An outbreak of *Salmonella typhimurium* phage type 1 associated with watermelon in Gisborne, January 2009

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**Abstract**

**Aim** To investigate an increase in *Salmonella typhimurium* phage type 1 (STM1) cases identified in the Gisborne region (eastern North Island, New Zealand) in January 2009.

**Methods** Initial investigations found that ham and watermelon were both consumed by a high proportion of cases. A case control study was conducted to determine if there was an association between cases of STM1 in Gisborne and consumption of ham or watermelon. Environmental investigations were conducted and included testing of ham and watermelon samples, as well as trace back of suppliers of these foods.

**Results** The case control study included 15 cases and 40 controls and found that cases were seven times more likely to have eaten watermelon compared with controls (p=0.026). Cases were one and a half times more likely to have eaten ham compared with controls (p=0.620). Pulsed field gel electrophoresis analysis determined that cases were caused by indistinguishable STM1 isolates. *Salmonella* was not recovered from any food samples. Trace back found watermelons were purchased from roadside stalls and came from one grower.

**Conclusions** This outbreak was associated with watermelon consumption from a grower in the Gisborne region. The outbreak was most likely controlled by the implementation of chlorine washing of watermelons at the grower’s pack house.

An increase in salmonellosis notifications was observed in the Gisborne region in late January 2009. Typing of isolates from Gisborne cases found that all notified cases were caused by *Salmonella Typhimurium* phage type 1 (STM1). An increase of STM1 cases was also seen in Auckland so further typing of STM1 isolates from Gisborne and Auckland was performed using pulsed field gel electrophoresis (PFGE). Pulsed field gel electrophoresis analysis demonstrated that STM1 cases from Gisborne were indistinguishable and were distinct from cases in Auckland and other regions. Initial case investigations found that nearly all cases had eaten watermelon and shaved ham.

A case control study was performed to examine the potential association between cases of STM1 with the Gisborne PFGE profile and consumption of watermelon or shaved ham.

**Methods**

**Case control study**—All cases were interviewed by a local Health Protection Officer, and samples of left over food were collected. Cases who agreed to participate in the case control study were subsequently re-interviewed by telephone. Trained interviewers used a standardized questionnaire...
which included questions about demographics, clinical symptoms, and exposure to potential risk factors for salmonellosis.

Risk factors included travel and fresh fruit and/or meat consumption. A case was defined as “a person who is infected with *Salmonella* Typhimurium phage type 1 with the ‘Gisborne’ PFGE profile, with onset of symptoms (diarrhoea and/or vomiting) after 01 January 2009, residing in New Zealand”.

Progressive digit dialling was used to recruit controls. The last digit of each case’s land line telephone number was increased by one and dialled. The person in the household to have the next birthday was asked to be interviewed. The process was repeated until three controls had been recruited for each case. This method gave a broad match on location. No other matching was performed. Each phone number was tried three times with at least two calls after 5pm. Controls were excluded from the study if they had been overseas during the last five days or if they had experienced symptoms of vomiting or diarrhoea at any time since 01 Jan 2009.

One case resided in Auckland, but was in Gisborne for their entire incubation period. The phone number used to recruit controls for this case was the phone number of the place the case stayed whilst in Gisborne. Where possible, the same interviewer conducted all interviews for a case and control set.

Differences in the distribution of demographics between cases and controls were calculated using Pearson’s chi squared test. Crude odds ratios and 95% confidence intervals were estimated. P-values were calculated using Fisher’s exact test. Logistic regression was used to estimate odds ratios adjusted for age and sex. STATA version 9 was used for all analyses.

**Environmental investigation**—Trace back of the watermelon consumed by cases found that the majority of cases had purchased watermelon from roadside stalls belonging to a particular watermelon grower in the region. Health Protection staff visited the roadside stalls, as well as the watermelon growing patch and pack-house of the watermelon grower. Watermelons from the packhouse and fields were also collected for microbiological testing.

