

Foodborne disease surveillance in the Pacific: perspectives for the future

Tom Chiller*

Hannah Yan**

Nuku'alofa Tu'uau-Potoi***

Michael O'Leary****

Benoit Garin*****

Marinara Singh*****

Theodora Magno*****

John Dunn*

Tony Hazzard*****

Jan Pryor*****

* MD, MPH Center for Disease Control and Prevention Foodborne and Diarrheal Disease Branch Address: 1600 Clifton Rd, Mailstop D-63, Atlanta, GA 30342 Phone: 404.371.5406 - Fax: 404.371.5444 E-mail: TChiller@cdc.gov. **Emerging Leaders Program, Department of Health and Human Services, USA. ***Ministry of Health, Samoa. ****PIHOA, Guam. *****Institute Pasteur, New Caledonia. *****Secretariat of the Pacific Community. *****Ministry of Health, PNG. *****WHO/WPRO, Food Safety Office. *****Fiji School of Medicine

Abstract

Foodborne diseases are an important cause of gastrointestinal illness in Pacific Island Countries and Territories (PICTs). They are known to have significant health and economic consequences, however, reliable data on the various causes and the foodborne sources associated with specific disease are limited. This lack of data limits our understanding about foodborne diseases in the PICTs, their burden and impact on public health, and possible ways to improve food safety. There is an urgent need for better surveillance data. Improving country surveillance systems and the capacity for outbreak investigations will help address these limitations. This paper is the outcome of individual research and a four-day meeting of technical experts convened to develop practical options that PICTs might consider to enhance foodborne disease (FBD) surveillance systems. It is anticipated that the content and recommendations outlined herein will assist in establishing a regional strategy for Pacific FBD surveillance. It gives a framework on how to develop and enhance FBD surveillance for both the regional and national levels and provides examples that countries in the Pacific may consider to enhance their foodborne disease surveillance systems. (PHD, 2005 Vol 12 No 2 Pages 127 - 133)

Introduction

This paper is a summary of analysis and recommendations on practical options that Pacific Island Countries and Territories (PICTs) might consider to enhance foodborne disease (FBD) surveillance systems. The final concepts and framework were the result of discussions at a meeting jointly sponsored by the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the Secretariat of the Pacific (SPC) on the "Future Action on Food Safety in the Pacific" which was held in Malaysia in May 2004.

Foodborne diseases have significant health and economic consequences, and represent an important global public health problem. Foodborne diseases are thought to be an important cause of gastrointestinal illness

in PICTs. Available data demonstrate a high incidence of gastrointestinal illness, even among countries with limited capacity to perform surveillance. Between 1995 and 1997, diarrhea was reported in 170,826 persons, not including persons from Papua New Guinea, making diarrheal diseases the second most common reported infection among Pacific Islanders.¹ Diarrhea represented the third highest reported cause of morbidity in 2001 in Tonga with an incidence of 2,890 cases (per 100,000 persons), in 1998 in Kiribati with 18,054 cases (per 100,000 persons) and in 1994 in Nauru with 462 cases (per 100,000 population).² Information on pathogen-specific foodborne illness data is even more limited, but cases of salmonellosis have been reported in the late 1990s in American Samoa, French Polynesia, Guam, Nauru, and Northern Mariana Islands.^{2,3}

