AN OUTBREAK OF SALMONELLOSIS LINKED TO A MARINE TURTLE

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Abstract. In September 1998, an outbreak of gastroenteritis occurred in a coastal Aboriginal community in the Northern Territory over a seven day period. An investigation was conducted by the Center for Disease Control, Territory Health Services. Thirty-six cases were detected and 17% (n=6) were hospitalized. *Salmonella chester* was isolated from eight of nine stool specimens. Sixty-two percent of cases interviewed (n=28) reported consumption of a green turtle (*Chelonia mydas*) within a median of 24 hours prior to onset of illness. Of the remainder, all but two were contacts of other cases. *Salmonella chester* was isolated from a section of partially cooked turtle meat. There are no previous published reports of salmonellosis associated with consumption of sea turtles despite them being a popular food source in coastal communities in the Pacific.

INTRODUCTION

Salmonellosis is one of the commonest notifiable diseases in the Northern Territory (NT), Australia, with rates in the Aboriginal population four times higher than the non-Aboriginal population (Center for Disease Control, 1998). Disease occurs predominantly in the under five year olds and point source outbreaks are rarely detected.

On September 18, 1998 the Center for Disease Control (CDC), was notified of an outbreak of gastroenteritis predominantly affecting adults in a north-east NT community. There had been no previous presentations to the community clinic in the month of September with vomiting or diarrhea. On September 14, a green turtle (*Chledonia mydas*) was cooked and distributed to an undetermined number of households in the community. Water collected from a waterhole near the community (known as the aerator) was used as drinking water at the cook site and to cook the meat. In addition, there were reports that kava, a plant derived tranquilliser (Alexander *et al*, 1987), had been consumed the night before using water from the same source. An investigation was conducted to determine the etiology and source of the outbreak, and to instigate prevention and control measures.

MATERIALS AND METHODS

Community X is a coastal Aboriginal community with a fluid population of between 700 - 1,500 people. A case series was conducted; events in the community prevented a case control study being undertaken.

A case was defined as any person who resided in, or had visited, Community X with onset of diarrhea and/or vomiting in the week beginning September 12, 1998. Case finding was by reviewing clinic records and household visits. Data were collected through an interviewer administered questionnaire with the assistance of an Aboriginal Health Worker. Traditional foods consumed in the community were included. All interviews were conducted before stool culture results were known.

Water, food and stool samples were obtained for microscopy, culture and sensitivities, as well as viral studies including electron microscopy. Inspections of the waterhole, town water supplies and community food outlets were conducted by Public Health Officers (PHOs), Environmental Health Officers (EHOs) and the community's Essential Services Officer.

RESULTS

Thirty-six people met the case definition, with onset of illness between September 14 to September 21, 1998. Twenty-nine cases (81%) agreed to be interviewed, four refused and three had left the community. Limited information was available for the non-responders. Of the 36 cases, 33 (92%) were Aboriginal, 21 (58%) were female and 28 (n=78%) were over 10 years of age.

The duration of the outbreak was seven days. The frequency of reported symptoms is presented in Table 1. Thirteen cases (45%) reported a combination of diarrhea, fever, vomiting, abdominal pain and nausea. The median duration of illness was two days (Range: 1-7 days). Six (17%) cases were hos-

Table 1
Frequency of self-reported symptoms in respondents (n=29).

Symptom	No.	%
Watery diarrhea	25	86
Abdominal pain	24	83
Nausea	22	76
Vomiting	20	71
Fever	21	72
Headache	12	43
Bloody diarrhea	0	0

pitalized and a further two required intravenous rehydration at the clinic.

Eighteen (62%) respondants reported turtle consumption within a median of 24 hours (Range: 8 - 96 hours) prior to onset of illness. Seven (21%) reported consumption of the aerator water and of these, six had also consumed turtle. The remaining case reported he had been swimming at the waterhole 36 hours prior to onset of illness. Four cases (14%) reported kava consumption, each at different times during the week. Two cases (7%) reported no exposure to turtle, water or anyone else who was sick.

Twenty-one (72%) cases lived in one of eight specific houses. Within each of these houses, at least one person reported consumption of turtle meat. Of the seven non-respondents, one person was known to have both turtle and water exposure and one person had water exposure alone. Six (86%) were household contacts of other cases.

A total of nine stool specimens were collected. Eight (89%) were positive for *Salmonella chester*. *Enterovirus* RNA was detected in the remaining stool. This case reported no exposure to turtle, water or other cases. *Salmonella chester* was also isolated from a sample of partially cooked turtle meat. Table 2 presents cases in the context of exposure history and positive stool cultures and Fig 1. presents the epidemic curve relative to the sequence of events, stool results and exposure history.

