Dengue in the Pacific – an update of the current situation

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Abstract

Dengue continues to be a threat to Pacific Island countries and territories (PICTs). The last DEN-1 epidemic reached 16 PICTs and in some of them it affected as much as 20 per cent of the population, aside from the massive impact on their fragile economies. Dengue is mostly introduced into PICTs from global travel, and many experts believe that it has a 3–4 year cyclical pattern of occurrence. All four virus serotypes (DEN-1, 2, 3 and 4) have caused epidemics, but those caused by DEN-1 and 2 have been somewhat larger. In light of this, dengue rightly remains a priority for the Pacific Public Health Surveillance Network (PPHSN).

The paper updates the situation regarding dengue outbreaks in PICTs over the last four decades, describes the pattern of presentations in the recent past, and provides an update on the potential risk to PICTs for the near future. It follows on from an earlier dengue update written in 1998.[1]

The utility of PPHSN services is also demonstrated in the paper: PacNet for alerts and communication about dengue outbreaks (raising awareness and preparedness levels in the region) and LabNet for investigations relating to dengue. Creative interventions towards dengue control and prevention are being tried in PICTs and early assessment and evaluations of their effectiveness in the field are being examined. ***(PHD, 2005 Vol 12 No 2 Pages 111 - 119)***

Introduction

Dengue is a major public health problem in Pacific Island countries and territories (PICTs). Its impact is only too clearly known by countries that have experienced serious outbreaks or epidemics in the recent past. Reportedly, in the last three decades there have been more than 50 outbreaks of dengue in the 22 PICTs. Expressed another way, the Pacific has experienced six major region-wide outbreaks since the 1970s. It is important to note that all four types of dengue virus (1, 2, 3 and 4) have featured, but some have caused bigger epidemics than others (see Table 1). In most cases one major serotype was isolated as the cause of each region-wide epidemic.

Dengue outbreaks not only have a devastating effect on the health status of small Pacific Island countries, but significantly affect their economies as well.[2] To date there is no standard or specific treatment for dengue, nor any vaccines against the four virus serotypes. Infection with one type provides immunity only to that virus; there appears to be no cross-immunity.[3,2] In PICTs, this means that significantly large numbers of people remain at risk of infection by one or more of the four serotypes, especially in the younger population (those born after the last epidemic of a given serotype), but also in the whole population (those not previously affected by a given serotype). In many places, these susceptible populations are large enough to sustain an outbreak of dengue once the proper serotype is introduced.

Therefore, as PICTs have large at-risk populations, creative prevention approaches remain the best strategy for control of dengue in the region. The risk is crudely described in this paper. In general, the risk is higher in areas where vector and population densities are high, and where infected individuals come in through global travel.

Background

For at least two decades prior to the 1970s, dengue appeared to be nearly absent from the Pacific. In the 1970s it made a major return, and since then PICTs have experienced outbreaks of varying magnitude. Dengue has presented in all spectrums, as undifferentiated fever and classic dengue fever, and less frequently as dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS).[3] High levels of morbidity have been experienced by some PICTs. Even with limited documentation, it is known that some outbreaks have affected as much as 20 per cent of a country's population.[2] It is believed that outbreaks have been lasting longer and are cyclical in pattern. In addition, there have been other communicable diseases concomitantly circulating with the dengue virus during some of the epidemics, thus blurring the disease picture. Often this has only been realised in retrospect. The mortality from dengue during outbreaks has been generally low, except in some places where high mortality has been reported amongst children.[4] In general, incidences of DHF and DSS have been low and very much unlike the experience of Asian and South American countries.[3]

Dengue is not endemic to PICTs, but epidemics have occurred frequently in the last few decades (see Table 1) and the viruses were introduced from outside the region.[4,5] All four types of dengue virus have caused outbreaks at different points in time (see Table 1). Of note is the fact that DEN-1 and DEN-2 have caused the largest number of epidemics, including most of the bigger ones.

