Guidelines for the Management of Norovirus Outbreaks in Hospitals and Elderly Care Institutions

Picture: Composite reconstruction of Norwalk virus recombinant capsids using cryo-EM at 22 Angstroms resolution. Reference: Dr BV Prasad, Baylor College of Medicine, Houston, Texas.

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Foreword

Outbreaks of norovirus gastroenteritis are being increasingly recognised in the community and within hospitals and elderly care facilities in New Zealand (Greening et al 1999; McClelland et al 1999; Simpson and Simmons 2001). The outbreak of norovirus gastroenteritis continues to be a significant test of the mettle of infection control practices in residential and health care facilities. Outbreak management has been defined as 'the process of anticipating, preventing, preparing for, detecting, responding [to] and controlling outbreaks in order that health and economic impact is minimised' (ESR 2002). These guidelines have been developed to standardise the approach of public health services, managers and health care workers of hospitals and elderly care facilities in New Zealand to both the investigation and control of institutional norovirus outbreaks. They draw on similar guidelines produced in the United Kingdom (Cartwright 2002; Doultree 1999) and the United States (Anonymous 2001) and, where possible, provide an evidence-based approach.

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1 Introduction

1.1 Burden of illness in New Zealand

Noroviruses (formerly known as Norwalk-like viruses, NLVs, or small round structured viruses, SRSVs) cause significant morbidity in New Zealand. Although illness is generally of short duration (less than 60 hours) (Kaplan et al 1982), outbreaks are common and often explosive. An estimated 53,000 cases of norovirus infection occur in New Zealand annually (Lake et al 2000) and in 2006 seven deaths were reported.

An outbreak is defined as 'an epidemic limited to localised increase in the incidence of a disease, eg, in a village, town or closed institution' (Last 1995, p 180). In simpler terms, it is defined as 'two or more cases of illness linked to a common source' (ESR 2002). An outbreak of norovirus should be suspected where one patient or resident shows signs of gastroenteritis. Outbreaks of norovirus gastroenteritis are being increasingly recognised in the community and within hospitals, hotels, and elderly and child care facilities in New Zealand (Greening et al 1999; McClelland et al 1999; Simpson and Simmons 2001). Outbreak data reported via the national notification system (EpiSurv) and pertaining to confirmed outbreaks of norovirus in elderly care facilities and hospitals are shown in Table 1.

Table 1: Norovirus outbreaks* in New Zealand hospitals and elderly care facilities, 2007

Outbreak setting	Elderly care facilities (rest home and continuing care)	Hospital (acute care)	Total
Number of outbreaks	127	18	145
Number of laboratory confirmed cases*	995	418	1413
Number of probable cases†	3283	466	3749
Total number of cases	4278	884	5162
Number of deaths	10	0	10

Notes:

* At least one case norovirus positive.

† Clinically compatible illness and epidemiologically linked to at least one confirmed case.

Source: Institute of Environmental Science and Research Limited, Porirua. Outbreaks reported to EpiSurv in the 2007 calendar year.

1.2 The importance of outbreaks in institutional settings

Institutional outbreaks involving hospitals and elderly care facilities are important. Table 1 shows that elderly care facilities accounted for over 85% of all institutional outbreaks reported during 2007. Protracted outbreaks of norovirus infection have been reported in elderly care settings (Jiang et al 1996; Kuusi et al 2002; Marx et al 1999; Milazzo et al 2002; Simpson and Simmons 2001). Hospital patients and nursing home residents represent high-risk populations for the transmission of gastrointestinal illness (Gerba et al 1996; Sawyer et al 1988). The patients and residents are likely to be relatively immunosuppressed and experience a more complicated clinical course.

Outbreaks spread through person-to-person transmission among residents and patients and are complicated by enclosed living conditions and immobility (Anonymous 2001). In nursing homes, faecal incontinence and reduced mental function may present additional challenges to outbreak control. An outbreak occurring in an Auckland elderly care institution in 2002 over a three-week period involved 106 cases, with a 66% attack rate among staff and residents, and resulted in one death.

1.3 Clinical features of norovirus infection

Gastroenteritis caused by norovirus is characterised by acute onset of nausea (81%), vomiting (54%), abdominal cramps (72%) and diarrhoea (85%) (Simmons et al 2001). Some cases suffer from vomiting alone (Adler and Zickl 1969). Vomiting is more common in the young, and diarrhoea more common in adults (Anonymous 2001). Constitutional symptoms such as fever (51%), rigors, muscle and joint pain and headache are also common.

Data from New Zealand outbreaks estimate that the incubation period for illness is 10 to 50 hours (median 32 hours) and duration 2 to 171 hours (median 36 hours) (Simmons et al 2001). It is likely that viral excretion precedes the onset of illness by several hours (Lo et al 1994). Asymptomatic infection has been documented with one-third of those infected in one volunteer study (Graham et al 1994). Asymptomatic infection is important in outbreaks involving infected food handlers (Whyte 2000). Viral excretion in stools persists well beyond the symptomatic phase of illness. Immunity following infection is short-lived and antibody levels correlate poorly with the risk of future norovirus infection (Anonymous 2001).

2 Routes of Transmission and Risk of Infection

2.1 Routes of infection

Genogroup I and II noroviruses are pathogenic only in humans. Faecal–oral spread is the primary mode of transmission although there is documented evidence of airborne spread through aerosolised vomit (Caul 1994; Chadwick and McCann 1994; Marks et al 2000) and spread via fomites (Cheesbrough et al 2000; Green et al 1998). Norovirus is often introduced by an index case who is a food handler, other staff member, new resident or short-term visitor to an institution. On occasion, asymptomatic carriage by staff with sick family members has caused large norovirus outbreaks (Whyte 2000). Contaminated water supplies should be considered as another possible source of infection.

Noroviruses are environmentally hardy, withstanding heating to 60^{o}C, freezing and chlorine concentrations of up to 10 parts per million (Anonymous 2001). One norovirus outbreak among carpet layers was thought to have been due to occupational exposure while removing carpet at a hospital some 13 days since the last case there (Cheesbrough et al 2000). In an institutional setting a major risk of transmission is associated with environmental contamination with norovirus. In particular, door handles appear to be efficient vectors for viral transfer. One study suggested that at least 14 people could be contaminated one after the other by touching a contaminated door handle (Reinbaben et al 2000).

2.2 Risk of infection

Noroviruses are highly infectious. The infectious dose is thought to be very low, possibly as low as one viral particle, the ingestion of which has been estimated to result in a 21% probability of infection in a susceptible individual (Moe et al 1999). The stools of cases typically contain 10^{9} viral particles per millilitre during the diarrhoeal phase of illness (Anonymous 2001).

3 Virology and Laboratory Confirmation

Noroviruses are non-enveloped, single stranded RNA viruses belonging to the human *Caliciviridae* family (Ando et al 2000). They are non-culturable, and diagnosis is based on nucleic acid testing. New Zealand has facilities for laboratory identification and genotyping of noroviruses. Testing of stools and some types of food is available.

Testing can be arranged by contacting the local public health service. Samples are tested using an RT-PCR method (Greening et al 2001) by the Institute of Environmental Science and Research Limited (ESR). Electron microscopy and serology are not available for diagnostic purposes in New Zealand.

