

Barker, J., I. B. Vipond, et al. (2004). "Effects of cleaning and disinfection in reducing the spread of Norovirus contamination via environmental surfaces." J Hosp Infect 58(1): 42-9.

A reverse transcriptase polymerase chain reaction assay was used to study the transfer of Norovirus (NV) from contaminated faecal material via fingers and cloths to other hand-contact surfaces. The results showed that, where fingers come into contact with virus-contaminated material, NV is consistently transferred via the fingers to melamine surfaces and from there to other typical hand-contact surfaces, such as taps, door handles and telephone receivers. It was found that contaminated fingers could sequentially transfer virus to up to seven clean surfaces. The effectiveness of detergent- and disinfectant-based cleaning regimes typical of those that might be used to decontaminate faecally contaminated surfaces and reduce spread of NV was also compared. It was found that detergent-based cleaning with a cloth to produce a visibly clean surface consistently failed to eliminate NV contamination. Where there was faecal soiling, although a combined hypochlorite/detergent formulation at 5000 ppm of available chlorine produced a significant risk reduction, NV contamination could still be detected on up to 28% of surfaces. In order consistently to achieve good hygiene, it was necessary to wipe the surface clean using a cloth soaked in detergent before applying the combined hypochlorite/detergent. When detergent cleaning alone or combined hypochlorite/detergent treatment failed to eliminate NV contamination from the surface and the cleaning cloth was then used to wipe another surface, the virus was transferred to that surface and to the hands of the person handling the cloth. In contrast, were surfaces where contaminated with NV-infected faecal suspension diluted to 1 in 10 and 1 in 80, intended to simulate surfaces that have become contaminated after secondary transfer, treatment with a combined bleach/detergent formulation, without prior cleaning, was sufficient to decontaminate surfaces and prevent transfer.

Bidawid, S., N. Malik, et al. (2004). "Norovirus cross-contamination during food handling and interruption of virus transfer by hand antisepsis: experiments with feline calicivirus as a surrogate." J Food Prot 67(1): 103-9.

While there is good epidemiological evidence for foods as vehicles for norovirus transmission, the precise means of spread and its control remain unknown. The feline calicivirus was used as a surrogate for noroviruses to study infectious virus transfer between hands and selected types of foods and environmental surfaces. Assessment of the potential of selected topicals in interrupting such virus transfer was also made. Ten microliters of inoculum of feline calicivirus deposited onto each fingerpad of adult subjects was allowed to air dry and the contaminated area on individual fingerpads was pressed (10 s at a pressure of 0.2 to 0.4 kg/cm²) onto 1-cm-diameter disks of ham, lettuce, or brushed stainless steel. The virus remaining on the donor and that transferred to the recipient surfaces was eluted and plaque assayed. Virus transfer to clean hands from experimentally contaminated disks of ham, lettuce, and stainless steel was also tested. Nearly 46

+/- 20.3, 18 +/- 5.7, and 13 +/- 3.6% of infectious virus was transferred from contaminated fingerpads to ham, lettuce, and metal disks, respectively. In contrast, approximately 6 +/- 1.8, 14 +/- 3.5, and 7 +/- 1.9% virus transfer occurred, respectively, from ham, lettuce, and metal disks to hands. One-way analysis of variance test showed that pretreatment (washing) of the fingerpads either with water or with both topical agent and water significantly ($P < 0.05$) reduced virus transfer to $< \text{or} = 0.9\%$, as compared with $< \text{or} = 2.3$ and $< \text{or} = 3.4\%$ transfer following treatments with either 75% (vol/vol) ethanol or a commercial hand gel containing 62% ethanol, respectively. Despite wide variations in virus transfer among the targeted items used, intervention agents tested reduced virus transfer significantly ($P < 0.05$) when compared with that without such treatments (71 +/- 8.9%). These findings should help in a better assessment of the potential for cross-contamination of foods during handling and also assist in developing more effective approaches to foodborne spread of norovirus infections.

Blackburn, B. G., G. F. Craun, et al. (2004). "Surveillance for waterborne-disease outbreaks associated with drinking water--United States, 2001-2002." MMWR Surveill Summ 53(8): 23-45.

PROBLEM/CONDITION: Since 1971, CDC, the U.S. Environmental Protection Agency, and the Council of State and Territorial Epidemiologists have maintained a collaborative surveillance system for collecting and periodically reporting data related to occurrences and causes of waterborne-disease outbreaks (WBDOs). This surveillance system is the primary source of data concerning the scope and effects of waterborne disease outbreaks on persons in the United States.

REPORTING PERIOD COVERED: This summary includes data on WBDOs associated with drinking water that occurred during January 2001-December 2002 and on three previously unreported outbreaks that occurred during 2000.