PICTs present desirable conditions for dengue outbreaks in that the following requirements often exist:

a) risk of introduction of the virus (any of the four types) by infected travellers;
b) high levels of appropriate vectors (*Aedes (Stegomyia) aegypti, Ae. albopictus, Ae. polynesiensis*), given appropriate environmental conditions for vector breeding;
c) a large group of susceptible people; and
d) facilitatory conditions for contact between infected persons and vectors, and between infected mosquitoes and susceptible individuals.

Dengue outbreaks are further facilitated by the lack of effective prevention activities in many PICTs. Inadequate diagnosis, aggravated by limited case and vector surveillance, presents major barriers to effective prevention of or response to outbreaks. In addition, many PICTs lack the capacity to respond to dengue outbreaks due to insufficient trained personnel and resources to implement control and prevention plans.[2] In a number of countries where interventions have been made, their effectiveness and timeliness have hardly been evaluated.

Dengue epidemics in general are difficult to predict.[3] Some Pacific public health practitioners and WHO suggest that the pattern may be cyclical, occurring approximately every 3–6 years.[2] Available data (see Table 1) do not appear to strictly fit the suggested pattern, but in general there is some concurrence with the observation.

Dengue epidemics past to present

Before the 1950s, dengue in the Pacific was reported in American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. Between 1950 and 1970 only two outbreaks were reported, both in French Polynesia, in 1964 and 1969.[6,7,8] Since the elimination of Ae. aegypti on Guam in 1944, there have been no reported outbreaks there.[4,5,9]

As has been noted, dengue activity in PICTs markedly increased in the 1970s, with occurrences of DHF and DSS being observed in some outbreaks. In the first 3–4 years of the 1970s most outbreaks were due to the DEN-2 virus (see Table 1). In 1974–1976 DEN-1 took over as the main virus responsible, causing reported outbreaks in all PICTs except the Federated States of Micronesia, Commonwealth of the Northern Mariana Islands, Guam, Niue, Palau, Solomon Islands and Tokelau.

At the end of the 1970s and the beginning of the 1980s most outbreaks were due to the DEN-4 virus. For a significant number of outbreaks during the 1980s the virus was not identified. However, it appears from the available data that in the late 1980s and early 1990s the predominant cause of outbreaks was the DEN-3 virus. In the same period a few outbreaks were caused by DEN-1 and DEN-2. In 1995–96, DEN-3 and DEN-4 were reported in the region in a few PICTs. In the second half of the 1990s the predominant cause of dengue outbreaks was the DEN-2 virus.

From 2000 to 2004 the predominant virus responsible for outbreaks was DEN-1, which affected at least 16 PICTs. DEN-1 viruses started to circulate in the region in Palau in 2000. At the beginning of 2001, a large and well-monitored epidemic blew up in French Polynesia, where an estimated 33,800 inhabitants were affected. More than 1300 people were hospitalised, including 633 severe cases of which 278 were diagnosed with DSS. Eight deaths from dengue were reported, all of children.

Fiji experienced a DEN-1 epidemic that started in 2001 and continued until 2004. Unfortunately no detailed data are available on the beginning or ending of this epidemic, the numbers affected or the number of deaths. New Caledonia experienced a similar outbreak of DEN-1 that began in 2002 with 105 reported cases, continued in 2003 and terminated in 2004 with 5673 and 2317 reported cases in the respective years, and at least 17 deaths.

Palau experienced an outbreak of DEN-1 during the 2004 Festival of Arts that affected 37 individuals.[10] Participants from PICTs had gathered for this regional celebration in Koror, Palau, when the outbreak happened. Fortunately Palau health authorities had been proactive and vigilant and had demonstrated good surveillance for possible