3.1 Collection of clinical specimens

In all cases where clinical or environmental sampling is envisaged, discuss this intention first with the local public health unit and ESR Public Health Laboratory staff (Christchurch) or ESR Environmental Virology Laboratory staff (Porirua). Collect samples in an outbreak linked to a common event or source where any of the following criteria apply.

- The incubation period is between 10 and 50 hours and has a mean duration of 12 to 60 hours.
- The predominant symptoms are vomiting or diarrhoea.
- Clinical samples are negative for bacterial pathogens.

Note that samples should be collected as soon as possible but in some cases may yield positive results up to 10 days after symptom onset.

All specimens must be carefully labelled with the case's personal details and accompanied by a request form with an EpiSurv outbreak number. To obtain an EpiSurv number, contact the local public health service. Samples accompanied by an EpiSurv number can be submitted to non-public health laboratories. Non-public health laboratories usually have existing courier systems that may be utilised to transport samples for viral analysis. Direct any request for this service to the community laboratory microbiologist.

3.1.1 Stool sampling

In addition to being tested for norovirus, stools should be tested for other common viruses (rotavirus, adenovirus), bacteria and parasites (*Giardia* and *Cryptosporidium*) that cause gastrointestinal illness, to exclude these pathogens. If possible, in consultation with the local public health service, it is also worthwhile to exclude toxin-forming bacteria, particularly *S. aureus* and *B. cereus*.

3.1.1.1 Timing of stool samples

Ideally stool samples should be taken during the symptomatic phase of the illness (zero to three days from onset). However, excretion persists for some days. Positive RT-PCR results have been frequently obtained on samples taken at three to four days from the onset of illness (Gao and Simmons 2000). A positive result has been recorded from a case some 12 days after the onset of illness (the literature reports a positive RT-PCR result for norovirus 14 days after symptom onset: Kakishima et al 1999). Parashar and co-workers reported a study where food handlers were found to excrete norovirus for up to 10 days following infection (Parashar et al 1998).

Therefore, generally consider stool sampling up to 10 days from the onset of illness.

3.1.1.2 Number of stool samples required for clinical analysis

For those cases in the symptomatic phase of illness, two stool samples from different bowel motions should be sufficient to confirm norovirus infection. Fill at least one-third of each standard specimen container with sample.

3.1.1.3 Total number of samples required

In small outbreaks, the number of clinical samples obtained may be limited by the low number of cases. For propagated outbreaks, the strategy is to test in batches of three until a positive result is obtained. Once the presence of norovirus is confirmed, subsequent specimens from new cases are usually not necessary.

3.1.1.4 Sample storage and transport

Store specimens awaiting collection in a cool place. This place may be a dedicated specimen fridge or freezer but, because of the risks of cross-contamination, specimens should not be stored in a food refrigerator.

Transport samples to the laboratory under biohazard precautions. Double-bag all specimens and preferably refrigerate them in a chilly bin during transportation.

3.1.2 Vomitus samples

Norovirus can be detected in vomitus. The same recommendations for storage and transport pertain to vomitus as for stool samples. However, virus yield is usually better from stool/faecal specimens than from vomitus so stool specimens are preferable.

3.2 Collection of other samples

3.2.1 Food samples

Norovirus tests on food samples are technically difficult and expensive. ESR will consider requests for analysis of food on a case-by-case basis but, in general, it requires strong epidemiological evidence linking a suspected food to an outbreak.

The foods for which testing is available include bivalve shellfish such as oysters and muscles (usually due to primary contamination at the growing site), salad greens, fresh whole fruits (berries, tomatoes) and ready-to-eat meats. Analysis is performed at the ESR Environmental Virology Laboratory, Porirua.

3.2.2 Environmental samples

3.2.2.1 Surface swabs

Solid surfaces such as door handles, taps and benchtops can be swabbed with sterile cotton swabs moistened in viral transport medium (VTM), placed back into the VTM container, and then sent to the ESR Environmental Virology Laboratory. VTM is available on request from either the Auckland ESR Public Health Laboratory or the ESR Environmental Virology Laboratory, Porirua.

Alternatively the commercially available 'green topped' viral culture swab can be used.

3.2.2.2 Water samples

Water testing for norovirus is now available in New Zealand. A 20-litre sample taken in a clean plastic drum is recommended. Take the sample from the cold tap only and do not flame the tap.

Discuss testing with the manager of the ESR Environmental Virology Laboratory, Porirua prior to sampling.

4 Management of Patients and Residents with Norovirus Infection

The aim of management is to minimise the exposure of cases to other residents, patients, staff and visitors, particularly during their symptomatic phase when excretion of virus is likely to be at its highest. It also involves keeping norovirus outbreak case log on all cases, including staff members, detailing which room they resided in (or, for staff, rooms they attended during the incubation period for illness) and the nature of symptoms, the date of their onset, and when the symptoms resolved (see Appendix 1).

4.1 Clinical assessment

Consider any vomiting staff member, patient or elderly care resident to have norovirus infection until proven otherwise. Shift them immediately into an isolation room (or, if staff, send them home) and give them priority medical assessment. Although norovirus gastroenteritis is a self-limiting infection, the elderly, particularly those with pre-existing medical conditions, often suffer greater morbidity. Carefully assess the state of hydration.

Where possible, cohort patients or residents who were exposed to a case or present during a defined outbreak period for a maximum incubation period (three days). Segregate any new admissions from those who may be about to develop symptoms.

4.2 Hand hygiene

The actions taken to decontaminate the hands so that they are free of micro-organisms with the potential to cause human illness are collectively referred to as 'hand hygiene'. Hand hygiene is critical to outbreak management. It is well documented as being the most important hygienic measure for preventing the spread of infection (CDC 2002; Pittet et al 2000).

Among the key actions required for hand hygiene are to: wash hands with soap and water, then dry them effectively; use antiseptic hand-wash; and use antiseptic (waterless) hand-rub or surgical hand antisepsis (CDC 2002).

Counsel all those in the institution where an outbreak occurs – staff, patients and residents – about hand hygiene. In an outbreak of norovirus infection, it is recommended that hands be thoroughly washed and dried in the manner outlined below.

4.2.1 Hand washing

The ingredients = running water + soap + friction + time

The time spent washing is important in reducing the transmission of micro-organisms. Recommended practice is to wash hands with running water, and vigorously rub with soap for at least 20 seconds (Miller and Patrick nd). The use of a nail brush is not recommended.

Local observations of the hand hygiene practised by the public in the toilets of a shopping mall give cause for concern. On average, people washed their hands for 8.6 seconds in these locations (Garbutt et al 2007).

4.2.2 Hand drying

Time spent drying is important – 'dry hands are safe hands'

Wet hands can transfer microbes more efficiently than dry hands that are not washed at all (Patrick et al 1997). The drying time required to reduce the transfer of germs varies with each drying method. Repeated drying of hands on a single reused cloth towel is not recommended. The practice is not effective for hand hygiene because the towel is likely in time to become wet and may act as a source of hand contamination rather than removing it.

The methods and recommended duration of drying are outlined in Table 2 (Miller and Patrick nd; Patrick et al 1997).