DESCRIPTION OF SYSTEM: Public health departments in the states, territories, localities, and the Freely Associated States are primarily responsible for detecting and investigating WBDOs and voluntarily reporting them to CDC on a standard form. The surveillance system includes data for outbreaks associated with both drinking water and recreational water; only outbreaks associated with drinking water are reported in this summary.

RESULTS: During 2001-2002, a total of 31 WBDOs associated with drinking water were reported by 19 states. These 31 outbreaks caused illness among an estimated 1,020 persons and were linked to seven deaths. The microbe or chemical that caused the outbreak was identified for 24 (77.4%) of the 31 outbreaks. Of the 24 identified outbreaks, 19 (79.2%) were associated with pathogens, and five (20.8%) were associated with acute chemical poisonings. Five outbreaks were caused by norovirus, five by parasites, and three by non-*Legionella* bacteria. All seven outbreaks involving acute gastrointestinal illness of unknown etiology were suspected of having an infectious cause. For the first time, this MMWR Surveillance Summary includes drinking water-associated outbreaks of Legionnaires disease (LD); six outbreaks of LD occurred during 2001-2002. Of the 25 non-*Legionella* associated outbreaks, 23 (92.0%) were reported in systems that used groundwater sources; nine (39.1%) of these 23

groundwater outbreaks were associated with private noncommunity wells that were not regulated by EPA. INTERPRETATION: The number of drinking water-associated outbreaks decreased from 39 during 1999-2000 to 31 during 2001-2002. Two (8.0%) outbreaks associated with surface water occurred during 2001-2002; neither was associated with consumption of untreated water. The number of outbreaks associated with groundwater sources decreased from 28 during 1999-2000 to 23 during 2001-2002; however, the proportion of such outbreaks increased from 73.7% to 92.0%. The number of outbreaks associated with untreated groundwater decreased from 17 (44.7%) during 1999-2000 to 10 (40.0%) during 2001-2002. Outbreaks associated with private, unregulated wells remained relatively stable, although more outbreaks involving private, treated wells were reported during 2001-2002. Because the only groundwater systems that are required to disinfect their water supplies are public systems under the influence of surface water, these findings support EPA's development of a groundwater rule that specifies when corrective action (including disinfection) is required. PUBLIC HEALTH ACTION: CDC and EPA use surveillance data 1) to identify the types of water systems, their deficiencies, and the etiologic agents associated with outbreaks and 2) to evaluate the adequacy of technologies for providing safe drinking water. Surveillance data are used also to establish research priorities, which can lead to improved water-quality regulations. CDC and EPA recently completed epidemiologic studies that assess the level of waterborne illness attributable to municipal drinking water in nonoutbreak conditions. The decrease in outbreaks in surface water systems is attributable primarily to implementation of provisions of EPA rules enacted since the late 1980s. Rules under development by EPA are expected to protect the public further from microbial contaminants while addressing risk tradeoffs of disinfection byproducts in drinking water.

Corwin, A. L., R. Soderquist, et al. (1999). "Shipboard impact of a probable Norwalk virus outbreak from coastal Japan." Am J Trop Med Hyg 61(6): 898-903.

Norwalk virus has been implicated in shipboard diarrheal disease outbreaks throughout Asia. A large outbreak of suspected Norwalk virus was investigated on a U.S. Naval aircraft carrier following the clinical recognition of 450 cases of gastroenteritis over a 2-week period (September 14-28, 1997) during coastal exercises. A random sampling of 44 cases from 450 personnel who sought medical attention was compared with 19 controls. Junior enlisted sailors and marines comprised 97% of all cases. There was no evidence of shipboard geographic clustering of cases. Furthermore, no single food type was associated with illness on the basis of comparative analysis (cases versus controls). Principal case signs and symptoms reported included watery stools (89%), nausea (82%), and vomiting (77%). Anecdotal reports indicated > 50% of the cases received rehydration therapy. An absence of fever was also noted in 32% of the cases and only 5% had blood in their stools. The mean duration of illness was 37 hr, with a range of 3-96 hr. Laboratory findings based on reverse transcription-polymerase chain reaction and Southern hybridization methods showed that 21 (72%) of 29 patients had evidence of the UK2 prototype of the Norwalk virus. A cross-

sectional study of 131 crew members from the ships population (n = 4,200) showed an attack rate of 44%. Attack rate is a variant of an incident rate applied to a narrowly defined population observed for a limited period of time, such as during an outbreak. The numerator is people who get sick and the denominator is people (population) at risk. An extrapolation of these findings suggests as many as 1,806 sailors may have been affected during the outbreak, of which only 26% (of the 57 outbreak related cases) were identified from sick call records. There was no difference in the mean ages between outbreak and non-outbreak affected crewmen, or geographic clustering based on berthing or work spaces. Outbreak-related cases reported signs and symptoms of watery-stools (79%), nausea (65%), and vomiting (47%). The mean duration of illness was 28 hr, ranging from 2 to 96 hr. Thirty-one percent of outbreak affected cases reported a sick call visit. Loss of work was reported by 39% of the outbreak affected population. This report documents the epidemic potential of Norwalk virus and the associated impact on fleet operational readiness. Additionally, that this outbreak occurred against a background of 3 other consecutive gastroenteritis outbreaks onboard the same ship (March 1997, February/March 1998, and June 1998), all sharing the same clinical and epidemiologic profiles, suggests possible shipboard persistence of Norwalk virus over time, despite periodic ship-wide disinfection efforts.