Table 1: Dengue outbreaks by country/territory, serotype and year, 1971-2005

COUNTRY	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
American Samoa		DEN-2			DEN-1 239														
Cook Islands						DEN-1 >2000	249			DEN-4 357									
FSM-Yap																		DEN-2	
FSM-Pohnpei																			
FSM- Kosrae																			
FSM-Chuuk																			
Fiji Islands		DEN-2 3400			DEN-1 16203				DEN-? 6914	DEN-4 127	DEN-1 18	DEN-2? 819		DEN-? 190	DEN-? 31	DEN-? 269		DEN-? 22	DEN-1(&3) 3600
French Polynesia	DEN-2 >40000				DEN-1 (&2) >1000		427	346	DEN-4 >7000		DEN-4 673	DEN-4 247	DEN-4 1546	DEN-4 453	DEN-4 142	DEN-4 229	DEN-4 232	DEN-4&1 133	DEN-1&3 8754
Guam																			
Kiribati	DEN-2			DEN-1					49	DEN-4 915		11						DEN-1 25	62
Marshall Islands				DEN-1															DEN-?
Nauru		DEN-2 3000		DEN-1 3500						DEN-4 538									
New Caledonia	DEN-2 40,000					DEN-1 282	260	56	DEN-4 11000							DEN-1, 85	-2, -3 10	& -4 134	DEN-3 (&1)* 2506
Niue		DEN-2 790								DEN-4(?) 749	DEN-? 88				47	DEN-3 269			DEN-2
Northern Marianas																			
Palau																		DEN-2 1254	
Papua New Guinea		DEN-2 >1119				DEN-? 564							DEN-?						217
Samoa		DEN-2			DEN-1 >1000		15	18	DEN-4 1035		19	25							DEN-? >336
Solomon Islands												DEN-?							
Tokelau				108				18											DEN-? 141
Tonga	DEN-2 ?			DEN-2 15000	DEN-1 772					DEN-4 (& ?) 3984		259	575	180	11			12	15
Tuvalu	DEN-2			DEN-1						DEN-4 15									DEN-3 58
Vanuatu		DEN-2			DEN-1 400		17		DEN-? 31	DEN-4 16									DEN-1 5606
Wallis & Futuna	DEN-2 790					DEN-1 520			DEN-4 270	21									DEN-3 2361

* : approx. 1% of all cases where DEN-1

Notes :

This table is an update of a previous similar table published in the PHD (ref. 1). The outbreaks are the ones reported through various channels, from various sources. The table does not include those that were missed or not reported.

As well, by default, if no more precise reports were available, SPEHIS data were used (arbitrarily, only >10 annual cases are reported). The information is not complete and reflects what was available to the authors.

The aim of the figures-if available-is to give an idea of the magnitude of dengue occurrence-and outbreaks-rather than precise and standardised data.

Details of outbreaks in 2004: decrease of DEN-1 activity in the Pacific Island region

Fiji - DEN-1 Jan to Mar 2004, no detailed data available

New Caledonia - DEN-1, continuation of 2003 outbreak, with 2317 cases (5673 cases reported in 2003)