Table 2: Recommended hand drying methods and times

Drying method	Recommended protocol	Total drying time	Comments
Single-use paper towel	Rub hands on two towels, drying for 10 seconds on each.	20 seconds	The first towel removes the bulk of the water; the second achieves a thorough dryness.
Single-use cloth towel (roller with plastic contamination guard)	Rub hands on two sections of the towel, drying for 10 seconds on each section.	20 seconds	The first section removes the bulk of the water; the second achieves a thorough dryness.
Hot air dryer	Rub hands together while rotating under warm air.	45 seconds	The prolonged period is required for complete dryness.
Combination of cloth/ disposable towel and hot air dryer	Rub hands on one section of cloth or disposable towel for 10 seconds to remove bulk of water. Then rotate hands while rubbing together under the hot air dryer for 20 seconds.	30 seconds	This is called the 10/20 drying method.

4.2.3 When should hand hygiene be performed?

Decontamination of hands is part of standard precautions and should be performed after any contact with the intact skin of a patient or resident or with environmental surfaces in their vicinity (CDC 2002). In general, hand hygiene should be performed at any time when significant hand contamination, such as hands-on contact with potentially infected people, has occurred and the potential for cross-contamination then arises.

Cross-contamination occurs when unhygienic hands move on to touch foods, utensils and other objects in the environment. 'Risk' activities resulting in hand contamination include:

- going to the toilet
- cleaning toilets and bathrooms
- handling potentially soiled clothes and bed linen
- cleaning up after emetic or faecal accidents
- handling cleaning accessories such as cloths, buckets and mops
- removing gloves
- touching any environmental surface in an isolation room of a norovirus case
- touching surfaces that are subject to high levels of manual contact by patients, residents, staff and visitors such as rails and door knobs.

Note: Hands should also be washed and dried after every break and on entry to the food preparation area.

4.2.4 Alcohol-based hand sanitisers

The use of alcohol hand disinfectant has been shown to have advantages over standard hand washing in respect of bacterial contamination of hands (Cookson et al 2001; Girou et al 2002; Parienti et al 2002). However, it is recognised that alcohol is usually ineffective in disinfecting non-enveloped viruses (Murray and Baron 2007) and there is conflicting evidence about how effective hand sanitisers are against viruses such as norovirus (Doultree 1999; Duzier and Bijkerk 2004; Gehrke et al 2004; Kampf et al 2005; Malik et al 2006; Yee et al 2007).

In an outbreak, encourage people to use alcohol gel only after they have washed and dried their hands thoroughly. However, in situations where access to adequate facilities for handwashing is limited, it is reasonable to provide and encourage the use of alcohol hand sanitisers as a means of achieving a degree of hand hygiene. Commercially produced alcohol hand-rub solutions are readily available but if these cannot be accessed an alcohol hand-rub solution can be prepared by adding 2 ml of glycerine, propylene glycol, or sorbitol to 100 ml of 60–90% alcohol solution (Engender Health 2004).

Pour 3–5 ml of alcohol hand-rub into the palm of each hand and then rub the hands together until they are completely dry. Chlorhexidine 4% can be used as a sanitiser during hand washing.

4.2.5 Use of gloves

Wearing gloves is not a substitute for hand hygiene. Gloves in themselves confer no protection against cross-contamination – like bare hands, they may transfer microbes to other environmental surfaces. When using gloves, wash and dry hands before and after significant contact with the patient or resident, and likewise replace gloves before and discard them after such contact. Hands must be washed after activities involving handling of contaminated items and after removal of gloves.

4.3 Patient/resident isolation

Place symptomatic patients or residents in contact isolation – preferably a single room with dedicated ensuite or toilet. Post signage, stating the patient or resident is in isolation, on the door of their room or wherever the isolation zone begins.

If the patient or resident is vomiting, instigate airborne precautions (see section 7.1.3). If there are a number of cases, consider cohorting them in the same room(s). Precautions can be discontinued 48 hours after symptoms cease in faecally continent cases.

4.4 Patient/resident movement and transfer

Restrict movement of patients or residents out of isolation rooms to essential purposes. Do not transfer symptomatic cases within the institution to other wards, hospitals or elderly care facilities for at least 48 hours after symptoms cease. Even at this point, the receiving institution should be made aware of the case's illness well before transfer so that extra infection control measures can be undertaken at the management's discretion. Local experience suggests that the transfer of previously symptomatic cases between institutions appears to be an important way in which norovirus is introduced.

Where patients or residents as a whole are likely to have been exposed to norovirus, a temporary ban on transfers to other hospitals and elderly care facilities is recommended.

4.5 Closure of facility to residents and admissions

In certain circumstances, such as where outbreak control is difficult and significant ongoing risk of norovirus infection exists, closure of hospital wards or elderly care facilities to new admissions or residents may need to be considered. In general, criteria for considering closure will include both of the following.

- There are ongoing cases despite full implementation of outbreak control measures.
- There is a high level of debility among new arrivals. For example, an elderly care hospital or hospice constitutes a considerable risk of severe disease.

5 Management of Staff

5.1 Staffing of isolation room(s)

Prevent non-essential staff from entering isolation rooms. Cohort staff who look after cases during an outbreak so that the minimum number of staff is exposed to cases.

Staff having direct contact with symptomatic cases in the isolation room should wear a gown and gloves. If the case is vomiting, they should also wear a P2 particulate respirator mask approved by the National Institute for Occupational Safety and Health (NIOSH) (N95). Suitable respirators available in New Zealand include 3M 1860, Moldex 2200, Gerson G1920 and Tecnol PFR 95 (Harrison and Calder 2002). If the case is not actively vomiting, there is no evidence that masks confer any greater protection against infection for close contacts (Chadwick et al 2000).

If possible, vent airflow to the exterior of the building from the isolation room(s) such as by opening exterior windows.

No staff or visitors should enter the isolation room unless familiar with isolation procedures. Highlight the importance of hand hygiene after glove removal to staff and visitors.

An example of an information sheet for staff is provided in Appendix 5.

5.2 Management of infected staff

The loss of a large number of staff through illness may place a significant burden on those remaining at work. However, exclusion of the ill is still an important strategy.

- A staff illness policy outlining the requirements for exclusion and the circumstances for return should normally operate in any institution.
- Operate a sickness log to record details of ill staff, including their symptoms when they became ill and their date of return to work.
- During an outbreak, exclude staff at the first suggestion of illness, such as nausea or abdominal pain.
- Emphasise hand hygiene and highlight information of how to deal with emetic or faecal accidents to sick staff that are going home so that the risk of household transmission of norovirus infection is minimised.
- Viral excretion persists for days so it is not practical to require clearance of norovirus from stool before staff return to work. Allow staff to return to work after they have been symptom free for at least 48 hours.
- In view of the above, further counsel returning staff on the importance of hand hygiene as they may still be infectious.

6 Management of Visitors

Minimise visits to symptomatic cases. Prevent visitors of a suspected case from visiting other patients or residents.

Visitors must comply with all isolation procedures. Supervise them when they are putting on and removing gown and gloves to ensure hand hygiene is thorough.

Tell visitors of a suspected case of norovirus infection that they must not visit patients or residents in other institutions for at least three days.

7 Cleaning and Disinfection

Undertake enhanced cleaning of the rooms of norovirus cases, their toilet and bathroom areas, and environmental surfaces exposed to hand contact such as telephones, hand rails and door handles.