**Laboratory investigation**—Watermelons (both swabs of the outside surface of the melons and fruit pulp) from the grower in question, as well as leftover foods from cases, were tested for *Salmonella* at the Public Health Laboratory, Institute for Environmental Health and Research (ESR), Christchurch using standard methods. Stool samples from cases were tested at local community and hospital laboratories using standard methods. *Salmonella* isolates were then sent to ESR Enteric Reference laboratory for serotyping, phage typing and molecular typing (PFGE) using standard methods.

**Results**

**Case control study**—Nineteen cases of STM1 with the “Gisborne” PFGE profile were identified from 01 Jan 09 to 04 March 09. Of these, 18 met the case definition for the case control study. Two cases did not have landline phones and one case had moved overseas by the time the study was initiated so was not eligible for the study; one case was not interviewed, giving a response rate for eligible cases of 94%. The epidemic curve for this outbreak is shown in Figure 1.
Cases ranged in age from 5 to 79 years with a median age of 33. Sixty percent of cases were female (n=9). Most reported New Zealand European/European ethnicity (n=6, 40%), four reported Maori ethnicity (27%), one reported “other” ethnicity and the ethnicity of four cases was unknown. There were no statistically significant differences between cases and controls with regard to age group (p=0.10), sex (p=0.87) or ethnicity (p=0.61).

Table 1. Symptoms experienced by cases (n=14)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Number</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>Nausea</td>
<td>11</td>
<td>78.6</td>
</tr>
<tr>
<td>Fever</td>
<td>12</td>
<td>85.7</td>
</tr>
<tr>
<td>Chills</td>
<td>7</td>
<td>50.0</td>
</tr>
<tr>
<td>Vomiting</td>
<td>11</td>
<td>78.6</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>13</td>
<td>92.9</td>
</tr>
<tr>
<td>Headache</td>
<td>10</td>
<td>71.4</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>14</td>
<td>100.0</td>
</tr>
<tr>
<td>Muscle ache</td>
<td>11</td>
<td>78.6</td>
</tr>
<tr>
<td>Other*</td>
<td>4</td>
<td>28.6</td>
</tr>
</tbody>
</table>

*Other symptoms reported by cases: loss of appetite (n=2), low energy or weakness (n=2), low blood pressure (n=1) and sweaty (n=1).
Symptoms experienced by cases are shown in Table 1. Five cases (33%) were hospitalised, no cases died. The median duration of symptoms was 7 days (range 6 – 21).

Crude and adjusted odds ratios for exposures with significant p-values (p≤0.05) are shown in Table 2. Three cases reported close contact with symptomatic persons, one case reported social contact with symptomatic persons. After re-analysing the data excluding these cases the associations between illness and cutting up watermelon before washing and peeling, as well as illness and peach consumption, no longer reached statistical significance.

Cases had seven times the odds of eating watermelon compared with controls (adjusted OR 6.8; 95% CI 1.3-36.6; p=0.026). When we excluded cases with contact with symptomatic people from the analysis, cases had 10 times the odds of eating watermelon compare with controls (adjusted OR 9.9; 95% CI 1.5 -66.8; p=0.019). Although not statistically significant, cases had one and a half times the odds of eating ham compared with controls (adjusted OR 1.5; 95% CI 0.3- 6.4; p=0.620). Removing cases with contact with symptomatic people did not change the adjusted OR (adjusted OR 1.5; 95% CI 0.3 - 8.0; p=0.567). Nor did controlling for the consumption of watermelon (adjusted OR 1.5; 95% CI 0.3- 6.7; p=0.609).

After controlling for ham consumption, the adjusted OR for watermelon was 5.2 (95% CI 1.1- 24.2; p=0.034).

Environmental investigation—Health Protection staff found that the watermelons the grower kept at the roadside stalls were kept in the sun and were very warm. They also found the pack-house to be a tin lean-to with a bare floor. Rat faeces were found throughout the pack house floor and on a number of surfaces (tables, shelves etc) and birds were nesting in rafters above the packing table. The watermelon patch itself was located near a septic tank with the effluent disposal trenches possibly extending adjacent to or into the growing areas.