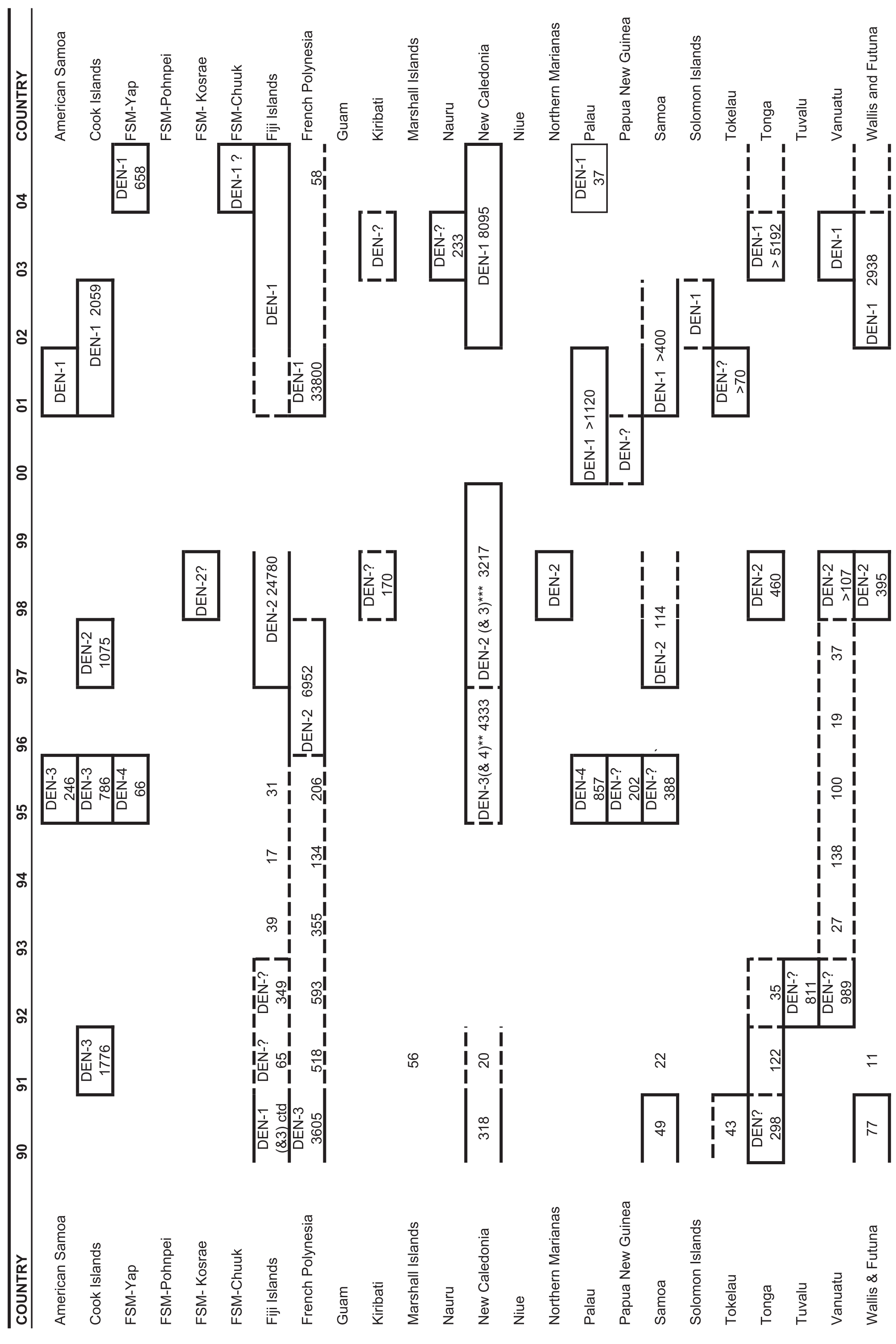
Palau - small DEN-1outbreak, with 37 cases during Pacific Festival of Arts

Yap - DEN-1, 658 cases, started 31 May and ended 29 Dec, with no deaths

Chuuk - DEN-1 outbreak believed to be source of Yap outbreak (not confirmed)

French Polynesia - 58 cases, DEN-1further circulation confirmed by serology, viral isolation and PCR

Wallis & Futuna - small-scale DEN-1 activities in Jan/Feb 2004 (2938 cases with 338 hospitalisations and 2 deaths, reported, with main outbreak from Oct 2002 until Oct 2003)



** < 0.5 % of all cases where DEN-4

*** < 1 % of all cases where DEN-3

infectious diseases and other events during the period. Thus, they recognised the outbreak of dengue fever very early. Their surveillance activities further demonstrated how "dengue surveillance [can] be done in Pacific Island nations",[11] not only during outbreaks but at other times as well. Their prompt public health communications on PacNet demonstrated what PICTs could do to assist each other in dengue or other outbreak-prone disease emergencies. In addition, the health authorities' overall response to the outbreak prevented its escalation and spread to other PICTs. Early communication and alert allowed PICTs to be vigilant and to prepare for the arrival of possibly dengue-infected festival participants, the possible source of a local epidemic.

In the Palau outbreak, participants from Yap were implicated as the source or importer of the virus. Yap experienced a DEN-1 outbreak in 2004 that affected 658 cases from 31 May to 29 December of that year.[12] It is believed that the index or primary case was from the state of Chuuk.