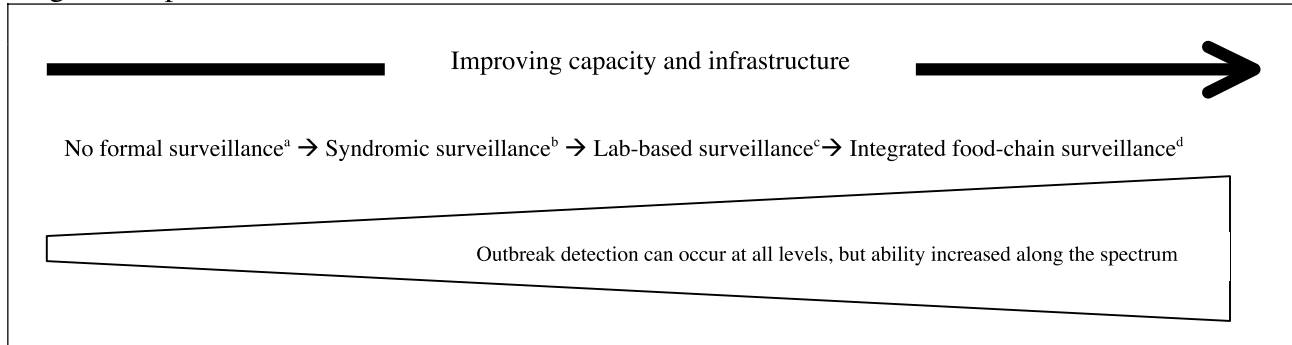
The absence of more robust data impedes our understanding of the extent of this public health problem in the PICTs. In order to make evidence-based decisions about ways to improve food safety and reduce the impact of foodborne illness in the Pacific, accurate country-specific data are needed. Improving FBD surveillance systems and the capacity for outbreak investigations will

help accomplish these goals by serving as a platform for strategies designed to decrease the incidence of foodborne illness, reduce associated morbidity and mortality, and efficiently direct health care resources.

The development of harmonized FBD data and information from reliable sources is needed. The region presents unique challenges to achieving a harmonized,

Diarrheal or gastrointestinal diseases may be the result of contact with infected persons or animals. The specific causes of foodborne diseases include viruses, bacteria, parasites, toxins, metals and prions, with the symptoms ranging from mild gastroenteritis to life threatening neurologic, hepatic and renal syndromes.⁵ Chemical or other non-infectious causes of foodborne illness are not considered in this report.

Figure 1. Spectrum of Disease Surveillance



a. Without formal surveillance, only large or unusual outbreaks can be detected.

b. Syndromic surveillance is based on groups of signs or symptoms indicative of a common diagnosis.

c. Laboratory-based surveillance relies on laboratory confirmed pathogens.

d. Integrated food-chain surveillance uses data from across the food chain.

coordinated surveillance effort. The islands in the Pacific are widely scattered. PICTS populations include small cities and villages with minimal infrastructure, great distances separate these cities and villages, and there are limited resources for healthcare in most PICTs.

In considering options for improving FBD surveillance systems in PICTs, we consider options for individual countries and options that may be applicable to the entire region. We focus our attention first on individual countries, that are at different stages in their ability to perform surveillance and then focus on options for the region, as changes to surveillance within one country can potentially affect many other countries.

The Current Situation – FBD Surveillance in the Pacific

It is important to first define FBD surveillance. Foodborne diseases are defined as diseases, usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food and water.⁴ Data on 'food poisoning' and 'fish poisoning' are commonly collected by PICTs and are also part of our definition of foodborne illness for this paper. The meaning of the term food and fish poisoning may vary from country to country. For the purpose of this paper, data on all diarrheal, enteric, and gastrointestinal diseases are included as part of foodborne diseases. Although many foodborne diseases manifest as a diarrheal illness, this is not the case for all foodborne diseases. The proportion of these diseases attributable to food is difficult to determine.

Surveillance is defined as the ongoing, systematic collection, analysis, interpretation and dissemination of data,⁶ it provides information for planning, implementing and evaluating public health policies. One way of looking at the spectrum of FBD surveillance is to divide it into four distinct levels, with each level becoming progressively more complex resulting in enhanced capacity for controlling and detecting disease but requiring more resources and infrastructure (Figure 1). At one end of the spectrum, no formal surveillance system exists and outbreaks are detected only if they are very large. Then the next level of surveillance is syndromic, followed by laboratory-based or pathogen-specific surveillance. Finally at the other end of the spectrum there is integrated food-chain surveillance. This spectrum frames surveillance as a continuous process and aids us in identifying appropriate options for each PICTs.

