Outbreak investigation and epidemiology - from practice to science - .

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Norovirus outbreak among primary school children who had played in a recreational water fountain

5.1 ABSTRACT

This chapter describes the study on a gastro-enteritis outbreak among primary school children, which was associated with playing in a Norovirus contaminated recreational fountain.

A retrospective cohort study was performed to estimate the magnitude of the outbreak and identify its source. An epidemiological investigation included standardised questionnaires about sex, age, school, class, possible risk exposures, and characteristics of the illness. Stool samples and environmental water samples were analysed for the presence of bacteria, viruses and parasites.

Questionnaires were returned for 191 schoolchildren (response 83%) with a mean age of 9.2 years, of whom 47% had experienced illness (diarrhoea and/or vomiting). Children were more likely to have been ill if they had played in the recreational fountain (RR 10.4). Norovirus was detected (Birmingham) in 22 (88%) stool specimens from ill children and 6 (38%) specimens of children without symptoms. The water sample derived from the fountain contained a Norovirus strain, which was identical to the Birmingham RNA sequence found in stools.

Not only drinking water, but also recreational water may be the source of gastroenteritis outbreaks. Adequate water treatment such as chlorination can prevent these types of outbreak.
5.2 INTRODUCTION

In recent years, Noroviruses (previously designated as Norwalk-like viruses or small round-structured viruses) have emerged as an important cause of food-borne and waterborne gastro-enteritis outbreaks. Reported waterborne outbreaks caused by Norovirus have been associated with private wells, small water systems and community water systems. Recreational surface water, including lakes and swimming pools, has also been associated with Norovirus outbreaks. However, recreational fountains have so far been associated with gastro-enteritis outbreaks caused by *Shigella* and *Cryptosporidium*, but not by Norovirus.

In this chapter, we describe the investigation of the first outbreak caused by Norovirus among schoolchildren due to their playing in a recreational fountain. On a hot summer day in June 2002, about 200 children of three primary schools enjoyed their annual pre-holiday school outing at a playground. Two days later, the principals of the schools informed the Municipal Public Health Service (MHS) about an estimated 100 children with symptoms of vomiting, diarrhoea, abdominal pain and headache. The Communicable Disease Act stipulates that institutions like primary schools have to notify the MHS of any unusual incidence of gastrointestinal symptoms. Food was not a probable cause of the illness, as most children had eaten their own homemade lunch. The only common food exposure was commercially packaged ice cream purchased at the playground by most children. One common water exposure was a recreational fountain (see picture). In addition, some children might have drunk from a water tap labelled ‘no drinking water’, close to the fountains and inside the sanitary facility. The inside and outside water taps both contained regular drinking water, but the outside taps were labelled as non-potable to avoid elaborate body washing at these taps.

All parents with ill children were given information about hygiene, risk of dehydration and the application of oral rehydration solution. In addition, a retrospective cohort study was performed to estimate the magnitude of the outbreak among these schoolchildren and identify its source.

5.3 METHODS

Epidemiological investigation

All three schools reporting ill schoolchildren had taken part in a visit to a playground, featuring a recreational fountain, on June 18. A retrospective cohort study was conducted among the 231 children attending the three primary schools who had visited the playground that day (referred to below as playground children). Standardised questionnaires were sent to their homes to obtain information about sex, age, school, class, possible risk exposures (playing in or drinking from the fountain, drinking from water taps or eating ice-cream),

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onset and nature of symptoms, duration of illness, contact with general practi-
tioner or hospital and prior illness. A primary case was defined as illness in any child or adult who had visited the playground and who had developed diarrhoea (three or more loose stools in any 24-hour period) or vomiting (at least one episode) or both in the time period of 72 hours after the visit. An exposed child was defined as a child who had played in the recreational fountain at the playground.

