Outbreak of diarrhoea among participants of a triathlon and a duathlon on 12 July 2015 in Utrecht, the Netherlands

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SUMMARY

On 12 July 2015, a triathlon competition with 900 participants took place in Utrecht, the Netherlands. An outbreak investigation was initiated after 56 participants reported health complaints. An online questionnaire was sent to 700 participants. Stool specimens from six participants and four water specimens were collected from the swimming location. A total of 239 participants completed the questionnaire (response rate: 34%), 73 (31%) of them met the case definition for acute gastrointestinal illness (AGI). A total of 67% of the respondents were male and the median age was 38 years. Almost half (42%) of swimmers reported health complaints. Consumption of energy drinks and ingesting ≥3 mouthfuls of canal water were identified as risk factors for AGI among swimmers only (adjusted relative risks (aRR) 1·6; 95% confidence intervals (CI) 1·0–2·5 and aRR 2·6; 95% CI 1·5–4·8). The collected water specimens tested positive for norovirus genogroup I and rotavirus and stool specimens tested positive for norovirus genogroup II. Our findings indicate that the outbreak could have been caused by exposure to norovirus during swimming. Swimmers should get information about the health risks for making an informed choice about participating. For future events, the organisers decided to change the swimming location from a canal to a recreational lake.

Key words: Gastrointestinal disease, norovirus, outbreak, swimming, triathlon.

INTRODUCTION

Swimming events in urban canals have become increasingly popular in the Netherlands. All sorts of multi-sport events can include swimming in canal water, such as triathlons, obstacle races and mud races.

The Public Health Services (PHS) in the Netherlands do not have evidence-based guidelines for preventive measures that should be taken in urban swimming events to protect the health of swimmers. Identifying the risk factors for the development of health complaints after this type of swimming event can help develop recommendations that will prevent outbreaks at future events.

The canals in the Netherlands are exposed to various sources of contamination such as overflow of sewage after heavy rains and run-off of manure from agricultural land [1]. A study in the Netherlands compared

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the water quality of recreational lakes and non-recreational canals in Amsterdam between 2003 and 2005. The water quality in the recreational lakes was found to be excellent, based on the European Bathing Water Directive, but poor in the canals [2]. Viral pathogens such as norovirus, rotavirus, and enterovirus were detected in canal water. This indicates that exposure to the water in Amsterdam canals could cause health risks [3]. A study on waterborne disease outbreaks during 1991–2007 in the Netherlands showed an association between exposure to untreated recreational waters, skin problems and acute gastrointestinal illness (AGI). Even when the official bathing water quality was compliant with European bathing water legislation, outbreaks of skin conditions and AGI have been reported [4].

Health risks associated with swimming in recreational waters were investigated in a Dutch prospective cohort study of seven triathlons and 15 duathlons between 1993 and 1994 [5]. Compared with non-swimmers, swimmers had a significantly increased risk of developing AGI in the week after swimming. In Denmark, two retrospective cohort studies after the triathlon events in 2010 and 2011 found that unintentionally swallowing contaminated seawater while swimming increased the risk of illness and the risk was further increased with the number of mouthfuls of seawater swallowed [6].

On 12 July 2015, a triathlon event took place in Utrecht with 900 participants. The participants of the event could compete in a triathlon (swim–bike–run) or a duathlon (run–bike–run) competition. The swimming competition took place in two locations: a harbour (Veilinghaven) near Utrecht City Centre and in a canal connected with the harbour (Merwedekanaal). Participants could choose to swim 500, 1000 or 1500 m. Fifty-six participants reported AGI to the PHS 2 days after the event. The public health authorities initiated a study to assess the magnitude of the outbreak, identify the source and determine the risk factors for becoming ill, as well as develop public health recommendations. An investigation was initiated in cooperation with the PHS and the National Institute for Public Health and the Environment (RIVM). In this paper, we describe this outbreak investigation that took place after the triathlon and duathlon event in July 2015 in Utrecht.

METHODS

A retrospective cohort study was conducted among participants of the triathlon and duathlon participants. A case was defined as a participant of the event on 12 July 2015 with AGI, including at least one of the following complaints: vomiting, diarrhoea, nausea and/or stomach pain that started within 7 days of the end of the triathlon or duathlon.