Cunney, R. J., P. Costigan, et al. (2000). "Investigation of an outbreak of gastroenteritis caused by Norwalk-like virus, using solid phase immune electron microscopy." J Hosp Infect 44(2): 113-8.

In February 1993, 95 persons (47 patients and 48 staff members) were affected by an hospital outbreak of viral gastroenteritis. Using direct electron microscopy (EM) the causative agent was identified as a small round structured virus. This was confirmed as a Norwalk-like virus using solid phase immune electron microscopy (SPIEM). Of 94 stool samples examined, 12 (13%) samples containing small round structured viruses (SRSV) were SPIEM positive for Norwalk-like virus. A further 25 (27%) samples contained small round featureless virus (SRFV) identified by direct EM and were negative on SPIEM. The illness was characterized by preceding influenza-like symptoms in 76% of cases followed by vomiting (76%), diarrhoea (79%) and abdominal pain (79%). One fatality was recorded. The outbreak lasted for 15 days, with a peak incidence of new cases amongst patients and staff occurring on day 5. It was controlled through a combination of ward closures, patient cohorting, suspension of duties for affected staff and disinfection procedures. Difficulties were encountered in the education of staff and in the implementation of environmental control measures. Screening of hospital catering services and a case control study, carried out among affected staff members, failed to identify a foodborne source. Consumption of tap water in the hospital was commoner among affected staff members than among controls, but this did not reach significance (P = 0.1).

Doultree, J. C., J. D. Druce, et al. (1999). "Inactivation of feline calicivirus, a Norwalk virus surrogate." J Hosp Infect 41(1): 51-7.

Norwalk and Norwalk virus-like particles (NVLPs) [also known as small round structured viruses (SRSVs)] are members of the family Caliciviridae and are important causes of gastroenteritis in humans. Little is known about their survival in the environment or the disinfection procedures necessary to remove them from contaminated settings. As NVLPs cannot be grown in tissue culture, survival studies require the use of a closely related cultivable virus. This study assesses the survival of the surrogate feline calicivirus (FCV) after exposure to commercially available disinfectants and a range of environmental conditions. Disinfectants tested included glutaraldehyde, iodine, hypochlorite, a quaternary ammonium-based product, an anionic detergent and ethanol. Complete inactivation of FCV required exposure to 1000 ppm freshly reconstituted granular hypochlorite, or 5000 ppm pre-reconstituted hypochlorite solution. Glutaraldehyde and the iodine-based product effectively inactivated FCV whereas the quaternary ammonium product, detergent and ethanol failed to completely inactivate the virus. The stability of FCV in suspension and in a dried state was assessed after exposure to 4 degrees C, room temperature (20 degrees C) and 37 degrees C. With increasing temperature, the stability of FCV was found to diminish both in suspension and in the dried state. FCV in the dried state did not survive for one day at 37 degrees C. This study provides a basis for establishing guidelines for disinfection protocols to decrease the spread of NVLPs in a community setting.

Duizer, E., P. Bijkerk, et al. (2004). "Inactivation of caliciviruses." Appl Environ Microbiol 70(8): 4538-43.

The viruses most commonly associated with food- and waterborne outbreaks of gastroenteritis are the noroviruses. The lack of a culture method for noroviruses warrants the use of cultivable model viruses to gain more insight on their transmission routes and inactivation methods. We studied the inactivation of the reported enteric canine calicivirus no. 48 (CaCV) and the respiratory feline calicivirus F9 (FeCV) and correlated inactivation to reduction in PCR units of FeCV, CaCV, and a norovirus. Inactivation of suspended viruses was temperature and time dependent in the range from 0 to 100 degrees C. UV-B radiation from 0 to 150 mJ/cm(2) caused dose-dependent inactivation, with a 3 D ($D = 1 \log(10)$) reduction in infectivity at 34 mJ/cm(2) for both viruses. Inactivation by 70% ethanol was inefficient, with only 3 D reduction after 30 min. Sodium hypochlorite solutions were only effective at >300 ppm. FeCV showed a higher stability at pH <3 and pH >7 than CaCV. For all treatments, detection of viral RNA underestimated the reduction in viral infectivity. Norovirus was never more sensitive than the animal caliciviruses and profoundly more resistant to low and high pH. Overall, both animal viruses showed similar inactivation profiles when exposed to heat or UV-B radiation or when incubated in ethanol or hypochlorite. The low stability of CaCV at low pH suggests that this is not a typical enteric (calici-) virus. The incomplete inactivation by ethanol and the high hypochlorite concentration needed for sufficient virus inactivation point to a concern for decontamination of fomites and surfaces contaminated with noroviruses and virus-safe water.