Wallis and Futuna experienced an outbreak of DEN-1 in 2002 and 2003 that affected 2938 people, with 338 hospitalisations and two deaths. That epidemic ended in early 2004.[13]

Vectors of dengue

Table 2: Number of countries experiencing dengue outbreaks by duration and type of virus

Virus type	Period and number of PICTs affected
DEN-1	1974–78 (13 PICTs), 1988–89 (5), 2000–05 (at least 16)
DEN-2	1971–75 (at least 13), 1988–89 (3), 1996–2000 (at least 11)
DEN-3	1989–91 (5), 1986 (1), 1991–95 (4)
DEN-4	1979–80 (at least 11), 1995 (3)

The traditional vector for dengue is *Aedes* (*Stegomyia*) *aegypt*i, a container-breeding mosquito that thrives in environments within and near human dwellings. This makes it the most efficient vector globally.[14] In PICTs it is the main vector for dengue, but other Aedes species have also been implicated as responsible. In the 2002–2003 outbreak in Wallis and Futuna, *Ae. polynesiensis* – which breeds in crab holes and tree trunks – was the implicated vector. In an outbreak in Yap, *Ae. hensilli* was implicated.[15,16] These findings underline the importance of determining the vector and its bionomics to allow successful interventions.

Fiji is perhaps the only country in the world where up to six species of mosquitoes can transmit dengue viruses. These include *Ae. aegypti* as the primary vector and *Ae. albopictus, Ae. polynesiensis, Ae. pseudoscutellaris, Ae. horrescens* and *Ae. rotumae* as secondary vectors.[17,14,18]

Vector bionomics must be studied for effective intervention strategies. *Ae. aegypti* was eliminated from the island of Guam in 1944, which perhaps explains why Guam has not experienced an outbreak of dengue since then despite being a hub for visitors from Asian countries. Unfortunately, due to trade (especially importation of used tyres and large containers), the Asian tiger mosquito, *Ae. albopictus*, has been introduced to Guam and many other PICTs.[18] Despite being generally considered an inefficient vector for the disease, this species has the potential to cause outbreaks and was suspected of playing a role in the outbreak in Fiji in the late 1990s.[17]

Where does the dengue virus come from?

It is well known that travellers are the key to the spread of dengue viruses in the Pacific. Infected travellers infect mosquitoes (vectors) globally, including in PICTs. Some formal evidence of this exists, but on most occasions it has not been studied in the Pacific. Suffice to say that through molecular biology and phylogenetic analysis of the viruses it is possible to indicate the path or spread of an epidemic.[18,19,20] DEN-2 viral strains in Tahiti, Cook Islands, New Caledonia and Samoa epidemics in the early second half of the 1990s showed great similarities with each other and also with the DEN-2 virus responsible for the 1992–93 epidemics in northern Queensland (Australia). The genetic analysis of viruses has shown that the most recent DEN-1 epidemic in PICTs was due to the introduction of multiple DEN-1 viruses from various origins.[21]

Who is at risk?

This is a hard question to answer precisely, but we can identify certain risk factors and grade the risks of PICT residents suffering an outbreak. PICTs are vulnerable to import of dengue viruses through trade and travel routes – especially from Southeast Asia, where global dengue activity is known to be the highest, and from the Americas and Caribbean islands.[20] The frequency of travel to and from Asia (where the dengue virus is endemic) has increased phenomenally in the last few decades, and with it the risk of dengue importation. Certain ports of entry in PICTs are at greatly increased risk, especially those receiving travellers from Asia, South America or northern Australia. In addition, inadequate vector surveillance at ports and other sites, the abundance of breeding sites on islands, the abundance of appropriate types of vectors, ideal climatic conditions for vector breeding and large susceptible populations certainly add to the risk of dengue outbreak. One way or another all PICTs are exposed to the potential risk of dengue.[2] In most PICTs, the risk is highest for DEN-3 and DEN-

4 transmission as there has been no real outbreak of DEN-3 since at least 1997 or of DEN-4 since at least 1995, or even earlier in many PICTs.

Cost of dengue in PICTs

Aside from the health consequences of explosive outbreaks of dengue, there is a substantial, even devastating impact on PICT economies. The cost of medical care and other direct and indirect costs have often not been quantified or estimated. A 1995 study of the social and economic cost of dengue (including DHF) in Thailand (which has a population of approximately 61 million) put the annual figure at US$31.5–51.5 million; however, this did not include economic losses due to decreased tourism and social disruption.[3]

Data on the costs of dengue epidemics in PICTs have only recently started underlining the importance of vigorously addressing the disease. For example, the 2002 dengue epidemic in Cook Islands (which has a population of 18,000, including tourists) cost the government NZ$1,156,177 directly and the broader economy NZ$3.39–4.52 million indirectly.[2] The 1998 epidemic in Fiji affected approximately 25,000 people and cost approximately FJ$12 million.[14] This cost would have been even higher had the indirect costs been accounted for in the total.