Public health surveillance systems in PICTs vary considerably. Some Melanesian countries, for example Vanuatu and the Solomon Islands, are currently without a formal surveillance system or rely primarily on syndromic surveillance. However, the more developed Melanesian countries (e.g. Fiji and New Caledonia) are examples of countries (and territories like New Caledonia) on the other end of the surveillance spectrum as they have or are developing a laboratory-based surveillance system. Other PICTs are in the middle tier having primarily syndromic surveillance with the potential for laboratory-based surveillance. In general there are few Pacific

island guidelines for the investigation of suspected FBD outbreaks.

In most PICTs, health care systems are delivered through a national government system, and are required to send in monthly reports with aggregate numbers for the local list of notifiable diseases. Some conditions are identified as urgently notifiable. Most lists of notifiable diseases in the Pacific comprise a mix of syndromes and diseases like cholera and typhoid. Table 1 provides the data from the 1996 South Pacific Epidemiological Health Information Service (SPEHIS) annual report, the latest report available on-line.⁷ This program was halted several years ago because of limited resources. It is generally unclear, however, how cases of FBDs are defined and if all cases are reported among other specific details of the FBD surveillance system.

There is limited information on FBD surveillance in the Pacific as reflected by the limited number of peer-reviewed articles on Pacific FBD surveillance. It is apparent, however, that few PICTs have a laboratory-based FBD surveillance system capable of tracking and reporting on pathogen-specific foodborne diseases. A recent Pacific Public Health Surveillance Network (PPHSN) survey sponsored by WHO demonstrated that 11 (50%) of 22 countries and territories have clinical laboratories in their country to isolate and identify *Salmonella* Typhi. Eight laboratories responded that they have the capacity to serotype *Salmonella*. Serotyping of non-Typhi *Salmonella* is infrequently performed even in the best hospital laboratories. Some PICTs, such as Federated States of Micronesia and the Cook Islands, send their isolates to other laboratories in the region, including laboratories Honolulu and Auckland, respectively. Some laboratories with budgetary constraints are unable to transport isolates to reference laboratories for further characterization. Transportation regulations, even where funds are available, also limit PICTs abilities to get specimens to the appropriate labs. Transportation of specimens between islands of the same country often also pose a serious challenge.

Unfortunately, even in countries where data may be routinely collected, data may not be optimally analyzed and be in "collection mode paralysis". This is probably in part due to limited personnel and to limited analytical capability. Even in countries with well-trained epidemiologists, there are many competing local health priorities that also require attention. The actual number of FBD outbreaks and the rate of diarrheal diseases in the population are therefore not known and may be unreliable for many PICTs.

Surveillance Networks and the Benefits of Pacific Island Countries Participating in such Networks for the Purpose of Foodborne Disease Surveillance

It is important to incorporate any strategy into existing networks, both regionally and globally. Furthermore, it is important that development efforts in the area of FBD surveillance be in line with the recommendations and strategies from relevant global and regional assemblies and conferences. Given the relative isolation and lack of resources in most PICTs, there are major advantages of linking improved FBD surveillance to the efforts of existing networks and with recommendations and strategies of relevant assemblies and conferences.

Of particular importance is the development of Pacific FBD surveillance within the context of the Pacific Public Health Surveillance Network (PPHSN) (<http://www.spc.int/phs/PPHSN/>). Established in 1996, PPHSN is a regional organization consisting of 22 PICTs, and various other allied health-related agencies including WHO and the Secretariat of the Pacific Community (SPC), which serves as the PPHSN Focal Point, located in Noumea.