Eggers, H. J. (1985). "[Viral diarrheas]." Zentralbl Bakteriol Mikrobiol Hyg [B] 180(2-3): 128-33.

In the developing countries diarrhoea ranks among the most frequent diseases: 5-18 million children are estimated to die annually from gastro-intestinal infections. But also in Europe and the USA diarrhoea is of utmost medical importance, especially among children and infants. It was only twelve years ago that 2 viral groups, the Norwalk and the rotavirus group, were discovered to be etiological agents responsible for a large proportion of gastro-intestinal infections. Whilst viruses of the Norwalk group cause primarily gastro-intestinal infections in schools and families (school-children and adults), rotaviruses attack mainly infants. In our latitudes rotaviruses are important agents responsible for nosocomial infections. A rapid diagnosis is crucial if the chain of infections is to be interrupted. Uncontrolled spread may not only lead to severe disease in infants and young children, but also burdens health insurance - plans considerably. Experiments intended to develop a rotavirus vaccine are under way.

Evans, M. R., R. Meldrum, et al. (2002). "An outbreak of viral gastroenteritis following environmental contamination at a concert hall." Epidemiol Infect 129(2): 355-60.

In January 1999, an outbreak of viral gastroenteritis affected more than 300 people who attended a metropolitan concert hall over a 5-day period. Norwalk-like virus (NLV) was confirmed in faecal samples by reverse transcription polymerase chain reaction assay. The index case was a concert attendee who vomited in the auditorium and adjacent male toilet. Gastrointestinal illness occurred among members of 8/15 school parties who attended the following day. Children who sat on the same level of the auditorium as the index case were much more likely to be ill than those seated elsewhere (relative risk 7.1, 95% confidence interval 5.4-9.2. $P < 0.001$). The majority of other reported cases had not been present on the evening of the vomiting incident. Disinfection procedure was poor and the disinfectant used contained no sodium hypochlorite. Transmission most likely occurred through direct contact with contaminated fomites. The outbreak has implications for disinfection procedures following vomiting incidents at public venues.

Flemmer, M. and E. C. Oldfield, 3rd (2003). "The agony and the ecstasy." Am J Gastroenterol 98(9): 2098-9.

The authors, who are from the Vessel Sanitation Program of the Centers for Disease Control and Prevention (CDC), summarize the recent outbreaks of acute gastroenteritis (AGE), which occurred on five different cruise ships. Attack rates among passengers ranged from 4% to 13% and among crew members from 0.2% to 3.3%. Subsequent epidemiological investigations by the CDC suggested that the incidence was higher, approaching 19-41% of passengers. Overall there were 21 outbreaks of AGE on 17 cruise ships, of which nine were documented to be due to norovirus, three due to bacterial agents, and nine of unknown cause. In general, subsequent outbreaks on each cruise ship were of the identical strain of norovirus by reverse transcriptase polymerase reaction, which suggests an

embedded source. The authors conclude that in addition to emphasizing basic food and water sanitation measures, control efforts should include thorough and prompt disinfection of ships during cruises and isolation of ill crew-members and passengers for 72 hours.

Gehrke, C., J. Steinmann, et al. (2004). "Inactivation of feline calicivirus, a surrogate of norovirus (formerly Norwalk-like viruses), by different types of alcohol in vitro and in vivo." J Hosp Infect 56(1): 49-55.

Hand disinfection is an important measure to prevent transmission of norovirus (formerly called Norwalk-like viruses) from hands or environmental surfaces to other objects. Therefore, three types of alcohol (ethanol, 1- and 2-propanol) were examined for their virus-inactivating properties against feline calicivirus (FCV) as a surrogate for norovirus. Tests were performed as quantitative suspension assays or as in vivo experiments with artificially contaminated fingertips. The in vitro experiments showed that 1-propanol was more effective than ethanol and 2-propanol for the inactivation of FCV: in tests with the 50 and 70% solutions of the different alcohols, a 10(4)-fold reduction was observed with 1-propanol after 30 s, whereas the other alcohols were effective only after 3 min contact time. The greatest efficacy did not occur at the highest concentrations (80%). The following concentrations (extrapolated data) showed the greatest virus-inactivating properties in the suspension test: ethanol 67%, 2-propanol 58% (exposure times of 1 min) and 1-propanol 60% (exposure time of 30 s). The results from fingertips experiments with 70 and 90% solutions and an application time of 30 s confirmed these findings: the 70% alcoholic solutions were more effective than the 90% solutions. In contrast to the suspension tests, 70% ethanol showed the greatest efficacy in vivo with a log(10) reduction factor (RF) of 3.78 compared with 70% 1-propanol (RF 3.58), 70% 2-propanol (RF 2.15) and hard water (RF 1.23). Ethanol and 1-propanol-based solutions with a high alcohol content thus appear most effective.

