:00am - Review/Preview
9:30am - Introduction to Health Education

- Continued

10:30am - Introduction to Role Play

10:45am - Review Minor Infant Ailments

11:45am - Malnutrition

1:00pm - Lunch

2:00pm - Review Environmental Sanitation

4:00pm - Making Posters

3rd. Week -

- Monday

9:00am - Group 1 - OPD
Group II - Making Teaching Aids

10:00am - Changing Over

11:00am - Housing Animal, Waste Disposal, Safe clean Environment

1:00pm - Lunch

2:00pm - Diabetes and Hypertension

3:00pm - Practical - Urine Testing

- Tuesday

9:00am - Review/Preview

10:00am - Village Inspection - Vunitogoloa

1:00pm - Lunch

2:00pm - Review Home Visits

3:00pm - Speaker from Blind Society

Wednesday

9:00am - MCH Clinic

1:00pm - Lunch

2:00pm - Family Planning

- Thursday

9:00am - Review/Preview

10:00am - Demonstration by Health Inspector (Smokeless Stove, Tap Drainage)

1:00pm - Lunch

2:00pm - Complete Demonstration

- Friday

9:00am - Review/Preview

10:00am - Health Education (Teaching Methods)

11:00am - Referral of Cases

1:00pm - Lunch

2:00pm - Quiz
Assignment given regarding Environmental Sanitation

3:00pm - Growth Development (Chris Stone Physiotherapist)

4 Week - D

Monday

9:00am - Review/Preview

9:30am - Antenatal Clinic: Minor Disorders of Pregnancy; Nutritional Anaemia; Diet

Assignment: How many Child-bearing Aged Women in your Village?
How many Pregnant Women?
How many attending clinic?

1:00pm - Lunch

2:00pm - Weighing Patients, Taking BP's, etc.; Health Education Session (Teaching Methods)

Tuesday

9:00am - Review/Preview

9:30am - Dental Health Sessions

11:00am - Family Planning, STD's

1:00pm - Lunch

2:00pm - Health Education Session (Teaching Methods)

Wednesday

9:00am - Review/Preview

9:30am - Group I: MCH Clinic
GroupII: Make own Posters

10:00am - Tea

11:00am - Group II : MCH Clinic
Group I : Make own Posters

1:00pm - Lunch

2:00pm - Make own Posters; Evaluation Papers

Thursday

9:00am - Review/Preview

9:30am - Group II: Antenatal Clinic
Group I : Prepare for Teaching Session on Friday

10:00am - Tea

11:00am - Group I : Antenatal Clinic
Group II: Prepare for Teaching Session on Friday

1:00pm - Lunch

2:00pm - Make own Posters

Friday

9:00am - Review/Preview

9:30am - Present Health Education Talks (invite Present Health Workers)

10:00am - Tea

10:30am - Open Discussion with Present Health Workers & Provincial Representatives.

1:00pm - Lunch

2:00pm - Continue Discussion & Discuss Graduation Day

5th Week - 2

Tuesday

9:00am - Practical - Group I : Outpatients (Group II : Demonstration: Practice Bandaging, Temperature taking; Clean Technique, Dressings, Medication used

10:00am - Tea

10:30am - Group Change Over

1:00pm - Lunch

2:00pm - Artificial Respiration & CPR

Wednesday

9:00am - Group II - MCH Clinic
Group I - Demonstration/Practice: Temperature - taking; Pulse; Histories, Case Referrals

10:30am - Continue Morning Session

1:00pm - Lunch

2:00pm - Group I - Making Posters
Group II - As for Morning Group I

3:00pm - Briefing on Role Play; Nutrition Card Game

Thursday

9:00am - Review/Preview

9:30am - Same as Tuesday

10:00am - Tea

1:00pm - Lunch

2:00pm - Practice Artificial Respiration & CPR; Review First Aid

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Friday

9:00am - Health Education

10:00am - Tea

10:30am - Review/Preview Hypertension, Diabetes and Domicillary Care

11:30am - Health Education Talks from Participants

1:00pm - Lunch

2:00pm - Test

3:00pm - Role Play

6th Week

Tuesday

9:00am - Review: Outpatient; Casuality; First Aid; Drugs
10:00am - Tea
10:30am - Review: MCH; Family Planning; Antenatal/Natal
1:00pm - Lunch
2:00pm - Review: Environmental Sanitation; Introduce Group Role Plays

Wednesday

9:00am - Review/Preview
9:30am - Redefine Health Worker's Role; Record-Keeping; Reporting; Communication; Questions-Answers
1:00pm - Lunch
2:00pm - Health Education Session; Curative & Therapeutic Responsibilities of the Health Worker; Drugs & Medications the Health Worker will Keep, Prescribe, and dispense; Work on Role Plays

Thursday

9:00am - Review/Preview
9:30am - MCH Clinic
1:00pm - Lunch
2:00pm - Health Education Session: MCH; National Quiz; Work on Role Plays; Course Evaluation

Friday

9:00am - Present Role Plays

G R A D U A T I O N

!!!!!!!!!!!!!!!!!!!!!!!!!!!CONGRATULATIONS!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!