Noroviruses are non-enveloped, single-stranded RNA viruses. Quaternary ammonium compounds are commonly used for disinfection in a variety of settings and work by disrupting viral envelopes. As norovirus does not have an envelope, quaternary ammonium compounds do not have significant activity against them (Engender Health 2004; Harrison and Calder 2002; Yee et al 2007). Ethanol and anionic compounds have also been shown to be relatively ineffective as disinfectants for norovirus (Chadwick et al 2000).

Quaternary ammonium and phenolic disinfectants are **not** recommended for use in norovirus outbreaks as they are less effective than bleach. Household bleach is a high-level disinfectant capable of killing norovirus. To work properly, bleach disinfectant needs:

- enough time to kill – at least 30 minutes' contact time is ideal
- sufficient strength or concentration
- a surface free of organic material such as vomit or faeces.

IMPORTANT: Make up a fresh solution of the bleach each day and discard it if not used within 24 hours.

Supermarket bleaches are sold in different strengths, usually 2–5% sodium hypochlorite solution. The strength is written on the label. The recommended concentration of bleach disinfectant is 1000 ppm (0.1%) sodium hypochlorite (Cartwright 2002). To assist in achieving this concentration, Table 3 provides a guide to diluting supermarket bleach.

Table 3: Recipes to achieve a 0.1% bleach solution

Original strength of bleach (% sodium hypochlorite)	Volume of bleach needed (millilitres)	Volume of water needed (millilitres)	Total volume (millilitres)	Parts per million (ppm) achieved
1%	1000	9000	10,000	1000
2%	500	9500	10,000	1000
3%	333	9677	10,000	1000
4%	250	9750	10,000	1000
5%	200	9800	10,000	1000

An alternative to hypochlorite is accelerated potassium peroxymonosulphate, the active ingredient in Virkon®. Virkon is a broad spectrum virucidal which, at a strength of 1%, has been shown to be effective against feline calicivirus (Eleraky et al 2002). Although more expensive than hypochlorite, Virkon has advantages in that it is less corrosive than hypochlorite, is safe to use both as a spray and surface decontaminant and is virtually odourless.

Other alternatives are disinfectants containing 0.8% iodine or 0.5% gluteraldehyde (Doultree 1999). Chlorine dioxide can also be used.

7.1 Cleaning equipment

7.1.1 Cloths

For general cleaning of the environment, use disposable cloths and dispose of them in a biohazard bag.

As an additional precaution, use separate cloths of an identifiable colour for cleaning higher risk areas such as toilet and bathroom areas. Restrict their use to these areas only. Discard after use.

7.1.2 Mops

After use, soak reusable mops in 0.1% hypochlorite solution and hot launder them.

7.1.3 Personal protective equipment

No staff member should be expected to clean up faecal or emetic accidents or be exposed to toilet facilities of cases, without adequate personal protection. Recommended protective equipment includes:

- disposable gloves
- a disposable gown
- a particulate respirator mask (N95) if in the presence of vomiting cases or where aerosols may be generated (eg, cleaning the toilet bowl).

7.2 Cleaning of toilets, bathrooms and vacated rooms

Solutions exceeding 1000 ppm chlorine may be used in bathrooms, particularly if there have been faecal or emetic accidents. Pay special attention to toilet seats, bowls, toilet paper dispensers, door handles and latches, tap faucets and handles.

When a resident or patient who has been an outbreak case vacates their room, clean it thoroughly. Pay special attention to cleaning soiled mattresses and soft furnishings including drapes and carpets. Furnishings can be placed outside to expose them to sunlight as a way of assisting disinfection. Do not machine buff contaminated areas as norovirus particles may then become airborne. Dry vacuuming of carpets and soft furnishings is discouraged as the virus is suspected to persist for some weeks (Cheesbrough et al 2002) and vacuuming can re-suspend it in the air.

Clean both staff and public toilets more frequently. For example, clean them every two hours during an institutional outbreak.

When guests, residents or patients who have been cases vacate their rooms, clean environmental surfaces using hypochlorite solution, or Virkon, and disposable cloths (or steam clean soft furnishings). Launder curtains.

7.3 Swimming and therapeutic pools

A written protocol should exist for managing faecal or vomiting accidents involving swimming pools and accompany the records verifying good pool management procedures. This protocol should follow the standards outlined in New Zealand Standard 5826:2000 Pool Water Quality. The procedure should differentiate between solid faecal matter and diarrhoea, as well as between standard measures and disease outbreak measures in the case of diarrhoea.

These procedures aim to provide pool managers with adequate and practical measures to reduce the risk of pathogen contamination of pool water. The pool management **must** record all faecal accidents.

Faecal solids

After an accident involving faecal solids, undertake the following procedure.

1. Evacuate and isolate the pool.
2. Remove solids.
3. Spot super chlorinate (in excess of 100 mg/L) using a watering can or similar.
4. Keep the area clear for 30 minutes.
5. Ensure the chlorine is adequately dispersed before allowing people to re-enter the pool. (Spot test area to check chlorine dilution.)

Diarrhoea or vomit

After an accident involving diarrhoea or vomit, undertake the following procedure.

1. Evacuate and isolate the pool.
2. Remove any solid matter; vacuum to waste.
3. Increase the pool's free available chlorine (FAC) to no less than 5 mg/L.
4. Keep the area clear long enough for faecal matter to be removed by vacuum and at least three pool turnover periods.
5. Ensure the chlorine is adequately dispersed before allowing people to re-enter pool.

In an outbreak, consider restricting access to the pool for convalescent cases who are now asymptomatic.

7.4 Cleaning up vomit and faeces

Vomiting in particular confers significant risk of infection to those exposed to aerosols (Marks et al 2000). After a case has vomited, undertake the following precautions.

- Usher staff, apart from those necessary to attend to the case, and others quickly from the room or, if the incident occurred in a corridor, cordon off the area.
- Involve as few staff as possible in the clean-up operation. If possible, cohort staff involved in cleaning up contaminated material to limit the exposure of other staff.
- If possible, open windows and doors to direct the airflow to the outside of the building.
- Staff should wear disposable gloves, a plastic disposable apron and a particulate respirator mask (N95) if aerosols are likely to be present (if it is within an hour of the incident occurring).
- Clean up by removing soiled clothing in an impermeable and appropriately coloured bag for linen.
- If possible, remove soiled furniture to a safe and isolated place for thorough cleaning.
- Where there is soiling by faeces, it is important to first clean the soiled area with detergent and hot water, using a disposable cloth, to remove all organic debris then disinfect with hypochlorite. Where there is faecal soiling, using hypochlorite alone will not adequately decontaminate surfaces (Barker et al 2004).
- If possible, disinfect the contaminated and surrounding areas with 1000 ppm (0.1%) hypochlorite solution or 1% Virkon.
- Dispose of masks (where worn), gloves and aprons in designated biohazard bags.
- Wash and dry hands thoroughly following the hand hygiene protocol.
- Restrict access to the contaminated area for at least 30 minutes. If necessary, cordon it off.

7.5 Cleaning soft furnishings and fabrics

Hypochlorite is corrosive and may rot or bleach soft furnishings and fabrics. Virkon may be used on these fittings but its penetration into fabrics may be limited and organic material such as vomit may reduce its effectiveness. The following guidelines therefore apply to cleaning soft furnishings and fabrics.