Dengue prevention in the Pacific

It has long been accepted that the geopolitical setting of the Pacific can make a coordinated response difficult. In 1974, 1975 and 1978 WHO's Southeast Asia and Western Pacific Region Technical Advisory Committee on DHF suggested stockpiling insecticides and sprayers to control *Aedes* mosquitoes during outbreaks. The understanding was that the Pacific region would have ready access to emergency supplies of insecticides and ultra-low-volume spray equipment in the event of an outbreak. This was because some countries had identified a lack of these supplies and equipment as the main reason for their failure to put control measures into effect.

From 1980 to 1984 WHO tried to strengthen response to epidemics of arboviral diseases (dengue, Ross River fever) by improving case and vector surveillance, training health staff in early diagnosis and treatment and in prevention and control, and making stocks of spraying equipment and insecticides immediately available.[2] In 1984 an assessment of this approach suggested that a strategy of community participation and the use of larvicides should be the focus of vector control, and WHO's emergency assistance to dengue outbreaks diminished.

In 1996, an Outbreak Response Taskforce (ORTF) was established in the UN's Western Pacific Regional Office (WPRO) in response to increasing outbreaks. The increase in outbreaks was due to new, emerging and re-emerging communicable diseases, including dengue. The taskforce was involved in surveillance, emergency preparedness, training and research. To ensure rapid mobilisation of supplies and equipment during an emergency, stockpiles were established in Cambodia and Fiji in 1996 for vector-borne diseases.

The observations regarding dengue outbreaks and other epidemic diseases in the South Pacific led to SPC and WHO spearheading the formation in 1996 of the Pacific Public Health Surveillance Network (PPHSN). PPHSN's primary role was seen as strengthening surveillance, prevention and control work in the region as a matter of priority.

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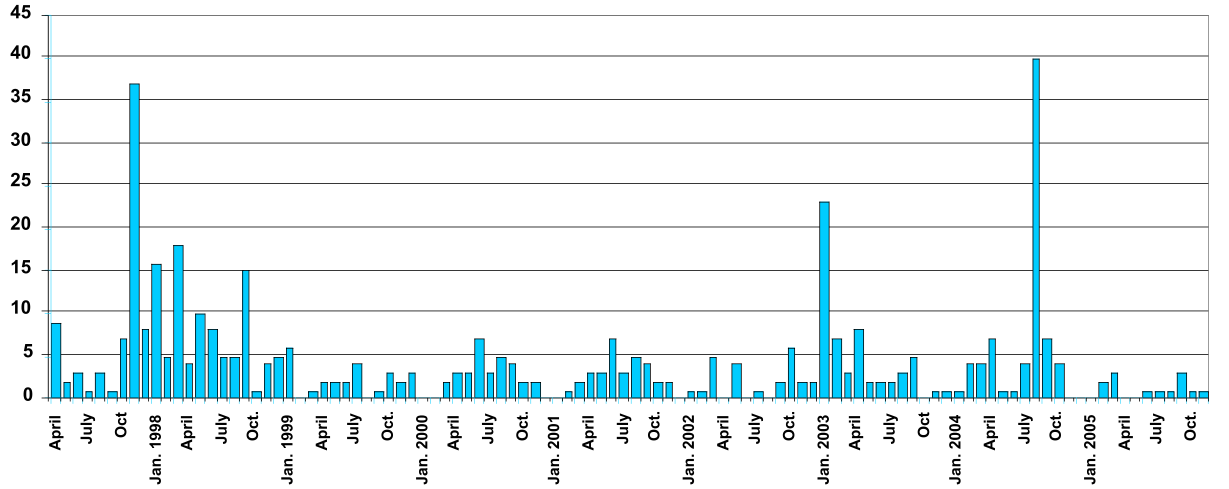
PPHSN and the dengue situation in PICTs

It appears that PPHSN has been effective in improving surveillance of priority diseases in PICTs, including dengue. As a result of participation by PICTs, information exchange before, during and after outbreaks of dengue fever has been improved via its listserver, PacNet. In addition, direct communication by the focal point of the coordinating body of PPHSN – the SPC Public Health Surveillance and Communicable Disease Control Section – has assisted PICTs through supplementary information, regular updates and alerts.