Hota, B. (2004). "Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection?" Clin Infect Dis 39(8): 1182-9.

Despite documentation that the inanimate hospital environment (e.g., surfaces and medical equipment) becomes contaminated with nosocomial pathogens, the data that suggest that contaminated fomites lead to nosocomial infections do so indirectly. Pathogens for which there is more-compelling evidence of survival in environmental reservoirs include *Clostridium difficile*, vancomycin-resistant enterococci, and methicillin-resistant *Staphylococcus aureus*, and pathogens for which there is evidence of probable survival in environmental reservoirs include norovirus, influenza virus, severe acute respiratory syndrome-associated coronavirus, and *Candida* species. Strategies to reduce the rates of nosocomial infection with these pathogens should conform to established guidelines, with an emphasis on thorough environmental cleaning and use of Environmental Protection Agency-approved detergent-disinfectants.

Koopmans, M. and E. Duizer (2004). "Foodborne viruses: an emerging problem." Int J Food Microbiol 90(1): 23-41.

Several groups of viruses may infect persons after ingestion and then are shed via stool. Of these, the norovirus (NoV) and hepatitis A virus (HAV) are currently recognised as the most important human foodborne pathogens with regard to the number of outbreaks and people affected in the Western world. NoV and HAV are highly infectious and may lead to widespread outbreaks. The clinical manifestation of NoV infection, however, is relatively mild. Asymptomatic infections are common and may contribute to the spread of the infection. Introduction of NoV in a community or population (a seeding event) may be followed by additional spread because of the highly infectious nature of NoV, resulting in a great number of secondary infections (50% of contacts). Hepatitis A is an increasing problem because of the decrease in immunity of populations in countries with high standards of hygiene. Molecular-based methods can detect viruses in shellfish but are not yet available for other foods. The applicability of the methods currently available for monitoring foods for viral contamination is unknown. No consistent correlation has been found between the presence of indicator microorganisms (i.e. bacteriophages, E. coli) and viruses. NoV and HAV are highly infectious and exhibit variable levels of resistance to heat and disinfection agents. However, they are both inactivated at 100 degrees C. No validated model virus or model system is available for studies of inactivation of NoV, although investigations could make use of structurally similar viruses (i.e. canine and feline caliciviruses). In the absence of a model virus or model system, food safety guidelines need to be based on studies that have been performed with the most resistant enteric RNA viruses (i.e. HAV, for which a model system does exist) and also with bacteriophages (for water). Most documented foodborne viral outbreaks can be traced to food that has been manually handled by an infected foodhandler, rather than to industrially processed foods. The viral contamination of food can occur anywhere in the process from farm to fork, but most foodborne viral infections can be traced back to infected persons who handle food that is not heated or otherwise treated afterwards. Therefore, emphasis should be on stringent personal hygiene during preparation. If viruses are present in food preprocessing, residual viral infectivity may be present after some industrial processes. Therefore, it is key that sufficient attention be given to good agriculture practice (GAP) and good manufacturing practice (GMP) to avoid introduction of viruses onto the raw material and into the food-manufacturing environment, and to HACCP to assure adequate management of (control over) viruses present during the manufacturing process. If viruses are present in foods after processing, they remain infectious in most circumstances and in most foods for several days or weeks, especially if kept cooled (at 4 degrees C). Therefore, emphasis should be on stringent personal hygiene during preparation. For the control of foodborne viral infections, it is necessary to: Heighten awareness about the presence and spread of these viruses by foodhandlers; Optimise and standardise methods for the detection of foodborne viruses; Develop laboratory-based surveillance to detect large, common-source outbreaks at an early stage; and Emphasise consideration

of viruses in setting up food safety quality control and management systems (GHP, GMP, HACCP).

Lawrence, D. N. (2004). "Outbreaks of Gastrointestinal Diseases on Cruise Ships: Lessons from Three Decades of Progress." Curr Infect Dis Rep 6(2): 115-123.