Laboratory investigation—All samples of watermelons and leftover foods from cases tested negative for Salmonella. PFGE analysis of isolates determined that cases were caused by indistinguishable STM1 isolates.

Discussion

The outbreak of Salmonella typhimurium phage type 1 in Gisborne was associated with the consumption of watermelon purchased from a road side stall in Gisborne. Although cases had increased odds of exposure to ham, this association was not statistically significant. Slicing the watermelon without washing and purchasing pre-cut watermelon were also associated with illness.

The epidemiological and environmental findings suggest that the watermelon surfaces may have been contaminated by bird, rodent and/or human waste, all of which have been implicated as sources of human salmonellosis. It is also possible that lack of temperature control may have contributed to the outbreak.

Although this is the first Salmonella outbreak associated with watermelon described in the literature in New Zealand, cut melon has been found to be associated with
salmonellosis elsewhere, and the US FDA have time and temperature requirements for the sale of cut melon.  

This study was relatively small, with only 15 cases and 40 controls, which limited our ability to detect significant associations. A sample size of 21 cases and 63 controls would be necessary to detect an odds ratio of 5.0 with 95% confidence and 80% power.

Recall bias may have been an issue in this study as the cases were re-interviewed for the case control study approximately 4 to 6 weeks post illness onset date. Cases were questioned about exposures in the five days prior to onset of symptoms (case exposure period). To minimise recall bias, we asked controls about the five days prior to interview rather than the corresponding case’s exposure period.

To determine the likelihood of controls having the same exposures during the corresponding case’s exposure period we asked controls “Are your responses to these questions likely to have been similar for the period <case exposure period>”. Half of the controls responded that it was likely to be the same; one fifth responded that it was likely to be different. The remaining (approximately 30%) were either not asked this question or did not know. For controls who responded that it was likely to be different, the reason most often given was that they were on holiday during the case exposure period so would have eaten out more often.

The large proportion of unknown responses was likely due to the fact that some interviewers were unaware of the case exposure period and did not ask this question. Of potential concern is that watermelon consumption is significantly affected by seasonality and changes in availability of watermelon. However, Gisborne public health staff indicated that watermelon was available in the area during the case control study.

Following preliminary investigations, the grower elected to chlorine wash the watermelons. Subsequent visits to the implicated grower found that watermelons and the pack house had been washed. It was reported that a strong smell of chlorine pervaded the area. There were no cases with onset dates after the chlorine wash. A media release also advised locals of the outbreak and recommended washing uncooked farm fresh produce before eating. Watermelon was not specifically mentioned in the media advice.

Although all watermelon samples tested negative for *Salmonella*, watermelon remains the most likely source of the outbreak. The epidemiological and physical evidence suggest the source of this outbreak was the watermelon from the implicated grower. The grower distributed watermelons outside the region but these were washed in chlorine wash before distribution. The only case of STM1 with the “Gisborne” PFGE profile residing outside the Gisborne region was visiting Gisborne during the five days prior to onset of symptoms.

It appears that only the watermelons purchased in the region from the roadside stall were a risk factor, as opposed to all watermelons from this grower. Prior to the outbreak, melons sent outside of this region were chlorinated whereas local melons sold on stalls were not. Chlorine washing of the watermelons prior to distribution is likely to have reduced contamination levels, or perhaps only some watermelons were contaminated, and these were only sold at the roadside stalls. This grower also
supplied other types of melon. Consumption of other melons was not associated with STM1 cases in this outbreak.

**Recommendations**—To prevent future outbreaks such as this, melon growers should be advised to keep fruit free from potential *Salmonella*-contaminated wastes and to chlorine wash watermelon prior to sale. Furthermore, cut watermelon should be kept chilled prior to sale.

**Competing interests:** None known.

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