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TONGA FIELD TRIP TO INVESTIGATE A DENGUE EPIDEMIC
(25 March - 16 April 1974)

by

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BACKGROUND

Tonga is the last remaining Polynesian Kingdom in the South Pacific. It lies a few hundred miles south of Samoa between Fiji and French Polynesia. I did not have the chance to count them but the tourist guide states that the Kingdom of Tonga is made up of 150 islands, which fall into three main groups: Tongatapu in the south, Ha'apai in the center and Vava'u in the north.

The largest island, Tongatapu contains roughly half of the estimated 90,000 population. The capital city, Nuku'alofa, contains approximately half of the people living on Tongatapu, while the other half lives in some 50 small villages.

It is generally considered that there has been no dengue on Tonga since World War II or possibly earlier. It was thus with some surprise that several of the clinicians at the major hospital in Nuku'alofa began to see an unusual number of cases of dengue-like illness in February, 1974. After discussing this matter with the medical officers, Dr. James Hitchcock reported the matter to Dr. Leon Rosen in Hawaii. Dr. Rosen had recently completed testing the sera from the village of Te'ekiu and found that, with rare exceptions, the people under the age of 40 had no antibody to dengue. Dr. Rosen therefore requested some sera samples from some of the cases and 7 specimens were sent during the first week of March. Four of these specimens were positive for dengue antibody while three "acute" specimens were not. Although this did not constitute absolute proof presence of dengue as would have been shown by antibody conversion between acute and convalescent serum specimen or by virus isolation, it was considered strong circumstantial evidence, especially in the light of Dr. Rosen's findings from Te'ekiu.

This information was then passed on to the medical officials in Tonga by Dr. Hitchcock and in turn, I was invited to come to investigate this outbreak.

EPIDEMIC INVESTIGATION

After a 3-day trip from New Caledonia to Tonga, I was met at the airport by Dr. Hitchcock who helped and worked with me throughout my stay. The emphasis of our activities during the first few days were to review the clinical characteristics of the cases, collect blood specimens for serologic studies and virus isolation by Dr. Rosen and to determine the extent of the epidemic, the time sequence involved and geographic distribution of the cases.

We examined hospitalized cases, reviewed hospital admissions and out patient visits from December, 1973 to the present, and reviewed mortality records for all of 1973 and 1974 to date. In order to detect other indirect evidence of an epidemic we also checked the attendance records for the major primary school in Nuku'alofa and two high schools just outside of town.

During the first few days of my visits we also met with the health officials and other people involved in the investigation (see appendix). We also had a general meeting of the Vaiola Hospital physicians and Public Health staff. I discussed the history of dengue in the South Pacific and the clinical problems with special emphasis upon haemorrhagic fever and the warning signs of this aspect of dengue. The clinicians at the meeting described the dengue-like illness they had seen and the time pattern of occurrence. Case visits began in the middle of February and built up to a constant level in March. We requested the aid of all the clinicians in filling out a clinical sheet on all suspect cases that they see especially in the outpatient clinic and paediatric and medical wards.

By the end of the first week we had some tentative impressions of the epidemic. Except in a few small villages, the outbreak was not explosive, but rather a smoldering one - with perhaps five to 10 people a day seeking medical care. About half of the cases were coming from Nuku'alofa, and the rest from about 10 of the eastern villages.

After reviewing the general patterns with the involved staff of the Department of Public Health on this outbreak we agreed that there was a need to develop a surveillance system in order to learn the degree and speed at which the epidemic was spreading. For this we chose two population groups to observe in detail. The first was the people of Longoteme village. The hospital visits indicated that the 500 people of this village were at high risk. We confirmed that the disease was indeed active by visiting the village and seeing over 15 people with dengue-like illness. A town meeting was arranged and Dr. Mapa explained to the people that we would be making a door to door survey for history of dengue-like illness from all household occupants and requesting a blood specimen from a sample of the people visited. Our plan was to re-interview the villagers every two weeks until there were no more cases, and then obtain a final blood specimen in June 1974.

For the second group we chose primary and secondary school children of Nuku'alofa. Using basically the same technique we interviewed them for history of illness and obtained a blood specimen. Follow-up histories every two weeks and a final blood specimen were part of the plan.

While these studies were being carried out, we also continued to check all cases of dengue-like illness and to obtain blood specimens, for virus isolation and serologic confirmation by Dr. Rosen. Over 50 specimens were sent during my stay. We are especially indebted to the laboratory staff for their help with the blood specimen.

During our meeting we also discussed a program of mosquito control. The health inspectors were requested to find out what equipment and insecticides were available. We also planned a health education campaign which would be put into action as soon as we had laboratory confirmation of the disease.

