

An outbreak of norwalk virus gastroenteritis following consumption of oysters

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Abstract

In August 1996, an outbreak of Norwalk virus gastroenteritis occurred among south-east Queensland and northern New South Wales residents over a four week period. Ninety-two of the 97 cases detected were confirmed as having consumed raw oysters within three days prior to developing the illness. No other food items or beverages were significantly associated with the illness. Environmental investigations indicated the Terranora Broadwater, Tweed Heads as the origin of the contaminated oysters. However, the primary source of Norwalk virus could not be verified. Oysters and other shellfish appear to be a common vehicle for transmission of this virus. This outbreak and the more recent hepatitis A outbreak associated with Wallis Lake oysters, highlight the susceptibility of oysters to environmental contamination and the urgent need for stricter quality control procedures. This report details the epidemiological, microbiological and environmental findings from an outbreak investigation conducted jointly by the Queensland and New South Wales health authorities. *Comm Dis Intell* 1997;21:317-320.

Introduction

Norwalk viruses are an important cause of both sporadic and epidemic gastroenteritis¹. Norwalk virus was first identified in 1972 following an outbreak of gastroenteritis in Norwalk, Ohio². Other viruses with similar

features were subsequently described and designated as Norwalk-like viruses^{3,4}. These were named after the places they were isolated from, for example, Hawaii agent, Snow Mountain agent, etc. These small round structured viruses (SRSV) have subsequently

been classified as members of the family *Caliciviridae*⁵.

In late August 1996, South Coast Environmental Health Services, a branch of the Southern Public Health Unit Network (SPHUN, Queensland) received a number of complaints from persons who

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had developed gastroenteritis following the consumption of seafood, in particular oysters. At the same time, the North Coast Public Health Unit (NCPHU, Lismore, New South Wales) were notified of similar complaints. A co-ordinated public health response was initiated by both public health units with the SPHUN investigating cases who were Queensland residents and the NCPHU investigating cases who resided in New South Wales.

Methods

Information on study participants was collected by questionnaire. This information included clinical details, demographic characteristics and food histories from cases and controls. These questionnaires were administered by telephone interview by the NCPHU, and by personal interview or posted questionnaire by the SPHUN. A case was defined as a person who developed either vomiting or diarrhoea, or nausea and one other symptom (abdominal cramps, fever, chills, joint pain, or headache) within 72 hours after eating a meal at which raw oysters were served, or visiting a restaurant, a community club or function where seafood was served. Controls were defined as persons nominated by a case as having attended the same event as the case without developing any symptoms of gastrointestinal illness within 72 hours of the event. Cases were either patients who presented directly to the public health units, or persons nominated by a case as having attended the same function and were known to develop a similar illness.

Stool samples were collected from persons who met the case definition. The samples were submitted for faecal microscopy, bacterial culture, and viral studies including electron microscopy and immune electron microscopy. As many of the cases identified oysters as the most likely cause of their illness, samples of raw oyster were collected from both retail and wholesale distributors, and also submitted for bacterial and viral testing. Bacteriological testing was performed by the respective State health laboratories. Specimens for viral studies were sent to the Institute of Clinical Pathology and Medical Research (ICPMR), Westmead, New South Wales. Four faecal samples and a composite oyster sample were forwarded to the Department of Veterinary Pathology, University of

Sydney for detection of Norwalk and other viruses by reverse transcriptase polymerase chain reaction (RT-PCR). No serological testing was performed.

Initial environmental investigations included ascertaining the area where oysters were harvested, testing the quality of water where oyster leases were located, and examining oyster purification plant operations. Subsequent investigations focused on the likelihood of raw sewage contamination through reticulation failures, checking the timing of tidal discharge of treated sewage, and exploring the possible influence of recent nearby residential development.

Epi-Info version 6.03 was used for the analysis of the data⁶. Crude odds ratios with 95% confidence intervals were calculated to estimate measures of association between exposures and illness, and two-tailed chi-square or Fisher exact tests were used for statistical significance testing.

Results

A total of 97 cases of gastroenteritis were identified by both public health units. Of the 97 cases, 93 (95.8%) responded to the questionnaires. There were 69 controls, with a response rate of 44.9%. The duration of the outbreak was approximately four weeks. The first reported date of onset of illness was 12 August (Day 1), and the last reported onset date was 4 September (Day 24) (Figure 1). Eighteen cases with onset dates on 25 or 26 August (Day 14 or Day 15) attended the same function. Approximately one week later, 24 cases with onset dates between 2 and 4 September (Day 22 and Day 24)