Six weeks after the first questionnaire, we sent a second questionnaire to all children's homes to obtain details about family size and possible secondary cases by person-to-person transmission. A secondary case was defined as illness in any child or adult - within a family with a playground child - who had not visited the playground and who had experienced diarrhoea (three or more loose stools in any 24-hour period) or vomiting (at least one episode) or both in the six-week period after the visit. This six-week period was chosen as the duration of shedding of the virus can be long and there might be even tertiary waves of cases. 13 We calculated relative risks (RR) with 95% confidence intervals (CI) to assess any association between illness and individual exposure factors. Secondary attack rate was calculated as the number of secondary cases divided by the total number of household members, excluding the playground children.

Environmental investigation

Two days after the visit, on the day of the notification, the playground was visited to conduct an environmental assessment. Hygiene policies and procedures were reviewed. The recreational fountain covers an area of about 40 m², in which about 40 jet spray nozzles squirt water jets whose height varies in time. Children playing in the fountain - frequently in underwear - are completely soaked by the water. The fountain system uses recirculated water that drains from the wet play floor into an underground reservoir. A filter is used for coarse materials like sand, grass and hairs and part of the water is subjected to sand filtration. The reservoir water is manually chlorinated using hypochlorite tablets and no continuous water analysis is performed to check chlorination levels. The reservoir is replenished with tap water each day to compensate water losses. The nearby water taps provide drinking water.

Environmental samples (100 ml) of the recreational fountain water and the drinking water were obtained for bacterial analysis according to the European recreational and drinking water guidelines, respectively. The water samples were cultured for coliform bacteria, E. coli, Enterococcus, Salmonella and Campylobacter species by standard culture methods. In addition,
large volumes (300 l) of drinking and recreational water were concentrated for rotavirus and Norovirus detection by PCR. Commercially packaged ice-cream sold at the playground was also obtained for microbiological investigation but not examined any further after the cause of the outbreak became clearer. In consultation with the manager of the playground, the recreational fountain and the water taps were closed on the day of sampling, until further research had clarified the cause of the illness. The water reservoir was emptied and disinfected.

**Laboratory investigation**

Stool specimens were collected 3-6 days after the playground visit, and were cultured for *Salmonella spp.*, *Shigella spp.*, *Campylobacter spp.*, *Yersinia enterocolitica*, enterohemorrhagic *Escherichia coli* (E. coli O157; VTEC) and *Staphylococcus aureus* by standard culture methods. A random sample of isolates of *E. coli* was serotyped. Faecal smears were examined by direct microscopy for ova and parasites including *Cryptosporidium spp.* and *Giardia spp.*. Faecal examination of a random selection of 11 follow-up samples was performed for *Giardia*, as it was expected that more positive samples would be detected after three weeks if *Giardia* should be the cause of the outbreak. Stool samples were examined for rotavirus and adenovirus by commercially available ELISA kits, while RNA amplification by reverse-transcription polymerase chain reaction (RT-PCR) was used to test for Astrovirus and caliciviruses, i.e. Noroviruses and Sapoviruses, as previously described, using primers JV12Y/JV131. Initial results indicated the presence of Norovirus genotype Birmingham in some faecal samples. Since it has been found that this genotype is difficult to detect with primers used in routine diagnostic procedures, we used an alternative RT primer and designed a specific primer for the PCR, designated NVp110 and JV12BH (5'-GTT TCA TTA TGA TGC TGA CTA-3'), respectively.

**5.4 RESULTS**

**Epidemiological investigation**

Questionnaires were returned for 191 schoolchildren (response 83%) and one for a parent who had accompanied the children on the school trip (see table 5.1). These data represent 160 different households. The mean age of the children was 9.2 years (sd: 1.5 years; range: 4 –12 years) and 53% (102/191) were girls. Symptoms of diarrhoea and/or vomiting were present in 47% of the children (90/191). No children had symptoms of diarrhoea and/or vomiting prior to or during the playground visit. The main symptoms among cases were abdominal pain (89%), nausea (78%), vomiting (75%), diarrhoea (70%), headache (70%) and abdominal cramps (49%). Only 8% of the cases (7/90) had contacted a general practitioner and none had been admitted to a hospital. The onset of symptoms in most children was one to two days after the trip (84%). The mean incubation period was 30 hours, with a range of
seven hours (June 18th) to 72 hours (June 21st; see epidemic curve in figure 5.1). Duration of symptoms was known for 67% of the cases. The remainder were still suffering from symptoms at the time of completion of the questionnaire. The mean duration for those who had already recovered was 1.7 days (sd: 0.8 days; range: 0.5-5 days). This implies that the estimate for all ill children, including those with longer duration (33%), would be higher (at least two days).