Dr. Duane Gubler arrived April 11, to begin special studies on vector competence, and on the time duration of viremia. The basic idea of the vector competence studies was to compare the main dengue vector Aedes aegypti with another Aedes (scutellaris complex) to determine if it could be a vector also.

The studies of viremia consisted of serial bleeding of cases of dengue-like illness to determine the length of time after onset a patient has circulating virus, and number of virus per unit of blood.

In order to accomplish these Dr. Hitchcock started a colony of Aedes aegypti and other mosquitoes were caught daily.

The blood specimens from the Longoteme, the school children, the cases and the special studies were to be hand carried to Hawaii by Dr. Gubler. The results of all of these analyses will be available in the near future.

RESULTS

Clinical Observations

During my stay in Tonga, I examined over 45 patients with dengue-like illness in the hospital and 25 others in their homes. In general, the disease was mild for most cases. Of the 45 hospitalised cases, all had a temperature, 80% complained of headache (usually frontal), 64% had general body or muscle pain, 33% had bone or joint pain, 33% complained of eye pain, and 24% had low back pain.

A measles-like rash was seen for only 13% of these cases, while petechiae were seen in 7%. Gastro-intestinal tract symptoms were reported by 11%, URI symptoms by 4%. Epistaxis was reported for 11% of these patients. There was, with one possible exception no other haemorrhagic signs or symptoms.

The one possible exception was the occurrence of G-I bleeding in a 64 year old male who had a sudden onset of fever, backache, general body pain. Five days after onset, he was admitted with bloody stools. He had a high white count (32000 WBC) and low haemoglobin (8.2 gr). He received fluids and 6 units of blood but 3 days after admission he developed signs of shock and died. His sera specimen taken 5 days after onset was positive for dengue antibodies. (N.B. After my return to New Caledonia, Dr. Gubler discovered a 15 year old patient with dengue-like symptoms and gastric bleeding.)

The patients seen in their homes were much like those described above. Fever, headache, muscle and joint pains were the common symptoms. Only a few had rash and two gave a history of epistaxis.

Several non-Tongan cases were also seen, including four Caucasians and two Orientals. These cases all gave a history of classical dengue and all had a rash.

The Time Pattern

In order to confirm the initial impression of the time pattern of this epidemic we sought data from both direct and indirect sources. An examination of all hospital admission by month from January 1973 to the end of March 1974 revealed no clear cut pattern of change indicative of an epidemic during this time period. There was a slight increase in the number of admissions from January to March 1974 but a similar peak was seen for the same months of 1973. Review of the mortality records during the same time period, January 1973 through March 1974 similarly revealed no unusual pattern. There were no deaths similar to dengue haemorrhagic fever or shock.

We visited one primary school with an average daily enrolment of over 1700 children and two secondary schools, one with over 800 male students and the other with over 300 female students. There was no unusual pattern of absenteeism throughout the 1973 school period for any of these three schools. The 1974 school year began the first week in February. The average daily absenteeism in the primary school was 5% until the 3rd week of February, when it climbed to a range of 12 to 20% for a two-week period and from a range of 8 to 10% during the rest of March.

The secondary schools showed a level of absenteeism of about 5% in February and 10% in March.

Several more direct sources of information indicated the pattern shown in Table I. A review of the outpatient clinic log books from November 1973 to the middle of April 1974 for dengue-like illness symptoms revealed a few cases in late January and then a gradual increase to a peak number in late March. Hospital admission for dengue-like illness showed the same pattern.

During our survey of Longoteme village, and a secondary boys school we obtained information about the date of onset of dengue-like illness. The information from Longoteme indicated that there were a few cases a week from late December 1973 to the last week of February and then an increased number of cases through March. There were too few cases among the school boys to detect any pattern. The general picture from all these sources of data indicated that this epidemic began in December 1973 or January 1974 and gradually built up through March. By the time I left in mid-April it appeared that the number of new cases was dropping, however, we will have to continue surveillance and complete the serologic studies to determine if this is true.

The only evidence that cases were occurring earlier than December 1973 comes from serologic studies completed by Dr. Leon Rosen. Samples of sera were taken in the village of Te'ekiu in August 1973 by Dr. Hitchcock. When these were tested for dengue antibodies, the general pattern was that people over the age of 40 had antibodies against dengue type 1, while younger persons did not. This indicated that the last exposure to dengue in this village occurred in the middle 1930's. There were, however, two people in their late twenties who had antibodies against dengue type 2. As these two people had never left Tonga, this finding suggests that dengue may have been active in Tonga before August 1973.

During the 1971-1972 period dengue type 2 epidemics were occurring throughout the Pacific. Clinical dengue was reported in Tonga in April 1971 but 11 pairs of sera tested by Dr. J. Miles's laboratory showed antibody rises for influenza B, but not for dengue.