Even in countries where data may be routinely collected, data may not be optimally analyzed and be in "collection mode paralysis"

The involvement of PPHSN's various partners will be crucial to the development of Pacific FBD surveillance. The Western Pacific Regional Office of WHO (WHO-WPRO) and SPC will play ongoing

pivotal roles in Pacific FBD surveillance through the organizing of relevant resources and by advocating the necessary changes that must occur for a sustainable FBD surveillance system to be established. Other key PPHSN allied members that will be of specific assistance to the development of Pacific FBD surveillance include Institute Pasteur in New Caledonia (IPNC) and the Fiji School of Medicine (FSM). IPNC will provide key training and diagnostic services to support Pacific FBD surveillance development, and the FSM will play an important role in organizing and implementing relevant research activities, and in providing a framework for relevant training and education.

PPHSN has established well-recognized mechanisms to foster cooperation within the region on matters related to disease surveillance and general and, as such, should take the lead in the development of FBD surveillance. However, while existing PPHSN structure and services may be available, scarce resources may be problematic. Therefore extension of PPHSN's scope to include FBD surveillance will need appropriate resources.

Collaboration with PPHSN should be augmented by partnership with the WHO Global Salm-Surv Program

(WHO-GSS), a global surveillance program of national and regional public health, veterinary and food reference laboratories and individuals. Initiated in January 2000, the WHO-GSS steering committee consists of 9 members, including the Centers for Disease Control and Prevention and the Food and Drug Administration from the USA, the Danish Institute for Food and Veterinary Medicine, the Public Health Agency for Canada and, OzFoodNet from Australia. WHO-GSS's primary goal is to enhance the capacity and quality of *Salmonella* and other pathogen-specific surveillance and antimicrobial resistance testing throughout the world, and to strengthen national and regional FBD surveillance and response systems.

In Australia, OzFoodNet was established by the Commonwealth Department of Health and Ageing in 2000 as a collaborative project with State and Territory health authorities to provide a better understanding of the causes and incidence of FBD in the community and to provide an evidence base for policy formulation. OzFoodNet is overseen by the Communicable Disease Network of Australia, a PPHSN allied member, and has expressed specific interest in supporting the further development of Pacific FBD surveillance.

At the FAO/WHO Regional Conference on "Food Safety for Asia and the Pacific" it was recommended that FAO and WHO:

- organize seminars/training sessions on the importance of FBD surveillance, involving all relevant stakeholders from all sectors;
- coordinate a working group to further discuss the details and logistics of a regional foodborne disease surveillance network in Asia and the Pacific;
- invite member countries of the Asia and Pacific region to designate their representatives in the initial working group on FBD surveillance; and
- provide continued capacity building assistance to member countries in all aspects of FBD surveillance to ensure the timeliness, accuracy, and relevance of the data that is collected.

As such, there is the potential that an Asia-Pacific Working Group on FBD Surveillance and an Asia-Pacific FBD Surveillance Network will be formalized. However, if other "Asia-Pacific" entities are any indication of how these FBD surveillance entities might function, there is a risk that the interests of the PICTs will be secondary to those of the Asian countries that tend to be dominant in such arrangements. Subsequently, while the PICTs should participate as appropriate in any Asia-Pacific FBD surveillance entities that might eventually materialize,

the Pacific interests are likely to be best met through the PPHSN framework.

Options that Pacific Island Countries Should Consider to Enhance Foodborne Disease Surveillance Systems

Some PICTs have surveillance systems that include routine reporting of FBDs. The existing systems in most PICTs, however, include either syndromic surveillance of diarrhea, or reporting of a few conditions in which food, water, or both may be implicated (such as typhoid or cholera).

In general, the ability of routine surveillance to contribute meaningful information on FBD burden and distribution is limited, and it is recognized that detailed and specific information on FBDs must primarily come from other sources, especially from burden of illness and etiologic studies, in selected sites at periodic or regular intervals. It seems,

however, that some attention to routine surveillance is warranted because:

- Basic surveillance systems already exist;
- Diarrheal disease surveillance can provide information on the magnitude and distribution of intestinal infections, and help guide interventions; and
- Routine surveillance provides a mechanism for recognition and reporting of outbreaks;
- Some food and water-related conditions require continuous monitoring and rapid intervention (e.g. cholera).

