

# A Large Foodborne Outbreak on a Small Pacific Island

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## Abstract

On March 25, 2009, the Ebeye Leroj Kitlang Memorial Health Center on the island of Ebeye in the Republic of the Marshall Islands was overwhelmed with over 100 patients presenting for vomiting and diarrhea. Epidemiologic investigation revealed that there were 174 cases among 187 attendees at a local funeral earlier in the day. Most cases had eaten served sandwiches containing egg products that had undergone severe time-temperature abuse. While no causal agents were identified, the epidemiology and clinical presentation is compatible with foodborne toxins, most likely enterotoxins of either *Staphylococcus aureus* or *Bacillus cereus*. Mitigation measures undertaken by public health centered on education of food preparers and the general public regarding safe food preparation practices. This large outbreak serves to remind us that, while there are simple and highly effective measures to prevent such foodborne disease outbreaks, we in the public health sector have a duty to improve the community's knowledge and understanding of these measures.

## Introduction

The tiny island of Ebeye, a part of the Kwajalein atoll in the Republic of the Marshall Islands (8.77 N, 167.73 E)(1), is one of the most densely populated areas on earth, with 9345 individuals (1999 figures) living on an area of 0.14 mi<sup>2</sup> (2). It is the Marshallese cultural and population center of the Ralik (eastern) chain of the Marshall Islands.

On March 25th 2009 at 8pm, a 4 year old boy presented to Ebeye's Leroj Kitlang Memorial Health Center emergency department with a chief complaint of vomiting and dehydration, warranting admission for acute gastroenteritis. Approximately 30 minutes later, the emergency department was overwhelmed by an influx of persons presenting with vomiting, diarrhea and abdominal pain; by 7am on the following morning, over 100 patients had presented with these symptoms. After all available hospital beds were occupied, patients were observed overnight in the emergency department and the hospital corridor. All patients reported to have spent the day attending a large funeral gathering at North Loi cemetery on Ebeye.

Over the following three days, we conducted an epidemiologic investigation to describe the epidemiology of the outbreak, determine risk factors for developing illness, and implement any relevant control measures.



## Methods:

We used cohort methodology as early investigation suggested that all cases were associated with attendance at the funeral event. The study was conducted among all persons who had either attended the funeral gathering or had consumed food brought home from the gathering. A case was defined as a person living on Ebeye who developed vomiting, diarrhea or abdominal pain within one day after eating food provided at the funeral gathering at North Loi on March 25, 2009.

We interviewed all attendees with a standardized questionnaire that collected demographic information, foods and drinks consumed at the gathering, illness status and relevant symptoms. Young children were interviewed by proxy through their caregivers.

Data were entered into Microsoft Excel 2003 (Microsoft Corp., Redmond, Washington, USA), and analyzed using Intercooled Stata 9.2 (Stata Inc., College Station, Texas, USA).

In addition to the cohort study, the epidemiologic investigation included environmental and clinical laboratory testing. The Ebeye Environmental Protection Agency (EPA) tested two water samples of 100 mL each for the presence of bacteria from the water source used to prepare the soup. Food samples of sandwiches and sandwich spread were cultured for routine foodborne pathogens. Stool samples were collected from fifteen patients and tested by fecal ova and parasite screening and stool culture for routine stool pathogens (ten tested locally; five tested on Kwajalein, with referral to Diagnostic Laboratory Services, Inc., in Honolulu, HI, USA).

## Results:

### *Clinical epidemiology:*

A total of 187 persons attended the funeral feast. We identified 174 cases. Patients presented to the emergency room beginning one hour after consuming food from the funeral (Figure 1). Median incubation period was 4.5 hours. The last case occurred 18 hours after food consumption.

The total number of patients that presented to the health center was 127; of these, 82 patients (65%) were admitted for observation and intravenous rehydration. The 47 patients not presenting to health center received home care. All 174 patients had full resolution of their symptoms within 12 hours of onset.

The majority (60%) of patients were female (Figure 2). Seventy-five percent were under age 15; the youngest patient was aged 7 months and the oldest 66 years. Thirteen persons did not develop illness.

The most common symptom was vomiting, experienced by 170 persons; followed by diarrhea, in 127 persons; and abdominal pain, in 46 persons. As noted above, many patients became volume depleted as a result of their symptoms. Other minor symptoms were noted but were not systematically recorded.



***Field investigation:***

Food for the funeral was prepared at two separate locations in the same area of Ebeye. Food was prepared by friends and relatives of the deceased.