Two days after the event, the organiser reported to the PHS that they were approached by 56 participants who self-reported health complaints such as nausea, vomiting and diarrhoea. Explorative telephone interviews with seven participants were used to develop an online questionnaire to identify exposure. Participants reported that organisers served free, pre-cut fruit (orange, banana and watermelon) and energy drinks. The fruit was prepared and served by volunteers and the energy drinks were diluted from concentrate and served from jerry cans by volunteers.

Information on the food and drinks that were served was collected from the organisers of the event. The PHS designed a questionnaire to collect information on symptoms and exposures. Information was gathered on socio-demographic characteristics, swimming-related exposures (i.e. swimming technique, duration, distance and average number of mouthfuls of swallowed water while swimming), detailed information on health complaints, the use of catering, the use of toilets or showers after or during the event, specific information on the participants' dietary habits and the use of food supplements. We categorised responses based on the literature (e.g. mouthfuls of water, body mass index (BMI)), or were arbitrarily chosen (age distribution). The distance categories were based upon the actual distances swam. The event organiser sent a questionnaire link to the event participants by email. The questionnaire was sent to 700/900 participants for whom an email address was available, and was accessible from 17 July to 21 July 2015. A NetQ questionnaire tool was used. The data was analysed jointly by the PHS and RIVM.

Statistical analysis

Relative risks (RR) with corresponding 95% confidence intervals (CI) were calculated using binominal regression models for the association between having AGI and independent variables, such as consumption of different food items at the event, the use of common toilets and showers, swimming-related factors and the use of medicines or supplements. Variables with a P-value <0·2 were selected for inclusion in the multivariable models and those with a P-value of <0·05 were retained. We fitted two multivariable

regression models, one for swimmers and non-swimmers together and another one for only swimmers. The multivariable models were built using backward selection. Age and gender were included in the model. When removal of variables changed the coefficients of other variables by >10%, the variable was retained in the model as a confounder, regardless of significance. Statistical analyses were performed using Stata, Version 13 software.

Laboratory and environmental investigation

A regional water board in Utrecht (de Stichtse Rijnlanden) performs regular screening of water specimens. The PHS collected water specimens at the swimming location 8 days after the event from the harbour and at three points along the route, in the harbour at the start and the end, and half way along the route. Stool specimens from symptomatic participants were collected and tested for viral (e.g. norovirus, rotavirus, adenovirus and sapovirus) and bacterial agents (e.g. *Salmonella*, *Shigella*, *Campylobacter* and *Yersinia*). Samples were further characterised by sequence analysis. The air temperature measured at a nearby weather station (De Bilt) for the month of July was examined, as well as the canal water temperatures during and before the event.

RESULTS

The questionnaire response rate was 34% (239/700) (Fig. 1). The median age of the respondents was 38 years (range 15–67) and 159 (67%) were male. A total of 73 (31%) of the respondents met the AGI case definition. The attack rate of AGI among swimmers (33%, 72/215) was higher than among non-swimmers (4%, 1/24). Nine cases had symptom onset on the day of the event, 61 developed symptoms during the 2 days after the event and the peak of the outbreak was on 13 July in the afternoon. The epidemic curve (Fig. 2) indicates a point source outbreak.

