Investigation of an Outbreak of Cholera Among Chuukese Residents of Guam, 2005

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Background

The fear instilled by cholera, a severe diarrheal illness caused by certain types of *Vibrio cholerae*, provided the impetus for modern public health surveillance activities, initially via the International Sanitary Convention in 1903.[1] *V. cholerae* is a motile gram-negative organism which produces a lipopolysaccharide O-antigen. Epidemic cholera is only caused by toxin-producing strains (i.e. toxigenic) of *Vibrio cholerae* belonging to serogroups O1 and O139. Although many other strains can produce diarrheal illness, nontoxigenic and non-O1 and non-O139 strains do not cause epidemics. Cholera was one of only three diseases that all member nations agreed to report to the World Health Organization under the subsequent International Sanitary Regulations, adopted in 1951 and renamed the International Health Regulations (IHR) in 1969.[1] In 2005, the IHR was revised to include the notification of diseases which constitute a "public health emergency of international concern", but cholera remains one of the special named diseases for which reporting is mandatory. [2] In 2009, 221,226 cases and 4,946 deaths from 45 countries were reported to WHO.[3] As has been the recent trend, nearly 98% of reported cholera cases were from countries in Africa.. There were only 3,859 cases reported in the Asia and Pacific region, accounting for less than 2% of cases reported, however given limitations in surveillance and under reporting due to the fear of trade and travel restrictions, the true burden of cholera is not known.3 Of the reported cases from Asia and the Pacific region, over half were reported from Papau New Guinea. Although no cases were reported from other Pacific Island nations or trust territories in 2009, cholera cases, and outbreaks have occurred in many of these areas in the past [4,5,] and the potential for further sporadic cases and recurrent outbreaks in some areas remains high.

Between 1974, when cholera was first reported in Guam, and 2004, there have been 23 episodes of cholera reported in Guam. These episodes have involved 26 confirmed and 20 suspected cases (Table 1). Ten episodes have been attributed to travel to or consumption of seafood from the Philippines; five to consumption of raw locally caught fish; three to travel or fish from Pohnpei; one to travel to Thailand; and one to travel to Chuuk. In three episodes, representing 3 confirmed cases and 3 additional suspect cases, the source was unknown. In 2000, a large cholera outbreak in neighboring Pohnpei State (FSM) occurred, resulting in over 3400 cases and 20 deaths.[6,7] During this same year, four confirmed cases of toxigenic *V. cholerae* O1 infection in Guam were associated with travel to or fish from Pohnpei.[8]

Given the potential for continued spread of cholera from Pohnpei to the surrounding areas, epidemiologists from the U.S. Centers for Disease Control and Prevention (CDC) at that time evaluated the cholera surveillance and preparedness program in Chuuk.[9] The investigators found the cholera surveillance system to be operating poorly with multiple reporting, poor data quality, and reporting delays. These investigators recommended the initiation of a network of sentinel surveillance sites, consisting of both lagoon island and outer island dispensaries. They advocated for the consistent use of diarrhea case report forms by dispensary health assistants and hospital clinical staff. Case report forms were to be systematically completed and entered into a database and monthly reports were to be disseminated to the various stakeholders. They recommended laboratory surveillance via culturing stool samples or rectal swabs from suspected case of cholera who presented to sentinel sites.

On October 20, 2005, a 29-year-old Chuukese man presented to an emergency room in Guam complaining of cramps in his leg and fingers and was hospitalized. Toxigenic *V. cholerae* O1 was isolated from his stool. During the subsequent 3 weeks, three additional suspected cases of cholera, based on preliminary stool culture results, were detected. An investigation of these cases was initiated to assess the source of infection and any potential epidemiologic connection. All three suspected cases were of Chuukese ethnicity, which led to the possibility that either travel to or food from Chuuk, Federated States of Micronesia (FSM), may have been the source of infection. The initial anecdotal evidence pointed toward fish imported from Chuuk and sold at a local fish market (Fish Market A) as the source of cholera. Fish from this market was confiscated, and initial testing revealed *Vibrio*-like organisms.

Here we report on the extent and source of cholera infections identified in Guam in 2005, assess risk factors for transmission, recommend prevention measures and to review epidemiological and laboratory-based surveillance measures in Chuuk.