There was no relationship between developing illness and drinking from the water taps or consumption of ice cream (see table 5.2). However, schoolchildren were more likely to have fallen ill if they had played in the recreational fountain (RR: 10.4; 95% CI: 1.5-70.8) or had ingested water from it (RR: 2.0; 95% CI: 1.4-3.0). The question whether they had ingested the water could not be answered ("unsure") by 43 (23%) of the children. As shown in table 5.3, the attack rate of children exposed to the recreational fountain was 54% (90/167). Attack rates were similar for both sexes (45% male versus 50% female) and similar in age. Attack rates were significantly different between the schools (school A: 55%; B: 71% and C: 32%; p=0.001). The duration of stay at the playground and an estimation of individual playing time in the fountain (time of exposure) differed also for the three primary schools (table 5.1). Primary school C had the shortest individual playing time (one hour) and, probably because of this relatively limited exposure, also the lowest attack rate for those exposed to the fountain (32%), while primary school B had the longest individual playing time (2.5 hours) and also the highest attack rate (71%). For school A, the attack rate for those exposed to the fountain was 55%.

\[\text{Figure 5.1. Epidemic curve of primary (affected schoolchildren) and secondary cases by date of onset of symptoms}\]
Figure 5.2. Phylogenetic comparison of genogroup I Noroviruses detected during 2002 in The Netherlands. Sequences derived from two representative faecal samples (EP2002109-21 and EP2002109-37) and the water sample of the fountain (EP2002109-water) in the described outbreak were compared with other sequences, using the Unweighted Part-Group Method with Arithmetic mean (UPGMA) after multiple sequence alignment of a 250 nucleotide segment of the polymerase gene. EP2002136, EP2002142, EP2002040 and EP2002026 were sequences of Birmingham291 genotype from faecal samples from different outbreaks before or after the described outbreak. These sequences are similar to but differ slightly from the water outbreak. Numbers in the last column indicate the month of detection.

Data about household size and possible secondary cases was received from 111 households who completed a second questionnaire (response 69%). The mean size of all households associated with the playground trip was 4.0 (two children and two parents), with similar figures for affected and unaffected households. Table 5.3 shows 39 secondary cases due to person-to-person transmission, out of the total population at risk of 258 susceptible household members, corresponding with a secondary attack rate of 15%. Secondary attack rates varied per school from 4% to 40%. The 39 secondary cases originated from 26
different households (26/111=23%). Most of them were parents (74%) of the affected
schoolchildren, including 15 fathers, 14 mothers, one grandmother (mean age 39 years).
Secondary transmission was reported in five brothers and four sisters (mean age 4.6 years).
The mean date of the onset of symptoms of the secondary cases was June 22nd, that is, 4.4
days after the playground visit (slightly longer in the nine children than in the 30 adults: 5.4
days versus 4.1 days). A primary case was found in 23 households with secondary transmission
(88%). In the remaining three households, the exposed child had been affected only by
abdominal cramps or headache, or had experienced no symptoms. All secondary cases
occurred in households in which a child had been exposed to the water fountain.