Dramatic improvements in sanitary engineering and, especially, operational procedures aboard cruise ships began in the mid-1970s after several large outbreaks of acute gastroenteritis. The US Centers for Disease Control and Prevention's Vessel Sanitation Program, working with the cruise industry, conducts ship inspections, provides public access to ship sanitation scores, and reports outbreak investigations. The significant increase in median ship sanitation scores over the past decade has been concomitant with a reduction in outbreak frequency to 3.7 per 1000 cruises. Most outbreaks of the past decade were linked to noroviruses (Norwalk-like viruses), enterotoxigenic *Escherichia coli*, or the residual "unknown" causes. Although norovirus outbreaks may begin as foodborne or waterborne disease, easy person-to-person transmission occurs through fecal- or vomitus-splattered surfaces, other items, clothing, and especially, hands. Control of person-to-person spread of illness among crew and passengers becomes the major objective. Rigorous handwashing, environmental disinfection, and other food service job-related restrictions are required to prevent multiple outbreaks on the same ship. Vigilance by public health and industry officials has prevented many thousands of illnesses and some associated deaths. Clinicians providing pretravel health advice and post-travel diagnoses and care can benefit from and contribute to epidemiologic investigations and thereby enhance the health of cruise passengers individually and collectively.

Levine, S. (2002). "Sick cruise ships. Cleaning vessels." US News World Rep 133(23): 50.

Miossec, L., F. Le Guyader, et al. (2000). "[Magnitude of rainfall on viral contamination of the marine environment during gastroenteritis epidemics in human coastal population]." Rev Epidemiol Sante Publique 48 Suppl 2: 2S62-71.

BACKGROUND: Sewage treatments are not efficient to eliminate enteric microorganisms. Viruses are able to persist and are discharged into the marine environment with treated effluents. Few data are now available on the magnitude and the contributive processes of marine viral contamination. This work evaluates the relationship between the magnitude of rainfall and the viral contamination of the marine environment during winter epidemics of gastroenteritis in human coastal populations. **METHODS:** A RT-PCR method was used to detect enterovirus, hepatitis A virus, Norwalk-like virus, astrovirus and rotavirus in shellfish, harvested monthly between August 1995 and July 1998. The frequency of virus detection in shellfish was expressed as an Index of Viral Contamination. Acute gastroenteritis in the population was estimated using the French Sentinel System for Monitoring of Communicable Diseases. Rainfall effects on the efficiency of sewage treatment were assessed using an estimated staying time of sewage effluents in the plant. **RESULTS:** The results indicate that the highest

viral contamination occurs in winter. Maximal indexes of viral contamination were respectively 70% in January 1996, 100% in January 1997, but only 31% in January 1998. Viral contamination variations seemed to follow the pattern of the winter epidemic of acute gastroenteritis in the local population in 1996 and 1997. These observations should be linked to the winter rainfalls. Heavy rains on short periods of time could create an hydraulic overload in the sewage treatment plant, reducing the staying time of the sewage effluents and thus the efficiency of the disinfection process. CONCLUSION: The magnitude of the viral contamination of shellfish seems to result from the simultaneity between the winter epidemics of acute gastroenteritis in the coastal population and heavy rainfall. To prevent public health hazards associated with shellfish consumption, the monitoring of microbiological quality in shellfish harvesting areas should include accompanying survey of viral epidemic in the coastal population, and of sewage outputs in the coastal environment.

Oppermann, H., B. Mueller, et al. (2001). "An outbreak of viral gastroenteritis in a mother-and-child health clinic." Int J Hyg Environ Health 203(4): 369-73.

An outbreak of diarrhoeal disease in a modern mother-and-child health clinic prompted the health authorities to initiate a retrospective cohort study in order to assess the scope of the outbreak and to identify possible risk factors. The management of the clinic had been rather concerned because four similar outbreaks had occurred during the last two years. A total of 151 guests, i.e. mothers with their children, who had arrived some days before the peak of the outbreak for a three-week-stay and another 15 guests who had arrived earlier and had extended their stay were enrolled in the study which mainly focused on the possible role of treatment measures as risk factors. In addition, a total of 49 staff members were requested to provide information about symptoms, working area and attendance at work. Relevant data were available from 164 of 166 guests and 47 of 49 staff members (response rates 98.8% and 96.0%, respectively). The attack rate among guests was 44.0% (adults 27.0%, children 54.0%) and among staff 23.4%. The mean age of affected children (3.5 years) was significantly lower than that of those not affected (6.3 years). The main symptoms were diarrhoea and vomiting. The sudden start of the outbreak suggested a single source of infection which, however, remained unknown. Person-to-person transmission was supposed to be the cause of the following spread. No association between distinct treatment measures and the disease was proven by the cohort study. Norwalk-like viruses as well as astroviruses were detected by polymerase chain reaction in specimens taken from seven patients. No other enteropathogenic agents were found. Regarding the special conditions in a mother-and-child health clinic where social contacts among guests are much more frequent and intensive than among patients in a "normal" hospital, measures to prevent the spread of gastrointestinal infections should concentrate on early recognition and isolation of symptomatic individuals. Guests and staff members should be instructed to keep to the rules of personal hygiene, especially handwashing. If disinfection is required, it should be virucidal.