- Clean contaminated soft chairs, mattresses and carpets (that are not bleach resistant) first with hot water and detergent. Subsequently steam clean them.
- Handle contaminated curtains, soiled linen and bedclothes with protective clothing (apron and gloves). Ideally place the linen in a colour-coded linen bag (eg, yellow skip) to warn of contamination. Put any waste into waste bags inside the case's room. Replace linen and waste bags at least daily or when two-thirds full.
- Vacuuming carpets (when dry) is discouraged as norovirus particles can become airborne and may remain infectious for weeks (Cheesbrough et al 2000).

7.6 Laundry

Laundry may be contracted out or some larger institutions may launder on site. Laundry workers need to be protected from the risk of norovirus infection. Hot-wash soiled clothes or linen. Workers handling these items should wear disposable gown, mask and gloves.

7.7 Food service

- Use the usual meal trays, plates and cutlery. Menus and trays do not need special treatment.
- Have a written infected food handler policy in place. Send food handlers home at the first sign of any illness.
- Limit access to the kitchen and food preparation areas to dedicated staff only.

8 Outbreak Notification

All suspected outbreaks should be promptly notified to the local public health service. A database recording all known New Zealand communicable disease outbreaks is maintained by the public health service and ESR via EpiSurv, the computerised communicable disease notification system. This database provides an important surveillance tool for outbreaks in the community, hospitals and elderly care facilities.

The manager of the institution should immediately notify a suspected outbreak to the local public health service who is responsible for disease control activities in partnership with infection control specialists (where available). Hold an urgent meeting of relevant stakeholders when an outbreak is **suspected**.

Outbreak management will involve both investigation and control activities. Investigation is important if there is an ongoing suspected source of infection or the investigators have an hypothesis about the source of infection that they want to test. Beyond this, given the importance of direct person-to-person transmission and high norovirus infectivity, most of the emphasis will be placed on outbreak control.

9 Public Health Investigation and Management

The World Health Organization offers this useful guide to outbreak investigation and management, which is outlined below.

- Confirm outbreak and diagnosis.
- Define case.
- Identify cases and obtain information.
- Conduct descriptive data collection and analysis.
- Develop hypotheses.
- Undertake analytical studies to test hypotheses.
- Undertake special studies if deemed necessary.
- Communicate with all relevant parties, including through the outbreak report.
- Implement control measures, which may include:
  - controlling the source of the pathogen
  - interrupting transmission
  - modifying host response (eg, antibiotics – not relevant in norovirus outbreaks).
- Evaluate process.

Outbreak management can be defined as 'the process of anticipating, preventing, preparing for, detecting, responding to, and controlling outbreaks in order that health and economic impact is minimised' (ESR 2002). Outbreak management is an important and skilled role. The manager(s) of the institution should, on suspecting an outbreak, hold an initial outbreak meeting. This meeting should involve key staff and members of external agencies including the local public health service and, if available, infection control specialists. A suggested agenda is provided in Appendix 2.

9.1 Outbreak recognition

In practice the recognition of an outbreak of gastrointestinal illness due to norovirus is usually straightforward due to the prominence of vomiting and diarrhoea and their acute onset in a number of people.

9.1.1 Clinical and epidemiological criteria for outbreak recognition

A number of clinical and epidemiological criteria have been used to assess the likelihood that an outbreak of gastrointestinal illness is due to norovirus (Kaplan et al 1982). Kaplan et al's four criteria are:

1. stool culture negative for bacteria
2. mean duration of illness of 12–60 hours
3. vomiting in over 50% of cases
4. incubation period of 24–48 hours (if known).

Subsequently Hedberg and Osterholm (1993) suggested on the grounds of improved discrimination that the third criterion be replaced by:

3. the ratio of frequency of vomiting to fever is greater than 1.

9.2 Outbreak definition

An outbreak of viral gastrointestinal illness can be defined as two or more linked cases exhibiting symptoms of vomiting or diarrhoea. However, for the purpose of control, suspect any vomiting person of having norovirus infection until proven otherwise and 'suspect' an outbreak with only one case.

9.2.1 Case definition

For the purposes of describing and summarising the outbreak, individual cases of norovirus infection are further defined as either:

- '**probable**' – clinically compatible illness, usually consisting of diarrhoea or vomiting
- '**confirmed**' – satisfies the 'probable' definition but has a positive stool/vomit RT-PCR test for norovirus.

9.3 Data collection and descriptive analysis

The following steps are involved in data collection and descriptive analysis.

- Obtain these descriptive data.
  - Who was ill (demographic data – age, gender) and when (date and time of onset)?
  - Was there direct contact between ill cases?
  - Where did ill residents reside (room number, occupancy and vacation dates)?
  - Was there preceding contact with ill staff?
- Document the timing of faecal and emetic accidents and those potentially exposed.
- Construct an epidemic curve (graph of the number of cases by time and date of onset).
  - Is the outbreak ongoing (are new cases occurring)?

9.4 Developing hypotheses

Based on the descriptive data, consider possible sources of infection and routes of transmission. The following are some questions to cover.

- Are any of the cases food handlers?
- Could drinking or bathing water be a source of infection?
- Is direct person-to-person transmission likely to be an important route of infection and, if so, how?

9.5 Further study

Perform a thorough site investigation.

- What hazards are there for norovirus transmission?

  - Contaminated water? Poor hand hygiene?
  - Review hand hygiene and ill worker protocols. Are changes necessary?
  - What is the system for disposal of soiled linen and clothing?
- Are the staff, residents and visitors adequately protected from exposure to norovirus?

Would there be any benefit in further investigation by way of analytical epidemiological study, such as a cross-sectional or case-control study, in documenting risk factors for illness?

9.6 Communication

The key issue in communication is: have all those who need to know about the outbreak been informed?

9.6.1 Media

Outbreaks of viral illness in institutions attract undue media attention. The friends or families of staff, residents or patients often alert the media. Sometimes the media are alerted to an outbreak before the public health authorities.

One agenda item in the initial outbreak meeting should deal with media inquiries, how they will be responded to and by whom. A proactive response to the media, characterised by an agreed strategy, is recommended.

9.6.2 Staff and residents or patients

Staff and residents or patients have a right to know about any outbreak of infectious disease to which they may be exposed and what to do to avoid infection. They also should be given advice on what to do if they display symptoms.

In relation to norovirus, circulate an information pamphlet (see Appendix 3). Update staff on developments and changes in control strategies at the start of their work shifts.

9.6.3 Visitors

Inform visitors of the existence of a norovirus outbreak. Preferably communicate this message in advance of their arrival or by signage or information at the door of the institution so that those who wish to avoid potential exposure, may do so (see Appendix 4).

9.6.4 Spokesperson

Decide if it is necessary to appoint a spokesperson and, if so, who should take on this role.

9.6.5 Outbreak report

Document all elements of the investigation and control activities, and include them in a formal outbreak report. Distribute the report to key staff, management and others who

need to know. If the local public health service is not involved in the report's preparation, give it a copy.