Methods

In response to those four presumed cholera cases, surveillance activities in Guam and Chuuk were reviewed. In Guam, we reviewed syndromic surveillance data for diarrheal illness. We defined a suspected case of cholera on Guam as acute watery diarrhea, with onset between October 20 and November 22, 2005 in a patient aged ≥5 years who developed severe dehydration or died. A confirmed case was defined as diarrhea in any patient with isolation of toxigenic Vibrio cholerae O1 between October 20 and November 22, 2005. Isolation of Vibrio cholerae was performed in a private laboratory in Guam using thiosulfate citrate bile salts sucrose agar (TCBS). *Vibrio cholerae* isolates were sent to CDC for confirmation. Pulsed-field gel electrophoresis (PFGE), biotyping, serogrouping, serotyping, and toxin testing were performed at CDC.

In Chuuk, we reviewed inpatient and ER log data from Chuuk Hospital to determine whether the incidence of diarrheal illness had increased from September through November 2005.

Clinical, epidemiologic, environmental, laboratory and surveillance information
Guam
Case Information

Case 1 is a 29-year-old Chuukese male resident of Guam who complained of leg and finger cramping on October 19, 2005, a few hours after eating pan-fried reef fish. He presented to the emergency room after symptoms worsened. On presentation, he denied diarrhea, nausea, vomiting, abdominal cramps or fever, but was found to have altered mental status and was admitted to the intensive care unit. *V. cholerae* was isolated from urine and stool specimens. He was treated with intravenous fluids and antibiotic therapy for 5 days, with good clinical response.

Case 1 was queried in the hospital regarding potential exposures, including travel and food history. He had not been "off-island" in the past 10 years. His food history was notable for the consumption of reef fish. This fish was caught locally on October 15, 2005 and pan fried and consumed on October 18 and 19, 2005. Case 1 specifically denied the consumption of raw fish or other seafood and did not purchase or consume fish from Fish Market A. Case 1 obtains water from a government supplied limestone/karst aquifer. This aquifer serves the northern portion of the island. It is uncertain whether water from other water sources was consumed.

Case 2 is a 32-year-old Chuukese male resident of Guam who developed nausea, vomiting, abdominal cramps, and diarrhea on the afternoon of October 26, 2005. He presented to the emergency room the following morning where he received intravenous fluids and 1 dose of antibiotic therapy. Symptoms continued for 2 additional days. *V. cholerae* was isolated in his stool sample.

Case 2 travelled to Chuuk to attend a funeral approximately 2 months before his illness. He denied handling the body or eating food prepared or served at the funeral. Case 2 denied consuming raw fish but does often eat seafood. During the week before illness, his lunch consisted of milkfish soup, squid soup, and pork spareribs soup. The milkfish in the soup, which was consumed in a fast-food restaurant, is cooked, boiled in coconut milk, and seasoned with onion, ginger, and garlic. He noted that the milkfish soup he ate the day before his illness tasted unusual. His wife typically prepares dinner, and he most often eats cooked fish (tuna, milkfish or reef fish) and rice. The rice is consumed on the day it is prepared. The fish is purchased from a variety of markets, including Fish Market A. He denied consuming any other seafood. Case 2 lives in Dededo and obtains his drinking water from the government supplied limestone/karst aquifer. He denied consuming water from other sources in the 30 days before illness.

Case 2 did have contact with Case 1 approximately 2 weeks before Case 2's illness. However, this contact was brief and the two men did not eat or fish together or share bathroom facilities.

Suspected Case 1 is a 47-year-old Chuukese male who presented to the hospital with abdominal cramps and diarrhea on November 5, 2005. He was seen in the emergency room, received supportive therapy and was discharged. His symptoms lasted 1 day. A stool specimen yielded *V. cholerae* non-O1, non-O139 which was subsequently confirmed at CDC.

Suspected Case 2 was a 39-year-old Chuukese woman, with a history of diabetes mellitus, who presented to the emergency department on November 13, 2005, complaining of "severe" diarrhea, vomiting and

abdominal pain for 1 day. She was afebrile, hypotensive and had a respiratory rate of 36. Laboratory values revealed elevated blood glucose (428 mEq/L), and arterial pH of 6.88, pCO2 of 15 mm/Hg and bicarbonate level of 2.7 mEq/L, consistent with diabetic ketoacidosis. Her serum sodium was 127 mEq/L, chloride was 93 mEq/L, creatinine was 5.1mg/dL, and her anion gap was 28.4. A stool specimen failed to yield enteric pathogens, including *Vibrio* species. Treatment with intravenous fluids, insulin, antibiotics and vasopressor therapy was initiated. Despite the above therapy, Suspected Case 2 went into cardiac arrest 5 hours after presentation. Cardio-pulmonary resuscitation was unsuccessful. Gastrointestinal biopsy specimens, obtained during the autopsy, were sent to the Infectious Diseases Pathology Activity at CDC.