In total, 90% (215/239) of the respondents swam and 38% ($n = 91$) reported health complaints. Among the AGI cases, 99% (72) swam and one case did not. The most frequently reported complaints among the AGI cases were: stomach pain (71%, 52/73), nausea (77%, 56/73), diarrhoea (59%, 43/73), vomiting (38%, 28/73) and fever (23%, 17/73). Among all respondents, other health complaints mentioned were headache ($n = 37$, 36 swimmers), muscle or joint pain ($n = 34$, all swimmers), shivering
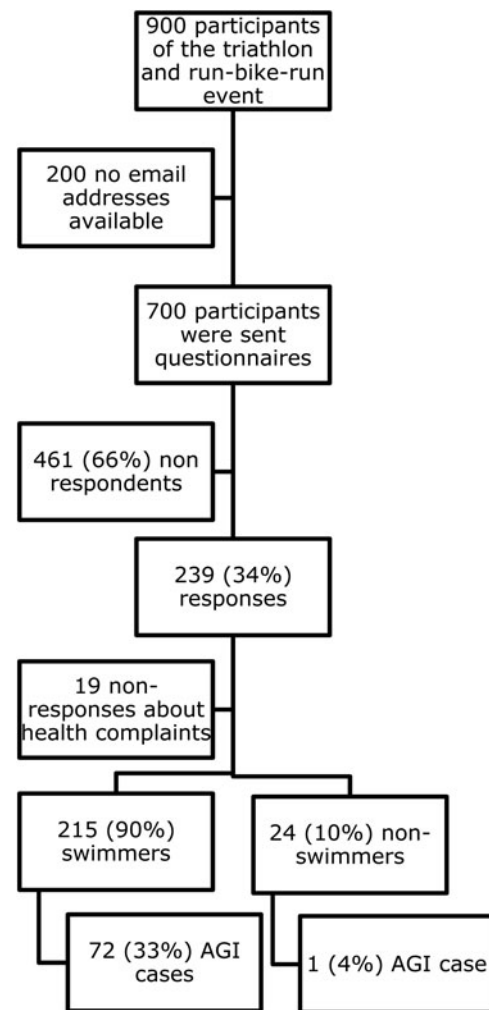

Fig. 1. Flow chart of study participants.

($n = 20$, all swimmers), respiratory symptoms ($n = 6$, all swimmers), red eyes ($n = 2$, all swimmers) or skin complaints ($n = 1$, one swimmer). One hundred and two respondents (43%) mentioned swimming in another open-water source in the week before the triathlon (cases $n = 37$, non-cases $n = 65$). Seven cases visited a doctor because of the health complaints following the event. Characteristics among cases and non-cases among the triathlon and duathlon participants are presented in Table 1.

In the univariable analysis, female gender, swimming, swallowing water, energy drink consumption, using any medicines or antacids and swimming in open water in the week before the event were associated with becoming ill (*P*-value <0·2, Table 2). In the first multivariable analysis among swimmers and non-swimmers, the risk of AGI was increased when they consumed free energy drinks (Table 3). In the second multivariable analysis among swimmers-only,
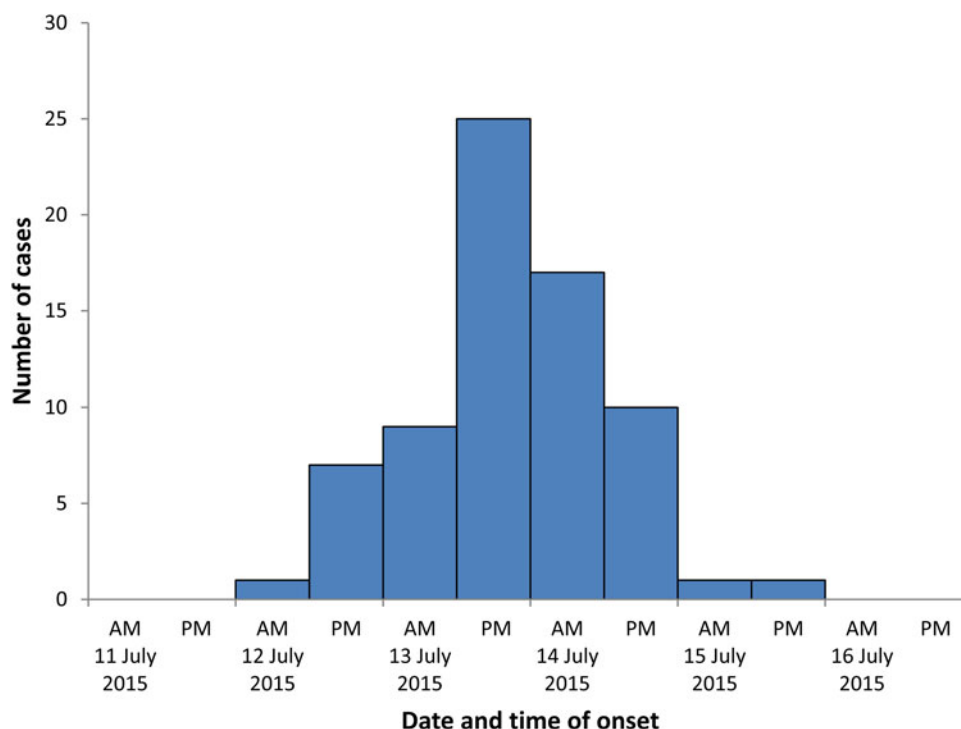
Fig. 2. Number of cases ($N = 73$) by date and time of AGI onset following the triathlon event on 12 July 2015 in Utrecht, the Netherlands. The time of onset is missing in one case who reported symptom onset on 12 July 2015.