ENVIRONMENTAL RESULTS

The run-off creek from the waterhole had been obstructed by a make-shift dam causing the water to stagnate. The grass around the perimeter had been recently mowed and dirty nappies were found in the water and around the site. Water samples had a fecal coliform count of 710/100 ml. None of this sample was retained for culture. One week after the dam was broken, the fecal coliform count was 50/100 ml and *Aeromonas* sp was cultured. The community's drinking water supplies were reported as not contaminated. EHOs reported no deficient food handling, storage or store hygiene practices in the two community food stores.

DISCUSSION

The laboratory evidence from this investigation supports consumption of the green turtle as the most likely vehicle of transmission for this outbreak of salmonellosis; with a high rate of secondary transmission. Water from the waterhole in which the turtle was cooked is also implicated however only one case with water as their sole exposure was detected, the water was boiled for cooking, and reports indicated others were exposed to the water and did not become ill. While a comparison group was not obtained for an analytic study, we believe the temporal relationship and biologic plausibility between the consumption of turtle and onset of the outbreak, together with the isolation of *S. chester* from both the meat and stool from cases, support our conclusion.

Table 2
Exposure history and number of culture positive stools.

Exposure	Responder	Non-responder	Stool culture
Turtle only	12		4 *S. chester*
Turtle + drank water	6	1	2 *S. chester*
Water only	1	1	
Household only	5*	5*	1 *S. chester*
Other contact only**	3		1 *S. chester*
None	2		1 *Enterovirus* RNA
Total	29	7	9

*All lived in same house as someone who had consumed turtle.
**Other contact, not household.

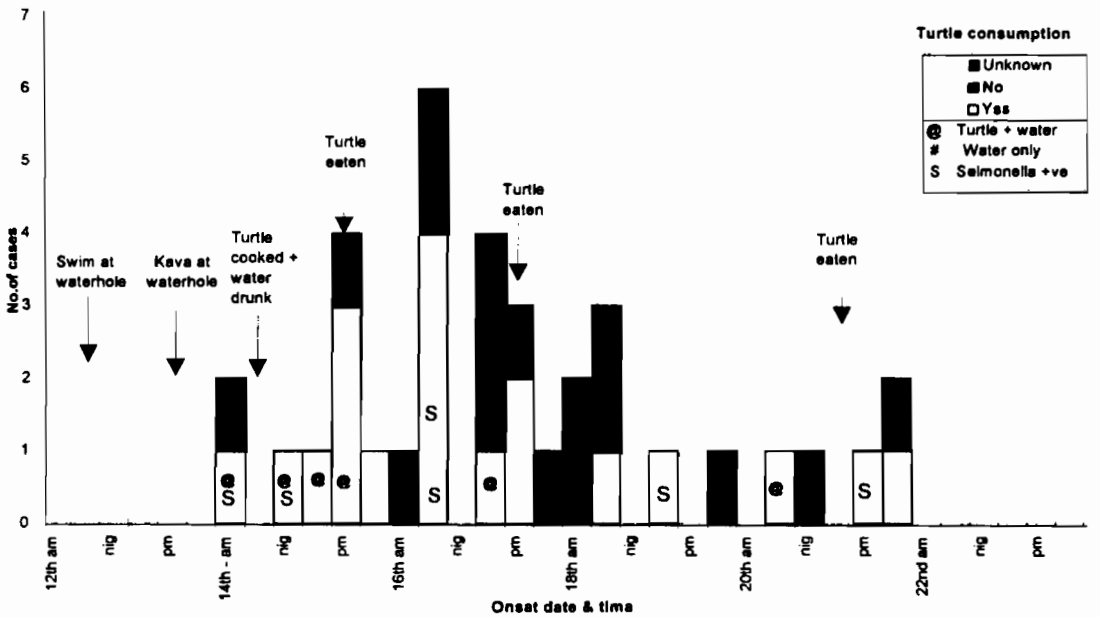

Fig 1–Epidemic curve of salmonellosis outbreak in an NT coastal community.

There had been no presentations to the clinic for gastroenteritis in the preceding two weeks, nor any notifications of *S. chester* from the community in the preceding two years, suggesting something new had happened. The age distribution is inconsistent with the usual pattern of notifications from the region, indicating the source was associated with an activity predominantly related to older children and adults. In addition, the outbreak was confined to a period of seven days and clustered within households suggesting limited access to a source that was exhausted over a short period of time. The last of the turtle was consumed on September 20 and no new cases occurred after September 21.