Table 5.1. Overview of general information per primary school

<table>
<thead>
<tr>
<th>General information</th>
<th>Primary school A</th>
<th>Primary school B</th>
<th>Primary school C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated number of school children</td>
<td>85 children</td>
<td>84 children</td>
<td>62 children</td>
<td>231 children</td>
</tr>
<tr>
<td>on the day trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of responding schoolchildren</td>
<td>59 children</td>
<td>74 children</td>
<td>58 children</td>
<td>191 children</td>
</tr>
<tr>
<td>(response %)</td>
<td>(69%)</td>
<td>(88%)</td>
<td>(94%)</td>
<td>(83%)</td>
</tr>
<tr>
<td>Number of households related to responding schoolchildren</td>
<td>56 households</td>
<td>48 households</td>
<td>56 households</td>
<td>160 households</td>
</tr>
<tr>
<td>Mean age of the schoolchildren (range)</td>
<td>9.6 years (8-11)</td>
<td>8.7 years (4-12)</td>
<td>9.4 years (8-10)</td>
<td>9.2 years (4-12)</td>
</tr>
<tr>
<td>Percentage female</td>
<td>51%</td>
<td>57%</td>
<td>52%</td>
<td>53%</td>
</tr>
<tr>
<td>Duration of stay at playground</td>
<td>7 hours</td>
<td>4 hours</td>
<td>3 hours</td>
<td>4.8 hours</td>
</tr>
<tr>
<td>Individual duration of playing in the recreational fountain</td>
<td>0.5-2 hours</td>
<td>2.5 hours</td>
<td>1 hour</td>
<td>1.6 hour</td>
</tr>
<tr>
<td>Percentage of households who responded to the second questionnaire</td>
<td>64% (36/56)</td>
<td>75% (36/48)</td>
<td>70% (39/56)</td>
<td>69% (111/160)</td>
</tr>
<tr>
<td>Mean household size</td>
<td>4.1 persons</td>
<td>3.9 persons</td>
<td>4.1 persons</td>
<td>4.0 persons</td>
</tr>
</tbody>
</table>
### Table 5.2. Univariate analysis of risk factors studied in the outbreak

<table>
<thead>
<tr>
<th>Exposed to risk factor</th>
<th>Not exposed to risk factor</th>
<th>Relative Risk (95% CI)</th>
<th>% of all cases exposed to factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ill</td>
<td>n</td>
<td>ill</td>
<td>not ill</td>
</tr>
<tr>
<td>Commercial ice-cream</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption of water from:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- taps near the recreational fountain</td>
<td>3</td>
<td>4</td>
<td>78</td>
</tr>
<tr>
<td>- taps near the sanitary facility</td>
<td>18</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>Recreational fountain:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- played in fountain</td>
<td>87</td>
<td>80</td>
<td>1#</td>
</tr>
<tr>
<td>- ingested from fountain</td>
<td>25</td>
<td>15</td>
<td>33</td>
</tr>
</tbody>
</table>

*The calculated RR for the risk of playing in the fountain is possibly underestimated as one ill case not exposed to the recreational fountain (#) could be a secondary case, infected by her exposed and Norovirus-positive brother.*

### Environmental investigation

No Enterococci or E. coli bacteria were detected in the drinking water samples taken at the sanitary facility, in compliance with the European drinking water regulations. The sample taken from the recreational fountain, however, had very high bacterial counts, exceeding the standards in the European recreational water guideline. Numbers of coli form bacteria exceeded the detection limit of 1,000 per ml and Enterococci were found at 3,500 per 100 ml, while the concentration of E. coli bacteria was 7,700 per 100 ml. No Salmonella, Campylobacter or Rotaviruses were detected in any of the water samples. The presence of Norovirus RNA in the fountain water was ascertained using the primer pair JV12BH/NVp110. The sequence of the PCR product derived from the fountain water was identified as Norovirus type Birmingham.
### Table 5.3. Overview of cases per primary school