It is still quite possible that a few cases did occur during the 1971-72 period. If so, this brings up the question of why there was no epidemic at that time, considering the presence of the major vector, and a susceptible population. I have written to Dr. Ian Prior to see if he has available sera specimens from his survey of 1973. Dengue serologic studies of these may clarify some of these questions.

The Geographic Pattern

The place of residence of the patients with dengue-like illness, admitted to the hospital or seen in the outpatient clinic were tabulated for February and March. It was immediately obvious that over half of the patients were coming from the different districts of Nuku'alofa. The great majority of the remaining cases were from villages on the eastern half of the island. Fua'motu, a large village near the airport, Tatakamotonga, Longoteme and several villages in Vaini district were the most common places. Visits to six of these east coast villages verified the impression that the disease was quite active in these areas.

On the other hand visits to several of the larger villages in the western half of the island revealed no indication of dengue-like illness. Interviews with the public health nurses who visited all of the western villages uncovered only one area with cases by early April.

We also tried to determine if the outbreak was occurring on other islands of Tonga besides Tongatapu. Cabled requests to medical officers in the Ha'apai and Vava'u groups in mid-March uncovered no cases. However, by early April we did have some indications of dengue-like illness elsewhere. These included a report from the medical offices of Eua of a number of cases of dengue-like illness, and a request for supplies to take acute blood specimens from the medical officers of Ha'apai. In addition, we had laboratory confirmation of dengue in a peace corp volunteer who arrived in Tonga from the U.S. on November 29, 1973. He stayed on Tongatapu until January 3 when he left for Pangai in the Ha'apai group. On February 1, 1974 he developed classical clinical dengue. As the incubation period seldom goes beyond 14 days, it is most likely that he contracted his disease in Ha'apai.

Vector Prevalence Investigations

Dr. James Hitchcock has surveyed the houses of cases in several villages, and has made a complete survey of Longoteme and several schools. Both adult and larval forms of Aedes aegypti were found in these areas. The density of these mosquitoes did not appear great but detailed reports will be available later.

Special Investigations - Epidemiology

As it was difficult to determine how many people had been infected, and how quickly the epidemic was spreading, we decided to develop two study groups to attempt to answer these questions.

These included the village of Longoteme, and a sample of primary and secondary school children in the Nuku'alofa area.

In Longoteme we conducted a house to house census and survey of dengue-like illness during the past 6 months and obtained blood specimens from 164 persons on the sample basis of every available adult and one third of the available persons under age 20. The people were reluctant to bring in small children under age 4 or 5.

Table 2 shows the population we interviewed and the percentage of those who gave a history of either dengue-like illness or, for children, just fever, by age and sex. Of the 412 persons contacted, 26% of the males and 20% of the females had a history of dengue-like illness, mostly within two months of the survey (see Table I). The highest rates, especially if fever alone was included, appeared in the 5 through 19 year old age groups. While these reports are indicative of the incidence, we must wait until the blood samples have been tested to know the true rates.

Once this base-line information was established, we arranged for a member of the Department of Public Health to revisit the village approximately every two weeks to determine the number of new attacks. Finally, after about 3 months we will rebleed the individuals who were negative on the first sample, to determine the conversion. By analysis of the clinical and laboratory data we will be able to determine the rate and degree of spread of dengue in this village.

In order to obtain the same kind of information for the major population center we set up the same kind of study including 100 primary school children aged 9-12, and 75 secondary school children aged 15-19. By history, 8% of the primary children and 13% of the secondary children had developed dengue-like illness or fever during the six months period prior to our survey. The same kind of follow-up as described above for Longoteme was developed for the school children.

Vector Control Measures

As vector control measures are the only presently known method of interrupting a dengue epidemic we placed a great deal of our emphasis on this aspect of the investigation. During the first phase of this investigation we met with several members of Dr. Mapa's staff including experts in health education, environmental sanitation and entomology.

It was decided that once the causative agent was confirmed, the Public Health Department would begin a major campaign along the following lines:-

1. Begin active public health education campaigns over radio and throughout the villages using nurses, inspectors and other public health personnel.
 - (a) Stimulate each household to take the responsibility to clean up their own house to reduce the number of Aedes aegypti breeding sites. Put special emphasis upon emptying cans, water barrels, sea shells and other small water containers near the house;
 - (b) Put oil or kerosene on standing water not used for drinking;
 - (c) Use individual sprays when available to kill mosquitoes inside the house.
2. Begin active public health sanitation campaigns to survey for breeding sites and stimulate individual responsibility and control. Special attention should be paid to schools and institutions where large numbers of people live.
3. Conduct mosquito surveys especially in Nuku'alofa and in large villages to determine the effectiveness of this campaign. (Dr. Hitchcock volunteered to teach needed techniques.)
4. As this epidemic may smolder for many months or may start again next year, the department of public health should purchase a ULV (ultra low volume) back pack spray unit for malathion type of insecticide and also have a stock of abate larvicide granules on hand.