Three food items were offered: a sandwich containing a spread of chopped ham, egg, and mayonnaise; a soup consisting of chicken, fish and rice; and a variety of soft drinks in cans and pouches. Bread for the sandwiches was obtained from a local bakery; all other ingredients were purchased from the local chain supermarket. The eggs were hardboiled on the evening prior to the funeral, at approximately 9-10PM, and left outside overnight. Sandwiches were assembled the following day (the day of the funeral) at 9am, along with the other food items.

Food was consumed at approximately 5pm. All but one person ate the sandwiches at the funeral feast. Among those who ate sandwiches, 34 also consumed soup and 29 also consumed soft drinks. The one person who did not consume sandwiches consumed soup only (and was ill). Food-specific attack rates and risk ratios are shown in Table 1, demonstrating that the highest attack rate occurred among those who ate sandwiches. Since nearly all persons ate sandwiches, a statistically significant risk ratio could not be calculated for this item.

***Laboratory investigation:***

Of the fifteen tested patient stool samples, two were positive for pathogens (Diagnostic Laboratory Services, Inc.): one for 3+ *Aeromonas hydrophila*; and one for 4+ *Vibrio cholerae*.

Sandwich or soup samples were negative for fecal pathogen growth. Testing for staphylococcal or other enterotoxins was not available.

One of the two water samples was reported by the EPA to have excessive *E. coli* and total coliforms.

***Control measures:***

Immediately upon learning of the outbreak, Ebeye public health authorities sequestered all remaining food from the funeral feast.

Information on safe food preparation was disseminated by health educators to the general public, to food preparers, and to church groups because of the upcoming Easter feasts. General information about safe water use and hygiene was also provided.

Enhanced vigilance for gastroenteritis outbreaks was emphasized to clinicians at the health center, in order to detect clusters of cases that may present on an outpatient basis.



## Discussion:

This outbreak was the largest recorded gastroenteritis outbreak in Ebeye's history, and had the sixth-highest number of hospitalized patients of any published outbreak involving food handlers (3). The outbreak caused considerable strain on local healthcare resources and resulted in a tremendous amount of preventable morbidity.

The etiology of the outbreak could not be conclusively determined as no causal organism or toxin was identified. Nevertheless, the results of the epidemiologic investigation and clinical picture are consistent with poisoning by bacterial toxins. This is supported by the short incubation period and duration of symptoms, the nature of symptoms, the absence of laboratory-identified pathogens (two disparate positives notwithstanding), and the time-temperature abuse described in the food preparation. Eggs cooked for the feast were kept at ambient temperature (approximately 85°F) for at least nineteen hours, and mayonnaise and other ingredients for at least eight hours. The most likely agents are enterotoxins of *Staphylococcus aureus* or *Bacillus cereus* (4). These are toxins elaborated by the bacteria when they are allowed to grow in food due to improper refrigeration; the toxins themselves, rather than infection by the bacteria, cause the illness.

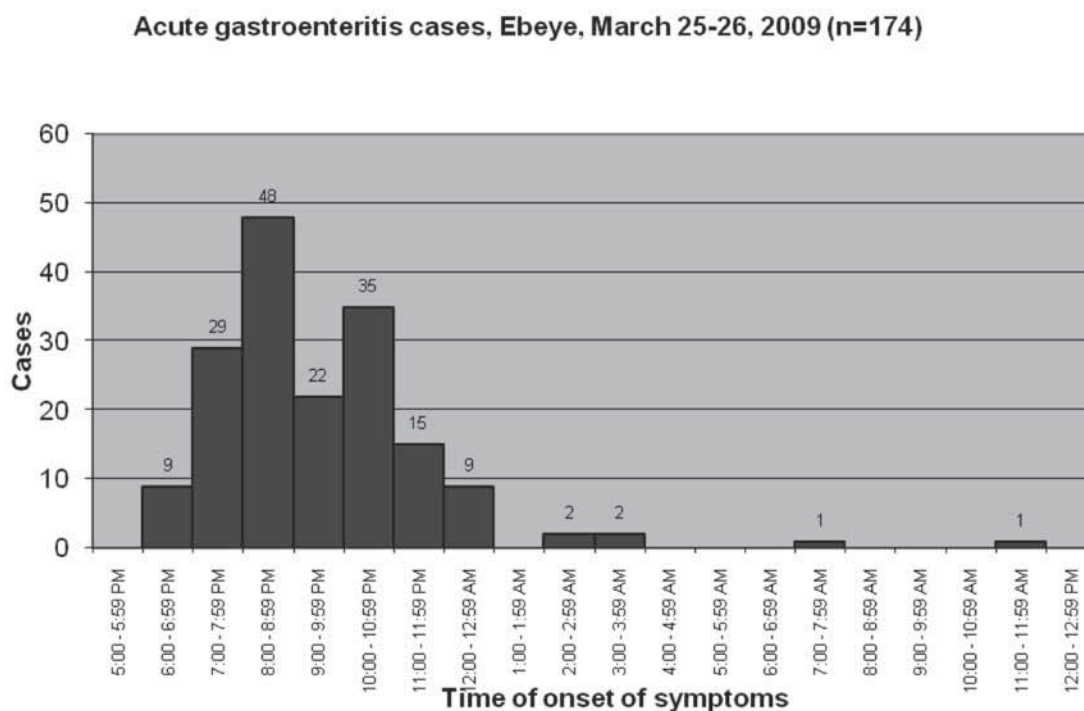
We were unable to identify a statistical association with a single food item as almost all the attendees ate sandwiches and subsequently became sick. Sandwiches were consumed by the highest proportion of ill people compared with other food items so it is probable that sandwiches, or an ingredient of sandwiches, were the cause of illness. Interestingly, consuming soup or soft drinks appeared to have a protective effect on developing illness, perhaps because these individuals consumed proportionately fewer sandwiches, indicating a dose-response effect.