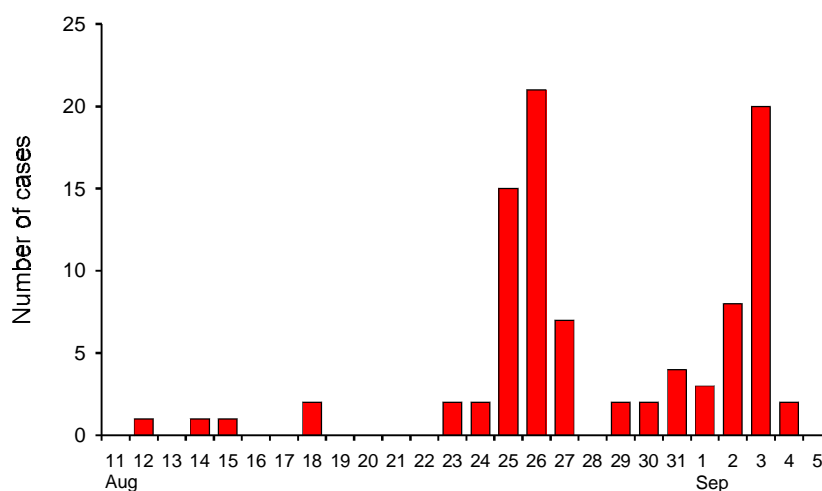
were all guests of another large function.

Restaurants, sports and community clubs, and a private function were all involved in the outbreak. The consumption of raw oysters within three days prior to becoming ill was the common feature among 92 of the 93 cases. One case did not eat any seafood but admitted to handling raw oysters before consuming other food at a restaurant. The incubation period following consumption of oysters ranged from 5 to 60 hours (median 35 hours). However, 87% of cases had an incubation period of between 24 and 48 hours. Nausea and diarrhoea were the most common symptoms, followed by vomiting, stomach cramps, headache, fever/chills, and joint pain (Table 1). The duration of illness ranged from six hours to ten days (median 48 hours). The cases ages ranged from 13 to 83 years, with a male to female ratio of 1:1. Twenty-four cases (25.8%) consulted a medical

Table 1. Frequency of symptoms in cases

Symptoms	Per cent of cases
Nausea	95.7
Diarrhoea	90.2
Vomiting	80.4
Cramps	73.9
Headache	57.6
Fever/Chills	56.5
Joint pain	51.1

Figure 1 Number of cases of gastroenteritis following oyster consumption, by date of onset.



practitioner. There appeared to be no secondary cases among household contacts to suggest person to person spread. Two controls at one of the above functions ate oysters but did not develop any symptoms. All other controls did not consume oysters.

Analysis of the data showed a strong association between consumption of oysters and illness (odds ratio 1334, exact 95% CI 99-22026). No other food item or beverage listed on function or restaurant menus were significantly associated with illness. The number of oysters consumed by individuals was not consistently reported to enable the calculation of a dose-response effect.

Seven faecal samples, including two collected during the acute phase of illness, were submitted for laboratory analysis. All were negative for ova, cysts and parasites, and for bacterial pathogens including *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., *Vibrio* spp., and *Yersinia* species. Faecal specimens examined by electron microscopy and immune electron microscopy failed to detect any virus particles. However, one of the four specimens subsequently tested by RT-PCR was positive for Norwalk virus (genotype 2). None of the above bacterial pathogens were detected in any of the raw oyster specimens. However, faecal coliform counts were elevated in some oyster samples (Australian Food Standards Code recommends a maximum *E. coli* level of 2.3/g). A composite oyster sample was positive for adenovirus by PCR. Norwalk virus was not detected in this oyster sample.

Environmental investigations indicated that the oysters associated with this food-poisoning outbreak were harvested from a common source, the Terranora Broadwater area at Tweed Heads. Water quality testing of numerous sampling sites near oyster harvest areas during a two week period showed faecal coliform counts varying between 4 per 100 ml and 340 per 100 ml (National Health and Medical Research Council, United States Food and Drug Authority and New South Wales Environmental Protection Agency guidelines recommend maximum faecal coliform levels of 14 per 100 ml)⁷. A number of possible sources of faecal contamination were identified during the investigation. These included leaking sewerage pipes, a leaking sub-marine sewerage pipe, 600 septic tanks in the residential

development on one side of the Broadwater, and stormwater drain discharges. Any contamination would be exacerbated by the poor tidal exchange in the Broadwater area. This had previously been demonstrated with the use of dye testing by the New South Wales Environment Protection Agency (EPA) in 1985. The timing of tidal discharge (outgoing tide) by the sewage treatment plants was in accordance with regulations. Two out of five oyster purification plants on the Tweed River were currently in use and found to have unsatisfactory purification and sterilisation techniques, although the limitations of these in removing viruses is widely acknowledged.

Discussion

The findings from this investigation clearly implicated oysters as the likely vehicle of transmission for this outbreak. Although the wide confidence interval around the odds ratio indicates a small study sample, it is unlikely that any other food or beverage item would be causally associated with this illness given the strength of the association with oysters. Similarly, the poor questionnaire response rate of the controls and the different approaches to data collection by each public health unit may have introduced biases into the study. However, it is unlikely that these would change the findings of this investigation.