In addition, we explored the possibilities of the use of larvicide and insecticides, especially in villages where the outbreak is active. We learned that the only equipment available for this type of control was in the Agriculture Department and this equipment was primarily meant for use with agricultural pests. No Abate or other larvicide was available on Tonga, but Dr. Hirshman, WHO Representative, Suva, kindly provided us with a supply to use in a pilot study.

The study was designed along the following lines. The Public Health Department would be on the alert for the development of cases in two villages which had not had cases earlier. As soon as 5 or more cases occurred then a combination control program would begin, including health education, breeding site destruction, fogging with Malathion, and Abate larvicide use in large water containers (1 part per million). Dr. Hitchcock agreed to conduct before and after surveys of mosquito vectors and the staff of the Public Health Department would follow the development of clinical cases. Control villages would be those where just the health education and sanitation activities were done. This study could only be done if the proper circumstances presented themselves. Because the cooler, drier season was beginning the epidemic might end without affecting new villages.

Conclusions and Recommendations

At this point in time it appears that this outbreak of dengue began reaching a noticeable level early in February, 1974. Clinical cases probably occurred in late December 1973. There is a possibility that rare cases were occurring earlier. The epidemic never became explosive but rather built up to a low plateau in early March and continued or possibly decreased in intensity through the middle of April. A few of the small villages on the eastern half of the island have had more intensive outbreaks.

Aedes aegypti has been found in all areas where they have been looked for, especially in areas where clinical cases have occurred.

The majority of cases to date have been mild. The few cases, with epistaxis and two possible cases with gastric haemorrhage underline the danger of haemorrhagic disease and the need to maintain a careful watch.

The main recommendations are those regarding vector control listed above. In addition we requested that the staff of the Department of Public Health continue the follow-up surveillance in Longoteme and the school children. As we have pre-epidemic blood specimens from Te'ekiu, this village should be watched closely and if disease begins to occur it should be surveyed routinely like Longoteme.

Aedes aegypti prevalence surveys should be continued to determine the effect of the control campaign, especially in Nuku'alofa and any village which has a sudden increase in cases.

Acknowledgements

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Dr. James Hitchcock, WHO Entomologist, helped in every phase of this investigation. It would have been a much more difficult task without his knowledge, humor and Tacos. Dr. Leon Rosen was in frequent contact with us from Hawaii via the Peacesat satellite, providing consultation and encouragement. He and his staff conducted the serologic and virologic analyses.

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TABLE I

NUMBER OF REPORTED CASES OF DENGUE-LIKE ILLNESS BY SOURCE AND TIME PERIOD

	Number of Cases of Dengue-like Illness in Longoteme	OPC Visits For Dengue-like Illness	Hospital Admissions For Dengue-like Illness	Number of Cases of Dengue-like Illness in 175 School Children
December 17 - 23	0	0	0	0
December 24 - 30	0	0	0	0
December 30 - January 6	1	0	0	1
January 7 - 13	3	0	0	0
January 14 - 20	4	0	0	1
January 21 - 27	4	2	0	0
January 28 - February 3	2	3	1	1
February 4 - 10	1	4	1	3
February 11 - 17	2	6	2	2
February 18 - 24	4	8	1	1
February 25 - March 3	4	14	2	2
March 4 - 10	11	20	3	4
March 11 - 17	17	26	7	5
March 18 - 24	29	39	13	1
March 25 - 31	31	42	13	1
April 1 - 7	Week of Survey	29	6	2
April 8 - 14		24	4	Week of Survey

TABLE 2

NUMBER OF PERSONS SURVEYED AND PERCENT WITH A
HISTORY OF DENGUE-LIKE ILLNESS, OR FEVER BY AGE AND SEX

M A L E S

F E M A L E S

AGE GROUPS	NUMBER SURVEYED	PERCENT ILL		NUMBER SURVEYED	PERCENT ILL	
		FEVER ONLY	DENGUE SYMPTOMS		FEVER ONLY	DENGUE SYMPTOMS
0 - 4	39	21	13	38	18	8
5 - 9	48	10	29	31	10	32
10 - 14	36	6	44	32	6	22
15 - 19	20	5	30	18		22
20 - 29	17		24	27		15
30 - 39	19		5	31		16
40 - 44	12		33	17		29
50 - 59	10		20	6		17
60 +	7		29	4		25
TOTAL	208	8	26	204	6	20