<table>
<thead>
<tr>
<th></th>
<th>Primary school A</th>
<th>Primary school B</th>
<th>Primary school C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary cases</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary cases</td>
<td>47% (28/59)</td>
<td>61% (45/74)</td>
<td>29% (17/58)</td>
<td>47% (90/191)</td>
</tr>
<tr>
<td>(vomiting and/or diarrhoea)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed children</td>
<td>91% (51/56)</td>
<td>86% (63/73)</td>
<td>91% (53/58)</td>
<td>89% (167/187)</td>
</tr>
<tr>
<td>(children who had played in the recreational fountain)#</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attack rate of primary cases</td>
<td>55% (28/51)</td>
<td>71% (45/63)</td>
<td>32% (17/53)</td>
<td>54% (90/167)</td>
</tr>
<tr>
<td>(= primary cases / exposed children)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Secondary cases</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of children in a family on school trip$</td>
<td>50% (37/74)</td>
<td>82% (54/66)</td>
<td>49% (40/82)</td>
<td>59% (131/222)</td>
</tr>
<tr>
<td>Affected households with secondary cases</td>
<td>14% (5/36)</td>
<td>49% (17/36)</td>
<td>10% (4/39)</td>
<td>23% (26/111)</td>
</tr>
<tr>
<td>Attack rate in exposed family members* (= secondary cases / susceptible family members)</td>
<td>5% (5/99)</td>
<td>40% (29/72)</td>
<td>4% (5/113)</td>
<td>15% (39/258)</td>
</tr>
</tbody>
</table>

# Parents of three children in school A and one child in school B answered the relevant question as 'unknown'

$ Calculated as number of children at playground visit divided by all children in relevant households

* Exposed households or family members are those related to exposed children (who had played in the recreational fountain)

**Microbiological results**

Stool specimens were available for 25 children who had fallen ill and 16 children without symptoms of diarrhoea and/or vomiting. Two stool samples were available from adults: a teacher and a parent who had accompanied the children on the playground trip. All stool samples were negative for bacterial pathogens. Of the nine faecal specimens cultured for *E. coli*, all showed possible strains of *E. coli*; a random sample of seven were serotyped. There was no similarity in serotypes, samples showing O7, O45, O86, O88, O141 and O166, while one turned out not to be of *E. coli*. This outcome does not match a common source outbreak and seems to reflect the commensal flora.
TABLE 5.4. Positive findings from stool sample analysis (43 stool samples tested)

<table>
<thead>
<tr>
<th>Diagnostic assay</th>
<th>CHILDREN</th>
<th></th>
<th></th>
<th>ADULTS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ill children</td>
<td>Healthy children</td>
<td>Ill adults</td>
<td>Exposed</td>
<td>Exposed</td>
</tr>
<tr>
<td></td>
<td>Exposed to fountain</td>
<td>Not exposed</td>
<td>Exposed to fountain</td>
<td>Not exposed</td>
<td>N=24</td>
</tr>
<tr>
<td></td>
<td>% pos. (n)</td>
<td>% pos. (n)</td>
<td>% pos. (n)</td>
<td>% pos. (n)</td>
<td></td>
</tr>
<tr>
<td>Norovirus PCR</td>
<td>JV12Y/JV13I</td>
<td>25 (6)</td>
<td>0 (0)</td>
<td>36 (4)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>JV12BH/NVp110</td>
<td>71 (17)</td>
<td>0 (0)</td>
<td>18 (2)</td>
<td>20 (1)#</td>
</tr>
<tr>
<td>Tests combined</td>
<td>92 (22)</td>
<td>0 (0)</td>
<td>45 (5)</td>
<td>20 (1)</td>
<td>50 (1)</td>
</tr>
<tr>
<td>Giardia species</td>
<td>13 (3)</td>
<td>0 (0)</td>
<td>9 (1)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

* This primary case is possibly a secondary case, as her brother (who had been exposed to the water fountain) was ill too. Her faeces was collected 3 days after the playground visit, and according to her questionnaire, the onset of symptoms was not until 4 days after the visit.