Many outbreaks have probably been prevented due to improved communication, timely dissemination and sharing of information, and adequate local response. The outbreak of dengue during the 2004 Pacific Festival of Arts in Palau was a classic demonstration of effective surveillance and communication and the timely use of PacNet, which prepared PICTs and helped to prevent outbreaks elsewhere.[10]

The level of communication regarding dengue is reflected by the frequency of reports of possible outbreaks or developing events in PICTs. The data in Figure 1 demonstrate the level of activity on PacNet regarding dengue. Of note is that only meaningful messages have been counted. As expected, communications peak around epidemic periods or during periods of threat from neighbouring regions. In 1997 communication peaked in November due to DEN-2 outbreaks in Tonga, Cook Islands, Fiji, New Caledonia and Samoa. Communications remained high in 1998 as the epidemic continued and spread to Vanuatu, Wallis and Futuna, Kosrae and Kiribati. From 1999 to mid-2000 it was rather quiet, but communications increased with a few peaks from mid-2000 to 2004 with DEN-1 affecting a number of PICTs, and a DEN-3 threat from Southeast Asia (especially Indonesia) in 2004.[22] The peak in January 2003 is related to a possible dengue case in Vanuatu, DEN-1 outbreaks in Fiji and New Caledonia and a discussion on dengue test performance. The peak in August–September 2004 is related to the outbreak of dengue during the Festival of Arts in Palau.

Figure 1: Number of dengue messages posted on PacNet by month, April 1997–December 2005



PPHSN's laboratory network service, LabNet,* has also usefully assisted in the diagnosis of and testing for dengue and other priority conditions in PICTs. Whilst still in its developmental stages, LabNet has continued to identify and make available better rapid testing capacities for dengue in PICTs – especially through the work of its partner, the Pasteur Institute of New Caledonia (IPNC), in the evaluation of existing dengue rapid and Elisa tests. LabNet still faces challenges in providing efficient services to PICTs, including timely typing of dengue viruses.

The PPHSN Coordinating Body focal point has attempted to address both vector surveillance and clinical laboratory-supported surveillance, especially during heightened risk periods (dengue outbreaks in neighbouring regions, e.g. in Southeast Asia), by initiating training activities in vector identification and surveillance training,[23] linking with the IPNC Entomologist. Whilst this activity is still at a rudimentary stage, it is promising and with further development and funding will benefit PICTs in need.

Unfortunately the focal point's capacity to provide technical support in terms of vector control remains a challenge. The EpiNet meeting resolution of 2004 suggested that PICT national Level 1 (L1) laboratories should have rapid diagnostic capacity for dengue and that Level 2 (L2) laboratories – i.e. Mataika House in Fiji, Public Health Laboratory in Guam, IPNC in New Caledonia and Malardé Institute in French Polynesia – should have confirmatory capacity. The L2 laboratories further link up with the WHO reference laboratories that provide Level 3 support in this scheme, especially for serotyping.

Dengue is the most common epidemic in the region, so a certain level of preparedness is assumed at national EpiNet, Dengue Taskforce and/or Communicable Diseases Control team level. The national teams must at least have guidelines for responding to dengue outbreaks.[2]

Diagnosis

Laboratory confirmation is crucial at the beginning of an outbreak (the first 5–20 cases should be tested), but also for outbreak monitoring (e.g. testing every 10th case or so) or if the outbreak patterns change or evolve (new areas affected, suspicion of another outbreak-prone disease).

Suspected dengue cases can be tested with a rapid dengue test kit. Further testing to confirm diagnosis is done via LabNet at L2 and L3 laboratories.[19] The L2 laboratories conduct confirmatory tests for dengue, and virus typing can be done at L3 or the WHO reference laboratory. Two of the L2 laboratories (IPNC and Malardé Institute) can also provide this level of support.