The number of cases related to this outbreak was probably considerably greater than the 97 cases identified, either because patients experienced only mild symptoms, or health authorities were not informed. However, the management of media releases assisted in the identification of unknown cases. The bimodal epidemic curve reflects two separate large functions held on consecutive weekends. Of the 94 persons known to eat oysters, all but two developed gastroenteritis. In contrast, only one out of 30 persons who were known not to consume oysters developed the illness. It is possible that the two subjects who did not become ill ate uncontaminated oysters, or both may have had asymptomatic infection.

The aetiological agent responsible for gastroenteritis appears to be Norwalk virus. This is a small round structured RNA virus (SRSV) which has previously been implicated as the

aetiological agent in a number of acute non-bacterial gastroenteritis outbreaks⁸⁻¹¹. Oysters and other shellfish appear to be a common vehicle for transmission of this virus. Oysters have also been shown to transmit bacterial and other viral pathogens including *Shigella* spp., *Salmonella* spp., *Vibrio* spp., and hepatitis A^{10, 12-14}.

The incubation period and clinical symptoms of cases were consistent with a Norwalk-like infection, according to 'Kaplan's criteria'¹⁵. Kaplan's criteria include; stools negative for bacterial pathogens, greater than 50% of cases with vomiting, a mean or median incubation period of 24 - 48 hours, and a mean or median duration of illness of between 12 - 60 hours. These criteria have been shown to have a relatively high specificity and sensitivity for a Norwalk-like infection during outbreaks of gastroenteritis. Although the gastroenteritis is usually self-limiting and not life-threatening, the likelihood of more severe disease may be increased for immunocompromised persons and the elderly.

Norwalk virus was not detected in seven faecal specimens tested by electron microscopy. However, the sensitivity of electron microscopy is limited if faecal specimens for viral examination are not collected within 48 hours of onset of illness. The recent development of RT-PCR as a diagnostic tool has improved detection rates, and the sensitivity of this test enables faecal specimens to be submitted up to seven days after the onset of illness¹⁶. The cost and time required to process specimens for Norwalk virus PCR testing currently limits its use as a routine diagnostic tool. The application of Kaplan's criteria as a screening tool would be helpful in determining whether faecal specimens should be sent for molecular diagnostic testing during outbreaks, particularly if there is a delay in the collection time of specimens rendering them unsuitable for electron microscopy.

Serological testing was not requested for any of the cases involved in this outbreak. Enzyme immunoassay (EIA) and radioimmunoassay (RIA) techniques have been used for the detection of Norwalk virus during foodborne outbreaks^{10,17}. Serological testing should become more widely employed during suspected Norwalk virus outbreaks. This would complement faecal diagnostic testing,

and also address the difficulty in detecting Norwalk virus in stools, and the poor compliance with submitting stool specimens during gastroenteritis outbreaks.

The elevated faecal coliform counts in some of the oyster samples, and the identification of adenovirus in a composite oyster sample, indicate probable sewage contamination. These findings are supported by the results of the water quality testing. Despite these findings, improved indicators of viral contamination of both water and oysters are needed since faecal coliform levels often correlate poorly with the presence of viruses¹⁸. Environmental investigations identified a number of possible sources of sewage contamination. Although the oyster industry is not responsible for sewage pollution, these events highlight the susceptibility of the oyster industry to environmental factors and the need for the industry to implement strict quality control procedures. Quality testing should include continual environmental monitoring of both water and oysters, and increased laboratory testing during and after pollution incidents. In addition, oyster purification and processing plants need to be monitored regularly by food inspection services. The recent outbreak of hepatitis A (over 400 cases) associated with the consumption of raw oysters from the Wallis Lake area in New South Wales highlights the urgency of these requirements.

Terranora oysters were removed from retail and wholesale outlets following strong evidence that oysters were the most likely vehicle of transmission during the outbreak. No other cases were detected following this intervention. Harvesting of oysters was prohibited from the river for several months, until water quality met recommended standards and a comprehensive ongoing quality assurance program was in place. This investigation also highlighted the shortcomings of existing regulations

designed to facilitate tracking of oysters from the consumer or retailer back to purification batches, oyster leases, or harvest dates. It was noted that record-keeping was inadequate and that mixing of oysters from different sources was widespread practice. This issue needs to be closely examined by government agencies and the oyster industry to enhance recall effectiveness while minimising the economic implications of the recall.

This outbreak of gastroenteritis has raised a number of significant issues regarding the oyster industry and public health safety. Effective quality assurance programs and more extensive collaboration and communication between oyster producers and local/State government agencies are urgently required.

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