Per suspected Case 2's husband, she had not traveled off the island of Guam. Her food history included consumption of rice, chicken, rice soup, watermelon and tuna fish. Her husband did not know whether or not she had consumed raw fish. The tuna fish, was purchased from Fish Market A, and consumed on October 13. Although the tuna fish was cooked, the method of preparation is unknown. She also receives water from the limestone/karst aquifer.

Environmental Information

Water is tested monthly from the limestone/karst aquifer at the source as well as from various "unofficial" connections. These connections consisted of garden hoses attached to a water pipe at a primary source location. Additional hoses are attached to provide water to remote locations. These connections are not regulated and do not have back flow protection, which would allow for the potential contamination of the source water. Water was tested for coliform bacteria and levels of chlorine. Coliform bacteria were not detected and the level of disinfectant was adequate. The pressure of the system was normal.

An investigation and environmental testing was conducted at Fish Market A, located in Dededo. All fish sold from this market is supplied from a distributor in Chuuk. The fish are shipped from Chuuk on Tuesday, Thursday and Saturday afternoon and arrive in Guam the same evening. Samples of fish (red snapper, unicorn fish, goat fish, and rabbit fish) along with environmental samples from a cooler, ice dispenser, bathroom sink and sink used for fish cleaning were collected on November 15, 2005. *Vibrio* species was isolated from the unicorn fish and goat fish samples. However, these did not demonstrate typical biochemical reactions for *Vibrio cholerae* and did not agglutinate in O1 antisera.

Laboratory Information

CDC confirmed the presence of toxigenic *V. cholerae* O1 Ogawa, resistant to furazolidone in confirmed Cases 1 and 2. PFGE patterns of the isolates from the two confirmed cases were indistinguishable by two enzymes. *V. cholerae* non-O1, non-O139 was confirmed in Suspected Case 1. Pathological specimens from Suspected Case 2 were tested at the CDC. Immunohistochemical (IHC) testing using an immunoalkaline phosphatase technique was performed; no IHC or molecular evidence of infection with a *Vibrio sp.* was identified. Additionally, tissue of the colon and small intestine was testing using a multiplex PCR assay. This testing was also negative for *V. cholerae*.[10] Based on the clinical, laboratory and post-mortem findings, this death was felt to be the result of diabetic ketoacidosis.

Surveillance Data

For the first 48 weeks of 2005, there was an average of 3.1 cases of diarrhea reported in the Guam Memorial Hospital Emergency Room per week.

Confirmed Case 1 presented in week 42, confirmed Case 2 presented in week 43, Suspected Case 1 in week 44, and Suspected Case 2 in week 46. Figure 1 illustrates the number of cases of diarrhea for these four weeks; by week, for the previous 5 years. The diarrhea rate did not differ between the years in this period.

An additional case of cholera was detected in Guam in late December. Given the date of onset of illness, this case was not considered as part of the initial outbreak. This case was a 26 year-old Chuukese female who has a food history negative for fish and denied any sick contacts. She was not familiar with the patients noted above. Toxigenic *V.cholerae* 01 was detected in her stool specimen; however the PFGE pattern was different from that of the isolates from Case 1 and Case 2.

Chuuk

The diarrhea surveillance system initiated in 2000 has not been maintained. Neither the network of sentinel surveillance sites nor the cholera task force is currently active. The diarrhea case report forms are not being used by either health assistants or hospital-based clinicians. As was the case before 2000, data on diarrheal diseases are collected from monthly summaries, submitted from the health dispensaries, and from the emergency room log book, and emergency room and outpatient discharge forms. This information is submitted to the medical records department.

We reviewed inpatient and ER log data to assess whether the incidence of diarrheal illness had increased from September through November 2005. We compared inpatient log data from 2005 to 2004 in both the medical (Figure 2) and pediatric wards (Figure 3). There was not a notable difference between these two years; however, a sizable amount of data was missing. Additionally, at least two cases of illness reported in 2005, would meet WHO's definition of a suspected case of cholera (i.e. a patient aged 5 years or more who develops severe dehydration or dies from acute watery diarrhea); however stool testing was not performed. One of these patients died as a result of diarrheal illness.