**LabNet is a PPHSN service that assists PICTs in the diagnosis of priority diseases, thus improving surveillance and response. Selected national labs (L1) are linked to more advanced confirmatory capacity regional labs in PICTs (L2 labs, i.e. Mataika, Fiji; Institut Pasteur, New Caledonia; Guam Public Health Laboratory; Malardé Institute, French Polynesia). These L2 labs are further linked to L3 labs in developed countries. L3 labs are generally WHO reference laboratories. All of these form a network of laboratories for regional priority disease investigation and confirmation.*

For countries with an existing and easier link with L3 laboratories (e.g. Vanuatu, Solomon Islands), L2 services can be provided by these laboratories.

Region-wide availability of rapid test kits would increase the likelihood of early detection, thus improving dengue surveillance. Some evidence from Thailand comparing rapid test kits is available, and work has been done in the Pacific by IPNC that indicates that the Pentax PA test kit is more sensitive and specific than the Pan Bio rapid test kit for dengue previously used in the region.[24]

Clinical diagnosis has its important place. In an outbreak that gets established, clinicians will quickly become familiar with the symptoms and signs of dengue. Refresher training at the first sign of a resurgence of dengue activity will enhance clinicians' effectiveness. Again, not all cases require laboratory investigation; thus diagnosis must rely more on clinical judgement and less on laboratory confirmation. Health authorities may formally advise a changeover from laboratory to clinical case definitions for surveillance.[11]

Dengue prevention in the Pacific: Where are we now? What's new?

Vector control methods remain an issue for PICTs. Eliminating breeding sites around homes is perhaps the best approach. Biological control is available, but it is still being looked at in view of practicalities and more research is needed. Testing vector sensitivity to insecticides using a WHO test kit is worthy but expensive; however, it appears a reasonable option if systematic chemical spraying is being considered and has previously been a strategy for vector control.

There is a lot happening in terms of surveillance and response, but it appears that much more needs to be done in a number of areas, including operational research

Recent prevention activities have considered a social mobilisation approach, using targeted campaigns to eliminate breading sites for *Ae. aegypti* through community-based participation.[14,25,26] This has been a creative initiative of WPRO, which has succeeded in involving communities in dengue prevention in Asian countries. The initiative, the COMBI (community-based initiatives) approach, appears to be very effective against *Ae. aegypti*, the main dengue vector, as it is a domestic mosquito. COMBI aims to have communities check potential container breeding sites around their homes at least once a week and has prompted dengue volunteer inspection teams to conduct larval inspections of community surroundings. Similar sanitary and environmental inspection activities have been carried out by the village women's association (Soqosoqo niVakamarama) in island villages in Fiji. These activities may be integrated with measures appropriate for biological or chemical control by health authorities.

In some PICTs, school programmes have mobilised children to check potential breeding sites in and around their homes, with a focus on eliminating the sites. In at least one PICT, community education intervention has been evaluated to review its effectiveness.[27]

Conclusion

This paper has given a broad update of the dengue situation in PICTs. There is a lot happening in terms of surveillance and response, but it appears that much more needs to be done in a number of areas, including operational research – a discussion that is perhaps outside the scope of this paper. Early detection, alert and response, awareness, and vector control – with communities playing a key role – are essential to combat the recurrence of dengue epidemics in the Pacific Island region.

Acknowledgements

This paper follows up and updates the article published in Pacific Health Dialog Vol. 5, No. 1, March 1998. It develops earlier published data from reports based on information in the South Pacific Epidemiological and Health Information Service (SPEHIS, produced by SPC from 1974 to 1996)[1,28] and PacNet. This paper especially updates data on dengue in the last eight years. A variety of information sources have been utilised to verify information on outbreaks in PICTs. PacNet has been one of the main sources, while other publications such as *Inform'ACTION* (the information bulletin of the PPHSN), public health and medical journals, and country and regional reports have also been used. In addition, various Internet sources have been used to capture information on regional dengue outbreaks that may have been reported outside the region. WHO websites and DengueNet publications have been used to cross-check information.

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Many outbreaks have probably been prevented due to improved communication, timely dissemination and sharing of information, and adequate local response.