Patterson, W., P. Haswell, et al. (1997). "Outbreak of small round structured virus gastroenteritis arose after kitchen assistant vomited." Commun Dis Rep CDR Rev 7(7): R101-3.

A wedding reception at a North Yorkshire hotel was followed by an explosive outbreak of gastroenteritis. The attack rate among the 111 guests was 50% and vomiting was a predominant feature. The results of laboratory and epidemiological investigations were consistent with a common source outbreak of small round structured virus (SRSV) infection genotype II. The source of the outbreak was traced to a kitchen assistant who suddenly became ill on the eve of the reception and vomited into a sink used for preparing vegetables. The sink was cleaned with a chlorine based disinfectant and used the next morning to prepare a potato salad, subsequently identified as the vehicle of infection in a cohort study of guests (odds ratio 3.21; CI 1.78-5.78, $p = 0.0001$). No other food was associated with illness. The outbreak provides further supporting evidence of the importance of vomiting in the transmission of SRSV infection, highlights the virulence of this group of viruses, and indicates their relative resistance to environmental disinfection and decontamination. It also highlights the need for the adequate training of catering staff and the implementation and enforcement of food hygiene regulations.

Ramia, S. (1985). "Transmission of viral infections by the water route: implications for developing countries." Rev Infect Dis 7(2): 180-8.

The "enteric" virus group comprises greater than 100 different viruses. These viruses typically infect the cell lining of the alimentary canal and are discharged in very large numbers in the feces of infected persons. Contamination of water supplies by enteric viruses represents an important source of viral infection. Many communities, particularly in developing countries, depend on sewage-polluted sources for their recreational and drinking water. Because conventional methods of sewage and water treatment have proved inefficient in the removal and inactivation of most enteric viruses, great concern has been raised over the impact of waterborne infection on the health of such communities. Current evidence implicating drinking and recreational water supplies in the transmission of nonbacterial gastroenteritis and hepatitis A virus and adenovirus infections is overwhelming. Water-borne transmission of other enteric viruses is also possible. Effective antiviral drugs are generally unavailable, and current vaccines can control only a limited number of viral infections; therefore, provision of uncontaminated water is a basic requirement in raising the standard of health in affected communities.

Richards, G. P. (2001). "Enteric virus contamination of foods through industrial practices: a primer on intervention strategies." J Ind Microbiol Biotechnol 27(2): 117-25.

Hepatitis A and E viruses, rotaviruses, Norwalk-like caliciviruses, and astroviruses are among the enteric viruses known to cause food- and waterborne illness. These viruses are spread by the fecal-oral route and are a major cause of morbidity and mortality worldwide. Foods may be contaminated at any time pre-

or post-harvest; however, many outbreaks are associated with foods handled by infected restaurant workers. Produce may be contaminated by improper irrigation or fertilization practices, by the hands of infected pickers or processors, or as the result of adulteration during any stage of handling. Outbreaks have been commonly associated with foods which are served raw or only lightly cooked, such as molluscan shellfish, fruits and vegetables, and salads or products contaminated after cooking like frosted bakery products. The farming, shellfish, processing, transportation, and restaurant industries must maintain vigilance to reduce outbreaks of enteric virus illness. Intervention strategies to enhance product safety include increased industry and consumer education; changes in industrial practices, product management, and processing technologies; worker immunizations; and the development of improved monitoring tools for the detection of enteric viruses in foods.

Sattar, S. A. (2004). "Microbicides and the environmental control of nosocomial viral infections." *J Hosp Infect* 56 Suppl 2: S64-9.

Viruses are important causes of acute and chronic diseases in humans. Newer viruses are still being discovered and those that are already known are being incriminated in the aetiology of clinical conditions with hitherto unknown causes. Apart from frequently causing infections in the general community, many types of viruses are also significant nosocomial pathogens. While it is generally agreed that we underestimate the proportion of nosocomial infections that are viral, due to a lack of routine monitoring, viruses easily account for more than 30% of the cases of hospital-acquired infections in many paediatric settings. Indeed, the relative importance of viruses in this respect is increasing due to a number of societal and demographic changes as well as alterations in healthcare practices. Safe vaccines against many common nosocomial viral agents are currently unavailable while there is also a virtual lack of effective and affordable chemotherapy against them. There is, therefore, renewed emphasis on preventive strategies by better understanding of the relative importance of various vehicles in the nosocomial spread of viruses and by infection control using microbicides. This, in turn, has stimulated considerable interest in the development of formulations that are not only safer but which also have demonstrated activity against major types of nosocomial viral pathogens. Further, much work is now underway to design better methods to assess the virucidal activity of microbicides used to decontaminate hands, reusable medical devices and environmental surfaces in critical areas of healthcare settings. It is anticipated that these approaches will result in reducing the health and economic impact of nosocomial infections due to viruses.