Exposure to pet turtles is a recognised risk factor for salmonellosis. (Lamm *et al,* 1972). National and international outbreaks have occurred, (Baker *et al,* 1972; Tauxe *et al,* 1985), and legislation enacted in Canada and the US on the control of pet turtle breeding farms and sales resulted in a decrease in the frequency of salmonellosis in children (Cohan *et al,* 1980; D'Aoust *et al,* 1990). However while there are reports of a toxic illness associated with consumption of turtle (Limpus, 1987), none could be found reporting salmonellosis from consumption of meat despite sea turtles being a popular food source in northern Australia and the Pacific.

In Australia, *Salmonella* sp have been isolated from wild green turtles in western Australia and southern Queensland (C Limpus, personal communication). Prolonged carriage of *Salmonella* sp of up to 11 months in other turtles has been demonstrated, together with high rates of infected eggs and hatchlings (D'Aoust *et al,* 1990). Latent carrier states can be affected by periods of stress precipitating a bacteremia (Shane *et al,* 1990). This can also occur if the turtle had lesions in the gut, parasitic infections, or was caught in shallows at low tides leading to rapid body heating (C Limpus, personal communication). This particular turtle had been tied up to rocks at a beach for nearly two days prior to slaughter.

Water either consumed at, or collected from, the aerator site was a possible source. Two cases were ill prior to the turtle being consumed. The first, a child from whom a stool was not obtained, had exposure to the aerator water two days prior. However, his only reported symptom was diarrhea. The high rate of hospitalizations in this outbreak suggested a particularly virulent strain and more severe disease in a young child may have been expected. Infection with a different pathogen is plausible given the high fecal coliform count in the aerator water.

The second, an adult, from whom *Salmonella chester* was isolated, had consumed the water (used to mix kava) the night before onset of illness and ate turtle after she became unwell. However, she had also been drinking alcohol on the Sunday night

which may have precipitated gastrointestinal symptoms the following morning; later exacerbated by turtle consumption. As the stool specimen was collected after exposure to the turtle we cannot distinguish between sources.

The water was used to cook part of the turtle meat, but it was reported as boiling at the time and it is unlikely the meat was contaminated at that stage. Six people who ate turtle also reported drinking the aerator water, further limiting the ability to separate the two. That it is not as likely as the turtle is supported by reports the waterhole is a popular swimming spot for residents of the nearby town and more cases from outside the community may have been expected. This would be dependent on how long the waterhole was stagnant and how many other people were exposed during that period. This information is unknown. Reports did indicate a large group of people were present at the waterhole on the Sunday night drinking kava and there were no cases detected who had this event as their sole exposure.

While 38% of cases had no exposure to either the turtle or the aerator water, only two reported no known personal contact with another case. As the majority were household or workplace contacts and occurred 24 - 48 hours after consumption of turtle by index cases in those environments, it suggests person-to-person transmission through contamination of other food sources occurred, possibly during preparation of meals. For those with no contact, *Enterovirus* was detected in one person's stool, suggesting a different illness; and for the other, history is uncertain as she gave a negative response to all questions on the questionnaire other than symptoms.

Both consumption of undercooked turtle flesh and contaminated water are preventable health risks. The prompt action of public health officers included: notifying the community and nearby township through media channels, schools and council offices; encouraging personal and domestic hygiene and use of Oral Rehydration Solution on a house-to-house and community wide basis; and distributing educational material through businesses, schools and community organizations. Warning signs regarding the suitability of the water from the waterhole for swimming and drinking were produced. Feedback was given to the AHW and the community council illustrating the relationship between inadequately cooked animal food sources and diarrheal disease for dissemination through the community. As turtles are considered a delicacy in coastal communities in northern Australia and the Pacific, preventing future outbreaks will require culturally appropriate education regarding food hygiene and preparation.

This investigation was also an avenue for evaluating the usefulness of a standard foodborne disease outbreak questionnaire in these settings and issues that will need to be addressed in future. Importantly, it highlighted the significant contribution of Aboriginal Health Workers to implementing investigations and associated public health responses within their communities; demonstrating support for the continuing development of specific training in this field.

ACKNOWLEDGEMENTS

We would like to thank the local public health staff, the community's council and health center, and the AHW for their invaluable contribution to this investigation. Community confidentiality requirements prevents their identification as authors on this paper.

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