Since 2000, the laboratory has maintained a log book of stool cultures tested for *Vibrio cholerae*. The majority of entries are from the first 5 months after CDC recommendations were initiated. Only four samples were tested after this interval and none in the 16 months prior to this investigation. The laboratory no longer has the supplies needed for isolation and serological identification of *Vibrio cholerae*. Indeed, the only microbiological studies currently available are the gram stain and stool test for ova and parasites.

Discussion

Three cases of V. cholerae 01 Ogawa infection were confirmed on Guam reported in 2005. Initially, two additional cases met the suspected cholera case definition, however, subsequent evidence was inconsistent with a diagnosis of cholera in either case. There have not been any additional cases of cholera reported from Guam since 2005.

The timing of the first two confirmed cases, whose onsets were 1 week apart, and the fact that they both live in the same area, were both of Chuukese ethnicity, and had contact with each other within 2 weeks before their illness suggest that their infections may have had a common source, or that secondary transmission from one patient to the other may have occurred. The laboratory data, particularly the PFGE subtyping results, are consistent with either of these hypotheses.

Although both confirmed cases are Chuukese, there is no other evidence to suggest that either travel to, or fish imported from Chuuk was the source of infection. Between 1974 and 1985, four outbreaks in Guam involving 6 confirmed and 8 suspected cases of cholera have been attributed to locally caught fish consumed raw. In the week before their illness, both of these confirmed cholera patients ate reef fish; however, Case 2 denied eating raw or salt dried fish. Although we made multiple attempts to re-interview confirmed Case 1, we were not able to do so. However he denied having eaten raw fish when questioned in the hospital.

Case 1 and Case 2 lived approximately 2 miles apart and shared a common water source that also serves a sizeable portion of the population. The negative test results from water samples and the absence of a more widespread increase in diarrhea cases evident in the syndromic surveillance data make it unlikely that contamination of the limestone aquifer was the source of infection.

The source of this current outbreak remains unknown, but the infections were certainly acquired locally, and are likely related through a common exposure or through secondary transmission. An environmental investigation revealed that both patients lived in crowded and unsanitary living conditions. While such an environment does not explain the introduction of *V. cholerae*, it does provide a potential avenue for continued transmission. The third case, with a distinct PFGE pattern, lends further support to our hypothesis that cholera was acquired locally.

As illustrated in Figures 2 and 3, there has not been an increase in the reported number of cases of diarrhea from September through December 2005, in Chuuk Hospital. This finding lends further support to the conclusion that Chuuk is not a likely source for the cholera cases in Guam. However, current surveillance for cholera in Chuuk is inadequate. The network of sentinel sites does not exist. Diarrheal case reporting and laboratory-based surveillance are not currently performed. One of the lessons learned from the cholera outbreak in Latin America during the 1990s was the need for consistent case definitions so that trends over time can be followed, and hence possible outbreaks detected.[11] Barriers to implementation included low literacy levels among the health assistants, lack of communication between the health dispensaries and the hospital, lack of laboratory supplies and lack of institutional support. These obstacles involve long-term planning and resources. Funding is needed to ensure the availability of necessary laboratory supplies as well as to provide radio communication to each of the health dispensaries. Understanding other barriers may assist in the sustainability of this surveillance system in particular and other public health efforts in general. Presently, it does not appear that Chuuk is prepared for the early detection of or response to a potential cholera outbreak.

Many previous cholera outbreaks in Guam were associated with the consumption of raw fish. Although we did not implicate raw fish as the source of either of the two recent cholera infections, cooking fish and shellfish is recommended to reduce the risk of cholera and other diseases. Chlorination of drinking water either at the source or at the point of use is also recommended.

Although there have not been any additional cases of cholera reported in Guam since 2005, current surveillance will be improved, in both Guam and Chuuk, if health care providers are encouraged to culture stool from patients with diarrhea for enteric pathogens. However, in order for such testing to be meaningful, the capacity of the public health laboratories to isolate and identify *V. cholerae* O1 and other enteric pathogens must be increased. Further, laboratory-based surveillance and reporting should be enhanced. This increased capacity is especially important given the rapid threat of emerging pathogens (e.g. avian influenza) and the continued threat of bioterrorism.