# One child who tested positive but had not been exposed and did not fall ill was possibly infected with Norovirus by his exposed and ill brother (secondary infection)

No parasites were found, except for four faeces samples positive for *Giardia lamblia*. As shown in table 5.4, all four of these children had been exposed to the fountain, but only three developed any illness. Three weeks after the playground visit, 11 stool specimens (four from healthy children and seven from primary cases) showed no new cases of *Giardia species*. Combined results from all PCRs used show that Norovirus was found in 22 (88%) of the samples from ill children, in six (37.5%) of the samples from healthy children and in one of the two samples from ill adults. All positive samples of the cases and five of the six positive samples of the healthy children had been taken from children who had played in the fountain. The one child who tested positive but had not been exposed and had not fallen ill was probably infected by his exposed and ill brother (secondary infection). Eleven random Norovirus-samples were genotyped, 1 as Mikkeli (healthy child), 9 as Birmingham (1 healthy child and 8 ill children) and 1 had both Mikkeli and Birmingham (ill child). The Birmingham strain was identical to the strain identified in the recreational fountain water.
5.5 DISCUSSION

Norovirus outbreak

This outbreak in children with a clinical profile of abdominal pain, nausea, vomiting and diarrhoea, with an attack rate of 54%, a mean incubation period of 30 hours, a duration of illness of about two days and 39 clear secondary cases, fits in well with Norovirus. The identical Norovirus strain (Birmingham) was detected in stool specimens from ill persons and in a water sample derived from the fountain. It is very unusual that we were able to detect the causative agent in the water, since the source is usually only identified epidemiologically. Although Norovirus gastro-enteritis outbreaks have emerged as the most common gastro-enteritis outbreak, to our knowledge the outbreak described here demonstrates a novel source of Norovirus: a recreational water fountain. The evidence of the source of this outbreak was provided by the complimentary nature of the epidemiological analytical and microbiological findings, reinforced by the specific Norovirus molecular sequencing analysis in stool specimens and water samples, which shows the great value of these techniques in discovering new relationships.

Exposure to recreational fountain

Recreational fountains using recirculating water are becoming more frequent in traditional playgrounds (but also in public parks or town centres), as they are very popular among children. Children like to stand directly over the nozzles (jets), so their entire bodies become soaked. Because these fountains are attractive to very young children, who still wear diapers, recreational water may be at high risk for contamination by enteric pathogens through overt faecal accidents or rinsing of contaminated bodies in the water. The duration of playing in the fountain per school suggests a dose-response relation, as the primary attack rate was significantly higher for the school with the longest duration compared to the school with the shortest duration.

This outbreak shows the potential risk of transmission of diarrhoeal illness in recreational fountains – especially on hot summer days when bacteria multiply rapidly. Earlier studies have noted this risk with Shigella and Cryptosporidium.1,12 The recirculated water of the fountains described in this article was inadequately chlorinated and only partially refreshed with clean tap water, increasing the risk of contamination and disease transmission. Although the quality of recreational surface water and swimming pool water is regulated by European recreational water guidelines, the water quality in recreational fountains is difficult to control, since such fountains are frequently open to the public without admission fees and therefore freely accessible at any time by anyone without supervision. Operators of these fountains should monitor levels of effective chlorine and microbiological water quality indicators routinely. Public health officials should regularly inspect public recreational fountains on these water quality procedures. EU-guidelines are based on bacterial indicators (general
contamination) but these are not always related to contamination with viruses – although, in our outbreak, there was bacterial contamination as well. It is not reasonable to routinely monitor on Norovirus because PCR-assays are difficult to perform and difficult to interpret.

Thus, preventive measures should be taken to reduce the risk of contamination, including adequate chlorination of the water and supervision of the chlorination system, frequent replacement of the water, especially after hot days with heavy use, and the presence of adequate, clean sanitary facilities. An automatic water handling system was later installed at the recreational fountain described here, which maintains continuous chlorination levels of 1.2 mg/l. Chlorine levels are registered in a journal three times a day. Procedures to fill the reservoir with fresh water every two days are documented and carried out, and microbiological analysis of water samples is performed by an authorised laboratory every 14 days. Additional measures - which would however be more difficult to maintain - include forcing visitors to shower at home or at the fountain area before entering the fountain, excluding patients with diarrhoea, excluding children wearing diapers and banning food consumption in the fountain area.