Furthermore, countries are at different stages in their ability to perform routine surveillance, and it is important to move forward quicker in some than in others. As such, we must consider options for individual countries, and other options for the region as a whole as events within one country can potentially affect many other countries.

In considering options for improving Pacific FBD surveillance systems, we would suggest the following general concepts:

- Develop a *country-specific approach*, focusing on evaluating and improving current in-country capacity and infrastructure within the current level of surveillance.
- Develop a *regional approach* consisting of two major goals within the PPHSN framework:
 - to develop a uniform definition for FBDs for reporting purposes as the basis for *syndromic surveillance*, and to facilitate centralized data

there is a risk that the interests of the PICTs will be secondary to those of the Asian countries that tend to be dominant in such arrangements

- collection and sharing, and
- to establish a *laboratory-based FBD surveillance network* in the Pacific.
- Develop *demonstration projects* in countries that are capable of moving into some type of laboratory-based system.

With the idea of focusing on a tiered system for the individual PICTs, within the context of a broader regional strategy for the Pacific, specific options focus on:

- Enhancing country-specific FBD surveillance systems in a stepwise fashion;
- Enhancing FBD outbreak detection and response throughout the region; and
- Conducting targeted studies on the etiology and burden of FBD.

Strengthening *syndromic surveillance of diarrhea and detection of FBD outbreaks* with the goal of increasing capacity to *laboratory-based FBD surveillance* is a good path for each country in the Pacific region. However, given the country-specific variability in capacity and needs, this multi-tiered, multi-approach strategy to Pacific FBD surveillance must be accomplished in an integrated, incremental stepwise fashion.

Enhancing country-specific FBD surveillance systems in a stepwise fashion

Routine surveillance can be improved with modest effort, within the existing PPHSN framework. In regards to this, what follows is a targeted proposal for improved routine surveillance, requiring little new input, but emphasizing tighter focus, better communication, regional standardization, and an emphasis on data interpretation and action. This re-orientation of routine surveillance is supplemented with in-depth assessments of foodborne and diarrheal disease burden and etiology.

The routine surveillance component builds on current national systems, and on PPHSN initiatives targeting selected outbreak-prone diseases. It recognizes that capacities and resources are limited at rural or peripheral health service levels in the Pacific, and that even at central levels, surveillance staff and laboratory support are constrained. The proposed options for surveillance may be assessed according to local capacity by:

- Reviewing the current situation using a new Pacific FBD Surveillance Assessment Tool;
- Determining the appropriate surveillance level for each setting, and defining the key elements of that surveillance;
- Performing a cost-effective analysis comparing a

broad-based approach to strengthen the control of priority communicable diseases with efforts to control FBD.

- Promoting harmonization of surveillance methods, and eliminating unnecessary elements of surveillance;
- Setting realistic surveillance goals (which may be similar to that already underway); and
- Supplementing basic routine surveillance with more detailed information on FBDs by conducting special surveys in selected sites at periodic intervals.

As a basis to enhancing country-specific FBD surveillance systems in a stepwise fashion, it will be necessary to first evaluate existing FBD surveillance systems to understand how FBDs are being monitored, to determine the utility of existing systems, and to take

targeted and appropriate steps to improve these systems. Previous PPHSN questionnaires in 1999 and 2003 have investigated the diagnostic capabilities of PIC clinical laboratories relative to priority diseases in the Pacific (i.e. cholera, dengue, hepatitis, HIV, influenza, leptospirosis, measles, meningococcal infection,

rubella, STIs, tuberculosis, and typhoid). However, to accomplish an appropriate evaluation of current FBD surveillance systems, it is necessary to expand data collection to food and water laboratories, and to relevant surveillance, reporting and response practices through the use of an assessment tool specific to FBD surveillance in the Pacific context.