9.7 Implementing outbreak control measures

The ability to respond to a norovirus outbreak will depend on the nature of the facility. Hospitals are likely to have dedicated infection control specialists. Elderly care facilities that are not hospitals are less likely to have ready access to technical assistance in terms of infection control. Where the capability to respond is limited, a closer liaison with the local public health service will be necessary.

In institutional settings, person-to-person transmission propagates outbreaks through the faecal–oral route either by manual contact or by exposure during faecal and emetic accidents and by aerosols.

The broad principles of hazard control involve elimination, isolation or minimisation. In this way a range of strategies can be envisaged in controlling the hazard of exposure to norovirus. Table 4 documents a range of outbreak control strategies.

Table 4: Summary of outbreak control strategies

Elimination	**Isolation**	**Minimisation**
• Send symptomatic staff home immediately. • Disinfect high risk areas for environmental contamination. • Clean and disinfect surfaces or areas contaminated with vomit or faeces. • Steam clean carpets and soft furnishings contaminated by faeces or vomit.	• Cordon off emetic or faecal accident sites. • Place cases in contact isolation. • Limit cases to dedicated toilet/bathroom. • Cohort cases' contacts separately. That is, observe those that shared a room with a symptomatic case, for 72 hours after last contact with the case.	• Practise thorough hand hygiene. • Wear a gown and gloves to clean up vomit or faeces (and a mask for actively vomiting cases) and open windows and doors to direct airflow out of the building. • Use aerosol spray after emetic or faecal accidents. • Limit staff contact with soiled clothing and bedding.

9.8 Evaluation

Hold a debrief meeting to discuss what went well and what went badly in outbreak management. The debrief meeting should identify and document any changes required to the institution's policies for managing norovirus outbreaks in the future.

Appendix 1: Norovirus Outbreak Case Log

Name	Age	Date of birth	NHI number	Male (M) Female (F)	Staff member (S) Resident (R) Patient (P)	Time and date symptoms started	Time and date symptoms stopped	Specimen sent to lab Y/N	Symptom – eg, diarrhoea, nausea, vomiting, abdominal cramps

Appendix 2: Template for Norovirus Outbreak Meeting Agenda

Meeting date:

Meeting time:

List of those present:

Outbreak summary

Location of outbreak:

Main symptoms:

Case definition:

Number of suspected cases:

Number of confirmed cases:

Total cases:

Number of cases in staff:

Date of onset of illness in first case:

Date of illness in most recent case:

Where are cases in the institution? Are they clustered geographically (eg, by proximity of rooms)?

Any suspected source?

If food is implicated, are there any leftovers?

Have any cases been seen by a doctor and stool sampled?

Outbreak investigation

Who will lead the investigation?

What staff will be necessary to do the investigation and what will be their roles?

Is an analytical (statistical) analysis contemplated? If so, is there capacity to undertake this 'in-house' or is assistance required?

Outbreak management

What needs to be done in relation to each of the following:

- Hand hygiene protocols
- Improved cleaning schedules
- Staff illness policies
- Cohorting of staff and cases.

Is a food safety audit based on Hazard Analysis and Critical Control Points (HACCP) indicated?

Is a risk assessment of the water supply indicated?

- Contemplating temporary closure
- Ordering extra personal protective equipment.

Develop a media strategy

Who will be spokesperson?

Is a proactive media release warranted – eg, to prevent public harm?

Provision of information

Provide information to those who need to know: guests, patients, residents, visitors.

How will this information be given – eg, signage, pamphlets?

Date and time of next outbreak meeting

Appendix 3: Norovirus Information Pamphlet

- Prevent ill food handlers from preparing food at home and at work until 24 hours after all symptoms cease.

Remember

- Source your shellfish from a reputable supplier.
- Cook food thoroughly - the virus dies when food is steaming hot.
- Avoid contact with infants, the elderly or those with long term illness until you are free of all symptoms.
- Don't handle food until you are free of all symptoms for at least 24 hours.
- Strict hand hygiene is important. Clean hands properly ("20 seconds to wash, 20 seconds to dry") after going to the toilet, before handling food and after going touching anything that may be contaminated with norovirus.

For more information contact
Auckland Regional Public Health Service,
Ph (09)623 4600.

Auckland Regional Public Health Service

Auckland Regional Public Health Service

Norovirus

A common cause of
Gastroenteritis

Norovirus

What is it?

Norovirus is a common cause of gastroenteritis or 'the 24 hour summer tummy upset'. Norovirus is easily spread when people eat food or drink fluids contaminated with the virus.

What are the symptoms?

Nausea, vomiting, abdominal pain and diarrhoea usually occurs 10 - 50 hours after contact with the virus. Headache, fever and chills may also occur.

Symptoms usually last from 12 to 72 hours, but some people may be unwell for longer.

Symptoms can be mild and sometimes infected people have none.

How is it treated?

There is no specific treatment to rid the virus from your body. Your immune system will overcome the virus, given time. To assist with recovery, extra fluid and rest are recommended. However, a doctor should always be consulted if symptoms are severe and they may give further advice or treat specific symptoms.

How is it spread?

People become infected when they swallow the virus. The virus can be found in:

- **The Environment**
  - Human sewage and sewage polluted water, can contaminate shellfish beds, irrigation water and drinking water if it is not reated adequately.
  - Person to person spread can occur through inhaling airborne particles of virus released during vomiting.
  - Norovirus is very hardy and can survive for long periods on any surface touched by contaminated hands. This is particularly so for toilet surfaces, door knobs and tap fittings.
- **Humans**
  - When people are ill, they excrete a large amount of norovirus in their vomit and faeces. Food can become contaminated if ill foodhandlers don't wash their hands well after toileting.
  - Proper hand hygiene (through washing+drying) is critical as infection can be transmitted from improperly cleaned hands to food, drink or surfaces.

How to Prevent it?

- Be careful when cleaning up after ill people. Vomit or faeces should be cleaned up using first a detergent solution then a solution of household chlorine bleach. If vomiting occurs outside of the toilet, open windows and doors to direct airflow to the exterior of the building.
- Clean hands thoroughly. Clean hands are hands that are washed with soap and water for 20 seconds and thoroughly dried on a clean dry cloth towel or disposable paper towel for a further 20 seconds. Clean hands after contact with soiled articles, after going to the toilet and before handling food.
- Prevent ill food handlers from preparing food at home and at work until 24 hours after all symptoms cease.

Appendix 4: Notice for Visitors about Norovirus Outbreak

ATTENTION

TO ALL VISITORS

PLEASE BE AWARE THAT THIS FACILITY

CURRENTLY HAS RESIDENTS WHO ARE

EXPERIENCING SYMPTOMS OF VIRAL

GASTROENTERITIS.
(VOMITING AND DIARRHOEA)

Viral Gastroenteritis can be easily transmitted from infected persons. If you need to visit a resident within the facility please identify yourself to a staff member.

Please remember to thoroughly wash and dry your hands before leaving the premises.

Appendix 5: Sample Information Sheet for Staff

Viral gastroenteritis outbreak

Suspected norovirus outbreak

Characteristics of a possible norovirus outbreak are:

- predominant symptoms of vomiting and nausea; other symptoms are diarrhoea, stomach cramps and fever
- short duration of illness (less than 60 hours)
- self limiting
- transmission through faecal–oral route and the inhalation of vomit particles
- environmentally hardy virus
- low infectious dose.