**Surveillance and mandatory notification**

Studies on gastro-enteritis outbreaks are regularly conducted in the Netherlands, as they are in many countries. Interim results of a study of gastro-enteritis outbreaks in the Netherlands in 2002 show that about 53% of 119 microbiologically investigated outbreaks were caused by Norovirus, and only one outbreak - described in the present report - was waterborne. In the United States, 3-6% of the Norovirus outbreaks have been reported to originate from water consumption. In the four-year period 1997-2000, 54 waterborne-disease outbreaks of gastroenteritis associated with recreational water were reported in the United States.19,20 Five (9%) were caused by Norovirus and associated three times with lake-water, ones with motel pool water and ones with hot springs in a resort. In Sweden, 15% of Norovirus outbreaks were food-borne or waterborne, no specification being provided of the percentage that originated from consumption water.21 In the United Kingdom, 0% of the Norovirus outbreaks originated from a water source.22 Prior outbreak surveillance in England and Wales showed that only one of 26 waterborne gastro-enteritis outbreaks was caused by Norovirus; it originated from recreational water sports on a river.23 In Ireland, only one of 67 gastro-enteritis outbreaks studied was waterborne (through water consumption).24 In Finland, 14 waterborne outbreaks were described, with one outbreak caused by surface water contaminated with Norovirus and seven outbreaks by groundwater contaminated with Norovirus.25

This shows that recreational waterborne Norovirus outbreaks are reported rarely. These outbreaks go easily unnoticed and are most likely underreported because Norovirus outbreaks are such common outbreaks, with over 90% caused through person-to-person transmission, that it is very difficult to motivate local authorities to stay alert and investigate
them in order to distinguish the food and waterborne outbreaks in an early stage from the bulk of person-to-person outbreaks. In addition, in waterborne outbreaks, affected people often do not know each other and do not visit the (same) general practitioner or school and, therefore, connections are easily missed between the different cases. Furthermore, in the Netherlands, as in most EU countries, testing capacity for Norovirus is not routinely available in the primary diagnosing laboratories receiving stool samples of the diarrhoeal cases. Norovirus outbreaks often show up as the outbreaks unexplained by well-known and routinely tested enteric bacteria, some viruses and protozoa. Confirmation of the outbreak as caused by Norovirus fully depends on these laboratories passing on the stools to the one or two national labs that are able to perform Norovirus tests. The large outbreak described in the present report would have probably remained undetected if the primary schools had not reported the cases to the MHS. This shows the value of mandatory notification of gastroenteritis clusters by institutions like primary schools. Outbreak investigations are important in public health to identify the source, implement control measures and prevent future illness; in addition, they frequently yield new knowledge that may lead to amended control policies. In the outbreak described, the novel source of Norovirus was a recreational fountain.
5.6 REFERENCES


12. From the Centers for Disease Control and Prevention. Outbreak of gastroenteritis


Legionella ook aangetroffen in Atrium Heerlen

Veel telefoontjes bij GGD over legionella

Grote controle op legionella

Tientallen tellers legionella

Veteranenziekte na douchen

Ringleidingen in tegen gevreesde brieven

Artsen moeten meer controleren op veteranenziekte

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Volkspoolzondheid en Vrom (Milieus, de maatregelen tegen legionellassmetting moeten worden bepaald naar instellingen is in een opgemend beheersplan worden vastgelegd. De beheersplannen gaan voor allerlei instellingen, van di water te maken dan moet het water onstaan van de nieuw gemaakt...}

Zuid-Limburg bekendgemaakt. Het gaat om de besmetting die relatief zeldzaam te voorkomen. Besmetting met legionella leidt tot ongerustheid

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Presentatie van het beleidsplan van de GGD-artsen in het zuidelijke deel van de provincie Noord-Brabant.

Tientallen tellers legionella

Veteranenziekte na douchen

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Legionella ook aangetroffen in Atrium Heerlen

Veel telefoontjes bij GGD over legionella

Grote controle op legionella

Tientallen tellers legionella

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