Table 1: *Vibrio cholerae* O1 reported on Guam, 1974 to present*

No.	Date	Cases (culture confirmed/total)	Serotype	Probable Source
1	July 1974	2/6	Ogawa	Local raw fish
2	July 1977	1/6	Inaba	Oysters from Philippines
3	Nov 1981	1/4	Inaba	Unknown
4	Oct 1982	2/2	Ogawa	Local raw fish
5	Aug 1983	1/1	Inaba	Travel to Chuuk
6	Apr 1985	1/1	Inaba	Travel to Thailand
7	Aug 1985	1/5	Ogawa	Local raw fish
8	Aug 1985	1/1	Ogawa	Local raw fish
9	Oct 1985	1/1	Ogawa	Fish from Philippines
10	Nov 1985	1/1	Ogawa	Crab from Philippines
11	July 1986	1/5	Ogawa	Travel to Philippines
12	July 1986	1/1	Ogawa	Fish from Philippines
13	Oct 1987	1/1	Ogawa	Travel to Philippines
14	Dec 1987	1/1	Ogawa	Travel to Philippines
15	Jun 1988	1/1	Ogawa	Travel to Philippines
16	Aug 1990	1/1	Ogawa	Crab from Philippines
17	Apr 1994	1/1	Ogawa	Unknown
18	Jan 19996	1/1	Ogawa	Tuna sashimi (local?)
19	Sep 1998	1/1	Ogawa	Travel to Philippines
20	Dec 1998	1/1	Ogawa	Unknown
21	Jun 2000	1/1	Ogawa	Travel to Pohnpei
22	July 2000	2/2	Ogawa	Fish from Pohnpei
23	Jul 2000	1/1	Ogawa	Fish from Pohnpei

* Data obtained from the Guam Morbidity Report, Office of Epidemiology and Research, Department of Public Health and Social Services, Government of Guam

Figure 1: Reported cases of diarrhea by week (2001-2005) in Guam

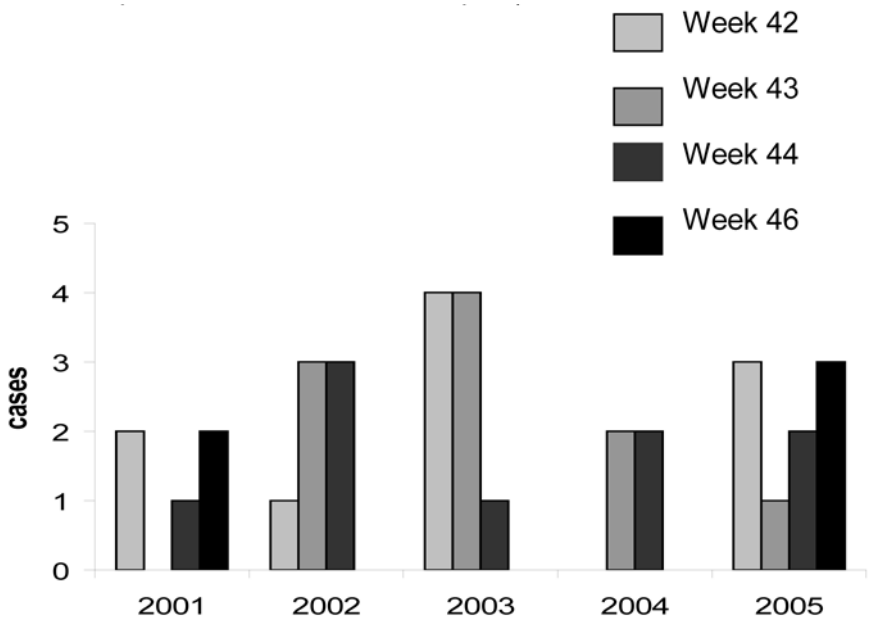


Figure 2: Cases of diarrhea or acute gastroenteritis by month, September – December 2004-2005 (Medical inpatient service- Chuuk Hospital)