Conducting targeted studies on the etiology and burden of FBD

Innovative strategies and methods are needed for foodborne disease surveillance in the Pacific to address the unique challenges of the region. However, support of these programs requires knowledge about the burden of foodborne disease and specific etiologies in the Pacific. The etiology of foodborne disease, the rate of diarrheal diseases in the population and its relation to food are not known or are unreliable for most PICTS. WHO should consider supporting studies to obtain this data and information for the Pacific region. Considering limited available resources, we recommend studies be conducted in a few selected countries. Initial planning and design should be conducted with a working group within PPHSN with expert consultants from WHO, OzFoodNet, CDC, and others in the region. As studies are conducted, and we gain more knowledge on the burden and etiology of foodborne illness, we will be able to focus on control measures.

Innovative strategies and methods are needed for foodborne disease surveillance in the Pacific to address the unique challenges of the region

Burden of illness studies

FBD burden of illness estimates have been recently developed for several countries, including Australia, Netherlands, United Kingdom, and United States. However, only limited information is available on the FBD burden of illness in countries in the African, Asian, Eastern Mediterranean, Latin American, or Pacific regions. This lack of information contributes to the low priority placed in these regions on public health surveillance and response to FBDs, and to the development and implementation of appropriate interventions to prevent FBDs. Currently, studies have been initiated in Jordan and Vietnam, and more are being planned in Cuba, Slovenia, and Malaysia. It will be important to conduct a formal consultation with experts to develop a work plan for studies in the Pacific.

For the Pacific, we propose that three representative countries be considered for BOI studies: Fiji, Samoa, and Kiribati, representing the Pacific sub-regions of Melanesia, Polynesia and Micronesia.

- In Fiji, a pilot laboratory-based surveillance project for *Salmonella* has been implemented, and will provide a platform for a study with *Salmonella*.
- In Samoa, there is syndromic surveillance for diarrhea and the national reference laboratory can test for *Salmonella* with routine culture confirmation of *S. Typhi*. A study could be performed in Samoa to

first determine the burden of diarrheal disease and simultaneously to estimate the burden of typhoid. During this process, capacity building in the national reference lab can be undertaken to improve stool testing.

- In Kiribati, it is generally felt that FBDs are a major cause of morbidity, but little is known about the true burden and specific causes. In designing a study in Kiribati, it will be important to investigate the use of laboratory testing at a national or hospital lab.

Important components of these studies will include integrating laboratory and epidemiology surveillance of foodborne pathogens, a survey of health-seeking behavior in the population, a survey of physician practices in managing patients with diarrhea, a survey of laboratory practices, and could include case-control studies of patients with foodborne infections. Increasing lab capacity for these specific studies clearly has cost implications, but will help provide an important source of training and capacity.

Quantifying the burden of illness due to foodborne diseases and, where feasible, pathogen-specific burdens, will provide information that can be translated into economic burden and can be used as an effective advocacy tool directed toward policymakers and funding agencies. This is important because most

Table 1: South Pacific Epidemiological Health Information Service (SPEHIS), 1996 Annual Report, Number of Reported Cases in 1996