Shin, G. A. and M. D. Sobsey (2003). "Reduction of Norwalk virus, poliovirus 1, and bacteriophage MS2 by ozone disinfection of water." *Appl Environ Microbiol* 69(7): 3975-8.

Norwalk virus and other human caliciviruses (noroviruses) are major agents of gastroenteritis, and water is a major route of their transmission. In an effort to control Norwalk virus in drinking water, Norwalk virus reduction by bench-scale

ozone disinfection was determined using quantitative reverse transcription (RT)-PCR for virus assays. Two other enteric viruses, poliovirus 1 and coliphage MS2, were included for comparison, and their reductions were assayed by infectivity assays as well as by RT-PCR. Virus reductions by ozone were determined using a dose of 0.37 mg of ozone/liter at pH 7 and 5 degrees C for up to 5 min. Based on two RT-PCR assays, the reductions of Norwalk virus were $>3 \log_{10}$ within a contact time of 10 s, and these were similar to the reductions of the other two viruses determined by the same assay methods. Also, the virus reductions detected by RT-PCR assays were similar to those detected by infectivity assays, indicating that the RT-PCR assay is a reliable surrogate assay for both culturable and nonculturable viruses disinfected with ozone. Overall, the results of this study indicate that Norwalk virus as well as other enteric viruses can be reduced rapidly and extensively by ozone disinfection and that RT-PCR is a useful surrogate assay for both culturable and nonculturable viruses disinfected with ozone.

Steinmann, J. (2004). "Surrogate viruses for testing virucidal efficacy of chemical disinfectants." *J Hosp Infect* 56 Suppl 2: S49-54.

Since important agents of viral nosocomial infections like hepatitis B and C viruses and norovirus do not replicate sufficiently in cell culture systems, disinfectants with suspected efficacy against these viruses must be evaluated by different methods. Besides molecular approaches and indirect tests, the use of surrogate viruses with similar biophysical properties and genomic structure allows the assessment of virucidal efficacy of chemical disinfectants in quantitative suspension tests. Furthermore, insights into the survival of these viruses in the environment are possible. In recent years, duck hepatitis B virus and bovine viral diarrhoea virus have been tested as surrogates for hepatitis B and C viruses. Feline calicivirus serves as a surrogate for the group of norovirus. By including these viruses in inactivation experiments, valuable data from suspension tests can be derived on the virucidal efficacy of chemical disinfectants. Even in vivo tests using fingerpads of adult volunteers can be performed with these animal viruses without risk of infection. In contrast to in vitro examinations, the results of these tests allow use recommendations of chemical disinfectants for outbreak situations and daily routine disinfection.

Tree, J. A., M. R. Adams, et al. (2005). "Disinfection of feline calicivirus (a surrogate for Norovirus) in wastewaters." *J Appl Microbiol* 98(1): 155-62.

AIMS: To compare the inactivation of feline calicivirus (FCV) (a surrogate for Norovirus, NV) with the reduction of a bacterial water quality indicator (*Escherichia coli*), a human enteric virus (poliovirus) and a viral indicator (MS2, FRNA bacteriophage), following the disinfection of wastewaters. METHODS AND RESULTS: Bench-scale disinfection experiments used wastewater (sterilized by gamma-irradiation) seeded with laboratory-cultured organisms. Seeded primary effluent was treated with different doses of applied free chlorine (8, 16 and 30 mg l⁻¹). FCV and *E. coli* were easily inactivated by $>4 \log_{10}$, within 5 min with a dose of 30 mg l⁻¹ of applied chlorine. Poliovirus was more resistant and a reduction of 2.85 log₁₀ was seen after 30 min, MS2 was the most

resistant organism (1 log₁₀ inactivation). In further experiments seeded secondary effluent was treated with different doses of u.v. irradiation. To achieve a 4-log₁₀ reduction of E. coli, FCV, poliovirus and MS2 doses of 5.32, 19.04, 27.51 and 62.50 mW s cm⁻², respectively, were required. CONCLUSIONS: Feline calicivirus and E. coli seeded in primary wastewater were very susceptible to chlorination compared with poliovirus and MS2. In contrast, FCV seeded in secondary wastewater was more resistant to u.v. irradiation than E. coli but more sensitive than poliovirus and MS2. SIGNIFICANCE AND IMPACT OF THE STUDY: FRNA phage was more resistant to inactivation than all the viruses tested. This suggests FRNA phage would be a useful and conservative indicator of virus inactivation following disinfection of wastewaters with chlorination or u.v. irradiation.