Hospitals and residential care facilities are at significant risk due to their high-risk populations (immunosuppressed, enclosed living conditions). Previous Auckland outbreaks have resulted in deaths.

Infection control

Hand hygiene

Meticulous and frequent hand hygiene practices are imperative. These practices include 20 seconds washing and 20 seconds drying; however, alcohol hand disinfectants are also satisfactory if hands are not visibly soiled. Undertake these hand hygiene measures after leaving each patient's or resident's room, after going to the toilet, after cleaning toilets, bathrooms and handling potentially soiled linen, after cleaning up emetic or faecal accidents and prior to handling or preparing food.

Patient/resident isolation

Place symptomatic patients or residents in isolation and post signage on the door of their room. Restrict movement of patients or residents out of isolation rooms to essential purposes only and prevent non-essential staff from entering the room. Do not transfer symptomatic patients or residents to other wards/facilities until at least 48 hours after cessation of symptoms. When they are transferred, inform the receiving facility of the case's illness.

Keep visitors to a minimum. However, if a visitor does have contact with a symptomatic person, they should not enter the room of any other patient or resident and also be advised against visiting any other patient or resident of a rest home, hospital or other institution for at least three days after this contact.

Staff protection

Any staff entering the room of a symptomatic patient should wear a gown, gloves and **if the patient is vomiting** an N95 particulate respirator mask. They should always follow hand hygiene practices after removing gloves.

Put in place a strict staff exclusion policy requiring symptomatic staff to stay away from work until they are symptom-free for 48 hours. In addition, operate a sickness log to record details of staff and their symptoms, onset and date of return to work.

Cleaning and disinfection

More frequent cleaning is required in an outbreak situation. This cleaning should include door handles, toilets, and other environmental surfaces exposed to hand contact (such as telephones and magazines). Disinfectant solutions must contain sodium hypochlorite in order to inactivate norovirus. Observing an appropriate contact time is also imperative – usually about 30 minutes is required (see the instructions on your product specifications).

Clean up faecal or vomit accidents straight away, following these steps.

1. Isolate area.
2. Restrict the cleaning task to the smallest number of staff possible.
3. Spray the area immediately with air freshener (to neutralise odour and assist in causing the virus particles to drop to the floor where they can be disinfected).
4. Open windows and doors to create airflow.
5. Staff working in the area wear personal protective equipment (gloves, apron and mask).
6. Remove soiled linen into disposable bag.
7. If linen is soiled with faeces, clean the soiled area with detergent and hot water using a disposable cloth to remove all organic debris before disinfecting with sodium hypochlorite.*
8. Carry out hand hygiene procedures.
9. Restrict access to the contaminated area for at least 30 minutes.

(*As sodium hypochlorite may rot some surfaces, Vircon can be used on soft furnishings and fabrics.)

Recommendations for cleaning and disinfecting

Hypochlorite has long been recognised as having outstanding disinfection properties and is widely available, cheap and commonly used in homes, schools, hospitals, swimming pools and drinking water supplies.

Hypochlorite is available under many brand names including:

- No Frills Bleach
- Janola
- Brite Bleach
- White Magic
- Hypersol
- Exit Mould.

Cleaning

Clean first before disinfecting to allow disinfectants to work. Soaps, detergents, scourers and hot water help with cleaning but do not disinfect. Scrubbing is also effective.

Disinfecting

- Household bleaches are sold in different strengths (usually 2–5% sodium hypochlorite). These strengths are written on the label.
- Dilute the bleach with water to make a 0.1% sodium hypochlorite solution. (See table below.)
- Saturate the area to be disinfected.
- Leave the solution on the area for as long as possible, preferably 30 minutes.
- Wash off the solution thoroughly with copious amounts of water.
- If using a toilet cleaner, make sure it is a product that contains at least 0.1% sodium hypochlorite.
- Never mix different chemicals.

Making a hypochlorite solution

- Fill the container with the appropriate quantity of bleach. (See table below.)
- Add the appropriate quantity of water.
- Put the cap on and mix gently.

Recipes to achieve a 0.1% bleach solution

Original strength of bleach (% sodium hypochlorite)	Volume of bleach (millilitres)	Volume of water (millilitres)	Total volume (millilitres)	Parts per million (ppm) achieved
1%	1000	9000	10,000	1000
2%	500	9500	10,000	1000
3%	333	9677	10,000	1000
4%	250	9750	10,000	1000
5%	200	9800	10,000	1000

Safety tips

- Never mix chemicals as toxic gases can be produced.
- Be aware – bleach irritates the nose, lungs and skin. Some people are particularly sensitive.
- Wear gloves, especially if handling undiluted bleach
- Store disinfectants and diluted disinfectants safely away from children. Label them properly.

References

Adler J, Zickl R. 1969. Winter vomiting disease. *Journal of Infectious Diseases* 119: 668–73.

Ando T, Noel J, Fankhauser R. 2000. Genetic classification of 'Norwalk-like viruses'. *Journal of Infectious Diseases* 181: S336–S348.

Anonymous. 2001. 'Norwalk-like viruses': Public health consequences and outbreak management. *Morbidity Mortality Weekly Review* 50(RR09): 1–18.

Barker J, Vipond I, Bloomfield S. 2004. Effects of cleaning and disinfection in reducing the spread of Norovirus contamination via environmental surfaces. *Journal of Hospital Infection* 58: 42–9.

Cartwright R. 2002. *Gastric Flu Outbreaks in Hotels*. Guildford: MicroDiagnostics (UK) Ltd, p 20.

Caul E. 1994. Small round structured viruses: airborne transmission and hospital control. *Lancet* 343: 1240–2.

CDC. 2002. Guideline for hand hygiene in health-care settings. *Morbidity and Mortality Weekly Report* 51: 1–44.

Chadwick P, McCann R. 1994. Transmission of small round structured virus by vomiting during a hospital outbreak of gastroenteritis. *Journal of Hospital Infection* 26: 251–9.

Chadwick P, Beards G, Brown D, et al. 2000. Management of hospital outbreaks of gastro-enteritis due to small round structured viruses. *Journal of Hospital Infection* 45: 1–10.

Cheesbrough J, Green J, Gallimore C, et al. 2000. Widespread environmental contamination with Norwalk-like viruses (NLV) detected in a prolonged hotel outbreak of gastroenteritis. *Epidemiology and Infection* 125: 93–8.

Cookson B, Teare L, May D. 2001. Draft hand hygiene standards. *Journal of Hospital Infection* 49: 153.

Doultree J. 1999. Inactivation of feline calicivirus, a Norwalk virus surrogate. *Journal of Hospital Infection* 41: 51–7.

Duzier E, Bijkerk P. 2004. Inactivation of caliciviruses. *Applied and Environmental Microbiology* 4538–43.

Eleraky N, Potgieter L, Kennedy M. 2002. Virucidal efficacy of four new disinfectants. *Journal of the American Animal Hospital Association* 38(3): 231–4.

Engender Health. 2004. Handwashing. URL: http://www.engenderhealth.org/ip/handwash/hw5a.html Accessed 12 November 2008.

ESR. 2002. *Disease Outbreak Manual*. Porirua: ESR.