Pacific Island Countries And Territories	Population [^]	Cholera Outbreaks	Diarrhea 0-11 Months	Diarrhea 1-4 years	Diarrhea ≥5 years	Fish Poisoning
American Samoa	58,900					
Cook Islands	19,600	0	179		406	304
Federated States of Micronesia	109,200	0	1,186		2,333	24
Fiji	800,500	0	527	1,025	6,211	721
French Polynesia	229,200	0	582	1,587	3,507	924
Guam	153,700	1				12
Kiribati	82,400	0	1,081	2,363	2,230	289
Marshall Islands	59,800	0	366		889	152
Nauru	11,200					
New Caledonia	196,800	0	373	549	1,063	109
Niue	2,000	0	4		115	15
Northern Mariana Islands	63,000					
Palau	16,900	0	46	220	710	0
Papua New Guinea	4,141,800					
Pitcairn Island	53	0	0	0	0	0
Solomon Islands	395,200		3,297	8,437	12,804	
Tokelau	1,500	0			329	4
Tonga	90,000	0	426	476	849	0
Tuvalu	9,800	0			1,394	19
Vanuatu	173,900	0	1,231	2,120	2,518	754
Wallis and Futuna	14,800	0	98	177	507	0
Western Samoa	165,100	0	469		1,197	68

[^] Population data from 1996.

* A blank entry indicates that no data were entered in the SPEHIS reports.

foodborne infections are undiagnosed and unreported, either because the ill person does not see a healthcare professional or the healthcare professional does not make a specific diagnosis. For example, based on studies, 37,000 cases of laboratory-confirmed *Salmonella* reported in the United States were estimated to represent the true annual burden of *Salmonella* of 1.4 million cases.

These studies do not have to be long standing and can be done at intervals to capture trend data. The data from these studies can assist in determining which diseases to focus on for surveillance and to include in the notifiable disease list for each country.

Etiological studies

To complement and provide support for burden of illness studies and to help focus our efforts, we need to determine foodborne pathogens that are causing illness in the Pacific. One approach is to perform research studies for selected pathogens such as *Salmonella*, *Campylobacter*, *E. coli*, *Vibrios*, and *Entamoeba histolytica*. These etiology studies could be conducted in the same countries where studies are being planned, therefore providing a platform for active FBD surveillance as well as the possibility to determine pathogen-specific burdens.

Summary Recommendations

Pacific Island Countries should:

1. Collaborate as appropriate in the step-wise implementation of FBD surveillance within the operational framework of PPHSN, including :
 - syndromic and / or lab surveillance
 - special studies
 - integration of food / water / animal surveillance.
2. Share FBD surveillance information with existing networks and interested parties.
3. Participate in training and capacity-building activities for effective FBD surveillance.

Regional / international agencies and development partners should:

4. Facilitate the formation of FBD technical working group.
5. Support countries in their FBD surveillance activities.
6. Further develop the surveillance related output of the 2004 WHO/FAO/SPC meeting into a FBD surveillance monograph for the Pacific.

References

1. UNDP. Pacific Human Development Report 1999: Creating Opportunities. Available at http://www.undp.org/fj/Pacific_Human_Dev_Report_1999.htm.
2. WHO Regional Office for the Western Pacific. Food Safety: Issues - Public Health Significance of Foodborne Illnesses. Available from: http://www.wpro.who.int/NR/rdonlyres/F2F62765-B851-4982-BE63-5AC9B52E81A2/0/food_safety01.pdf.
3. WHO Regional Office for the Western Pacific. The work of WHO in the Western Pacific Region: regional director's report 2000-2001. Available from http://www.wpro.who.int/rd_report_52.asp.
4. WHO. Fact sheet N°237: Food Safety and Foodborne Illness. Available at <http://www.who.int/mediacentre/factsheets/fs237/en/>.
5. CDC. Diagnosis and management of foodborne illness: a primer for physicians and other health care professionals. MMWR 2004; 53 (No. RR-4).
6. CDC. Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group. MMWR 2001; 50 (No. RR-13).
7. Secretariat of the Pacific Community. South Pacific Epidemiological and Health Information Services: Annual Report for the Year 1996, Reported Cases of Notifiable Diseases for the South Pacific Region. Available from: <http://www.spc.int/phs/ENGLISH/Dbases/db-introduction.htm>.

The powerlessness we feel is not just a sign of personal failings but reflects the incapacities of our institutions. We need to reconstruct those we have, or create new ones.
(Anthony Giddens – 2002)