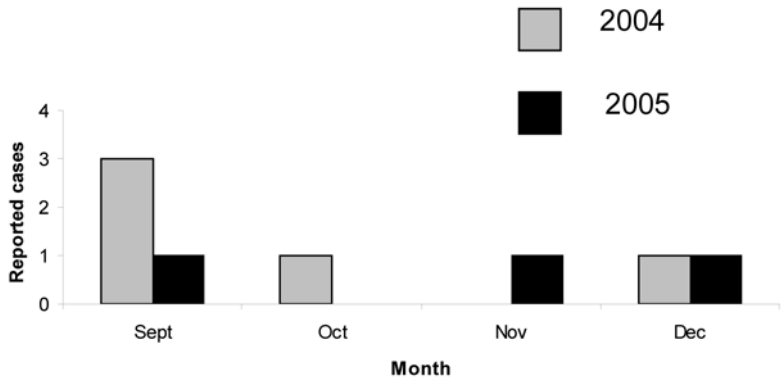
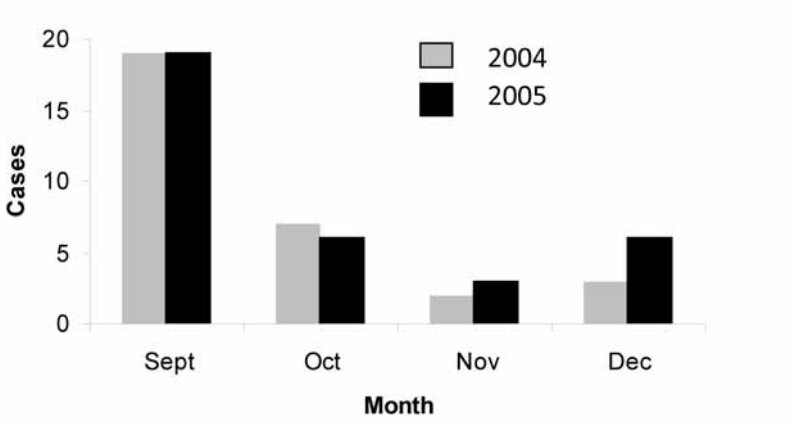


Figure 3: Cases of diarrhea or gastroenteritis by month, September-December 2004-2005 (Pediatric inpatient service – Chuuk Hospital)



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"The secret of health for both mind and body is not to mourn for the past, worry about the future, or anticipate troubles but to live in the present moment wisely and earnestly."

Buddha

TALANOA OCEANIA 2011

Talanoa Oceania facilitates events for people who are interest in the dynamic, energizing and fluid cultures of the peoples of Oceania (or Pacific Islanders, abbreviated as PIs). In the interests of PIs who have moved to overseas lands and are torn between where we live and our home islands, these events are necessary because:

- We are often **confused about who we are;**
- We are **easily misunderstood;**
- We are **not fully engaged** in our new locations;
- We long for **a sea of talanoa to root us** in our current locations;
- We have not been **meaningfully released** from our island homes;
- We need creative ways of **maintaining contact** with our island cultures and homes;
- We need to **come to terms with our differences and complex ways.**

WHEN, WHERE, HOW, AND WHAT?

Because we should! Pacificans are scattered throughout many lands over the seas, and Talanoa Oceania is one of our points of contact. Since we inherit the migrating urges of our ancestors, but in less stressful means and paths, we should stay in contact with one another, in better ways than our ancestors did.

Without staying in contact, we lose one of the key ingredients of what make us a relational people. Talanoa Oceania aims to facilitate our staying in contact, and our continuing to be relational with and responsible for, one another within island groups and across the currents of Oceania.

As explained during the 2010 gathering in Sydney, Australia, the term **niu** is playful: **Niu** is one of the words for coconut, and it anticipates new-ness.

Talanoa Oceania 2011 invites Pacificians to be both – to display not only what and who we are, but also what we have invented and/or accomplished.

Niu Flavours is about celebrating the achievements of the Pacificians in diaspora.

Niu Flavours is about how the generations of Pacific diaspora readjusted theirs cultures to fit their new homes away from their 'home' islands. Talanoa Oceania 2011 hopes to display every 'flavour' that the Pacificians have discovered or invented along the process of transition in diaspora.

We expect papers, performances and presentations to revolve around those **'flavours'.**

THEMES AND SUB-THEMES:

1. **Niu Flavours in Diaspora**
   - Diaspora identities
   - Human rights in diaspora
   - Parents, families and languages
   - Spirituality in diaspora
   - Traditional values and beliefs
   - Food and Nutrition
2. **Niu Flavours for Research and Practice**
   - Research and ethics
   - Indigenous notions of wellbeing
   - Pacific Health and Education
   - Curriculum Development
3. **Niu flavours in Development**
   - Economic Development
   - Disaster management and climate change
   - Social Justice, Empowerment and Social Policy
   - Women and Community development
4. **Niu Flavours in Art**
   - Performance Arts
   - Visual Arts
   - Contemporary Arts
   - Traditional Arts and Crafts