Gao W, Simmons G. 2002. *The Use of Clinical Symptoms in Defining Norwalk-like Viral Infection.* Report for Auckland Healthcare Public Health Protection. Unpublished.

Garbutt C, Simmons G, Patrick D, et al. 2007. The public hand hygiene practices of New Zealanders: a national survey. *New Zealand Medical Journal* 120: U2810.

Gehrke C, Steinmann J, Goroncy-Bermes P. 2004. Inactivation of feline calicivirus, a surrogate of norovirus (formerly Norwalk-like viruses), by different types of alcohol in vitro and in vivo. *Journal of Hospital Infection* 56: 49–55.

Gerba C, Rose J, Haas C. 1996. Sensitive populations: who is at greatest risk? *International Journal of Food Microbiology* 30(1-2): 113–23.

Girou E, Loyeau S, Legrand P. 2002. Efficacy of handrubbing with alcohol based solution versus standard handwashing with antiseptic soap: randomised clinical trial. *British Medical Journal* 325: 362–5.

Graham D, Jiang X, Tanaka T, et al. 1994. Norwalk virus infection of volunteers: new insights based on improved assays. *Journal of Infectious Diseases* 170(1): 34–43.

Green J, Wright P, Gallimore C, et al. 1998. The role of environmental contamination with small round structured viruses in a hospital outbreak investigated by reverse-transcriptase polymerase chain reaction assay. *Journal of Hospital Infection* 39: 39–45.

Greening G, Kieft C, Baker M. 1999. Norwalk-like viruses (NLVs): a common cause of gastroenteritis outbreaks. *New Zealand Public Health Report* 6(10): 73–7.

Greening G, Miriams M, Berke T. 2001. Molecular epidemiology of 'Norwalk-like viruses' (NLVs) associated with gastroenteritis outbreaks in New Zealand. *Journal of Medical Virology* 64: 58–66.

Harrison A, Calder L. 2002. *Guidelines for Tuberculosis Control in New Zealand 2003.* Wellington: Ministry of Health.

Hedberg C, Osterholm M. 1993. Outbreaks of food-borne and waterborne viral gastroenteritis. *Clinical Microbiological Reviews* 6(3): 199–210.

Jiang X, Turf E, Hu J, et al. 1996. Outbreaks of gastroenteritis in elderly nursing homes and retirement facilities associated with human calicivirus. *Journal of Medical Virology* 50: 335–41.

Kakishima Y, Sugieda M, Nakajima S. 1999. Detection of SRSV genes from health food handlers at school lunch facilities. *Japanese Journal of Food Microbiology* 16(3): 193–6.

Kampf G, Grotheer D, Steinmann J. 2005. Efficacy of three ethanol-based hand rubs against feline calicivirus, a surrogate virus for norovirus. *Journal of Hospital Infection* 60(144–9).

Kaplan J, Feldman R, Campbell D, et al. 1982. The frequency of Norwalk-like pattern of illness in outbreaks of acute gastroenteritis. *American Journal of Public Health* 72(12): 1329–32.

Kuusi M, Nuorti J, Maunula L, et al. 2002. A prolonged outbreak of Norwalk-like calicivirus (NLV) gastroenteritis in a rehabilitation centre due to environmental contamination. *Epidemiology and Infection* 129: 133–8.

Lake R, Baker M, Garrett N, et al. 2000. Estimated number of cases of foodborne infectious disease in New Zealand. *New Zealand Medical Journal* 113: 278–81.

Last J. 1995. *A Dictionary of Epidemiology*. 3rd ed. Oxford: Oxford University Press.

Lo S, Connolly A, Palmer S, et al. 1994. The role of the pre-symptomatic food handler in a common source outbreak of food-borne SRSV gastroenteritis in a group of hospitals. *Epidemiology and Infection* 113(3): 513–21.

Malik Y, Maherchandani S, Goyal S. 2006. Comparative efficacy of ethanol and isopropanol against feline calicivirus, a norovirus surrogate. *American Journal of Infection Control* 34(1): 31–5.

Marks P, Vipond I, Carlisle D, et al. 2000. Evidence for airborne transmission of Norwalk-like virus (NLV) in a hotel restaurant. *Epidemiology and Infection* 124: 481–7.

Marx A, Shay D, Noel J, et al. 1999. An outbreak of acute gastroenteritis in a geriatric long-term-care facility: combined application of epidemiological and molecular diagnostic methods. *Infection Control and Hospital Epidemiology* 20: 306–11.

McClelland M, Simmons G, Manning K. 1999. An outbreak of gastroenteritis at a mother's day function at an Auckland hotel. *New Zealand Journal of Environmental Health* 22: 8–13.

Milazzo A, Tribe I, Ratcliff R, et al. 2002. A large prolonged outbreak of human calicivirus infection linked to an aged-care facility. *Communicable Diseases Intelligence* 26(2): 261–4.

Miller T, Patrick D. nd. *Hand Decontamination: A comparative analysis of hand washing practices.* Unpublished.

Moe C, Sobsey M, Stewart P, et al. 1999. Estimating the risk of human calicivirus infection from drinking water. Presented at the First International Workshop on Human Caliciviruses, Atlanta, USA.

Murray P, Baron E (eds). 2007. *Manual of Clinical Microbiology*. Washington DC: ASM Press.

Parashar U, Dow L, Fankhauser F, et al. 1998. An outbreak of viral gastroenteritis associated with consumption of sandwiches: implications for control of transmission by food handlers. *Epidemiology and Infection* 121(3): 615–21.

Parienti J, Thibon P, Heller R. 2002. Hand-rubbing with an aqueous alcoholic solution versus traditional surgical hand scrubbing and 30-day surgical site infection rates: a randomised equivalence study. *Journal of the American Medical Association* 288: 722–7.

Patrick D, Findon G, Miller T. 1997. Residual moisture determines the level of touch-contact-associated bacterial transfer following hand washing. *Epidemiology and Infection* 119: 319–25.

Pittet D, Hugonnet S, Harbarth S. 2000. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 356: 1307–12.

Reinbaben F, Schunemann S, Brob T, et al. 2000. Transmission of viruses via contact in a household setting: experiments using bacteriophage X174 as a model virus. *Journal of Hospital Infection* 46: 61–6.

Sawyer L, Murphy J, Kaplan J, et al. 1988. 25- to 30-nm virus particle associated with a hospital outbreak of acute gastroenteritis with evidence for airborne transmission. *American Journal of Epidemiology* 127(6): 1261–71.

Simmons G, Greening G, Gao W, et al. 2001. Raw oyster consumption and outbreaks of viral gastroenteritis in New Zealand: evidence for risk to the public's health. *Australian and New Zealand Journal of Public Health* 25(3): 34–40.

Simpson A, Simmons G. 2001. Outbreak of acute viral gastroenteritis in an elderly care facility. *New Zealand Journal of Environmental Health* 24(1): 15–19.

Whyte R. 2000. Transmission of foodborne viruses by asymptomatic foodhandlers. *New Zealand Journal of Environmental Health* 23(1): 13–14.

Yee E, Palacio H, Atmar R, et al. 2007. Widespread outbreak of norovirus gastroenteritis among evacuees of Hurricane Katrina residing in a large 'megashelter' in Houston, Texas: lessons learned for prevention. *Clinical Infectious Diseases* 4: 1032–9.