The measures needed to avoid food poisoning outbreaks are well-established, effective, and low-cost: persons who are ill should not prepare food; good hygiene must be practiced by all; care must be taken to avoid cross-contamination, especially when preparing raw meats; and careful attention must be paid to avoiding time-temperature abuse, particularly for foods of animal origin (such as eggs)(5). We, in the public health sector, have a duty to improve the community's knowledge and understanding of these measures. This is particularly important in the Pacific, where food preparation for mass consumption is frequently performed by non-foodservice individuals (i.e., persons without formal training in safe food preparation). A proactive, rather than reactive, approach is needed; food safety education must be directed toward the general public, rather than waiting to identify food preparers. Potential venues include schools and community women's groups, as many food preparers are women. Improved knowledge and practices related to food safety will have the added benefit of preventing small household-level episodes of food poisoning, which likely represent a substantial proportion of the foodborne disease burden.

Clinicians must maintain a high degree of suspicion for food poisoning in patients presenting with gastroenteritis. Early recognition and reporting of an outbreak allows public health authorities to conduct epidemiologic investigations to identify the contaminated food source and additional cases, prevent further cases from the same source through control measures, and identify high-risk activities for future targeted preventive measures.



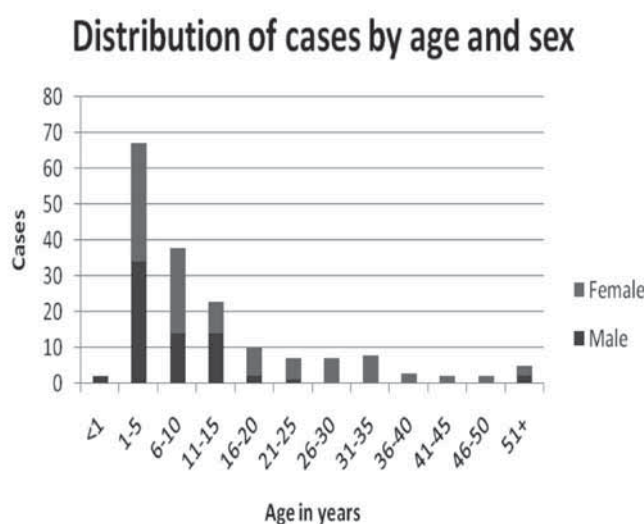
**Figure 1: Epi-curve**



Cases of acute gastroenteritis began presenting within 1-2 hours of the funeral feast; most cases occurred between 2 to 6 hours after the feast.

**Figure 2: Distribution of cases**

Cases of gastroenteritis occurred primarily in young children, largely reflective of the population structure of funeral attendees.



**Table 1. Food-Specific Attack Rates and Risk Ratios**

Food item	Number of consumers	Number Ill	Attack Rate	Risk Ratio	p-value (two-tailed Fisher Exact)
<b>Sandwich</b>	186	170	91%	0.91	1 (N.S.)
<b>Soup</b>	35	26	74%	<b>0.78</b>	0.00047
<b>Soft Drink</b>	29	21	72%	<b>0.76</b>	0.00071

Nearly all funeral attendees ate sandwiches; a statistically significant risk ratio could not be attained for consumption of this food, because of the paucity of persons who did not eat sandwiches. Consumption of soup and soft drinks was associated with a protective effect.

### References

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*“Patience, persistence and perspiration make an unbeatable combination for success.”*

*Napoleon Hill*