the risk of AGI increased after consumption of energy drinks (adjusted RR (aRR) 1·6; 95% CI 1·0–2·5), which was an independent predictor for illness. The mouthfuls of water swallowed showed an increased RR when comparing 1 to 2 mouthfuls and ≥3 mouthfuls to no ingestion of water (aRR 1·8; 95% CI 0·9–3·4 and aRR 2·6; 95% CI 1·5–4·8) (Table 4).

Laboratory results

Available stool specimens ($n = 6$) all tested positive for norovirus genogroup II (GII), of which four were norovirus GII.P4 New Orleans 2009 (polymerase) and one was GII.4 Sydney 2012 (capsid). Sequencing was unsuccessful in one stool sample. Routine water quality measurements from canals in Utrecht showed that *Escherichia coli* and intestinal enterococci levels were within normal limits in July. All four water specimens were PCR positive for norovirus genogroup I (GI) and for rotavirus.

DISCUSSION AND CONCLUSIONS

Following the triathlon and duathlon event on 12 July 2015 in Utrecht, 34% (72/215) swimmers reported AGI versus 4% (1/24) non-swimmers. The main

clinical symptoms were diarrhoea (59%) and vomiting (38%). The attack rate and the resolution of symptoms within 2 days suggested a viral origin, which was supported by the detection of norovirus in stool specimens as causal agent of the outbreak. Although numbers are small and the response rate was low, we assume a point source outbreak.

The increased risk of ingesting water and a dose–response of mouthfuls of water swallowed indicated that swimming in open water was the most likely source of infection. Outbreaks of norovirus are common and faecal–oral transmission is the most common route for infection, such as ingestion of contaminated food, water or through (in)direct oral contact with a contaminated object [7, 8]. In our study, none of the food items besides energy drinks were associated with AGI. Unfortunately, no food samples were available for microbiological analysis and vehicles for transmission such as contaminated door handles or toilet seats could not be investigated, as toilet and showering facilities had been removed from the location of the event. The event was mentioned in the local news, which could have encouraged more participants with health complaints to respond to the questionnaire compared with those without health complaints. Using a wide case definition could have

Table 1. *Characteristics among AGI cases (n = 73) and non-cases (n = 166) who participated as swimmer or non-swimmer following the triathlon event on 12 July 2015 Utrecht, Netherlands*

Characteristic	Case N = 73		Non-case N = 166	
	n	%	*n*	%
Gender				
Female	29	40	51	31
Male	44	60	115	69
Missing	–	–	–	–
Age, in years				
<25	7	10	15	9
25–35	28	38	54	33
>35	34	47	89	54
Missing	4	5	8	5
BMI				
Underweight	2	3	1	1
Normal	62	85	139	84
Overweight	7	10	24	14
Obese	0	0	1	1
Missing	2	3	1	1
Swam in triathlon				
Yes	72	99	143	86
No	1	1	23	14
Missing	–	–	–	–
Distance swam (m)				
500	25	34	65	39
1000	25	34	37	22
1500	22	30	41	25
Missing	1	1	23	14
Minutes swam				
⩽15	23	32	60	36
>15	45	62	65	39
Missing	5	7	41	25
Swimming technique*				
Freestyle	66	90	127	77
Breast stroke	21	29	40	24
Swallowed water				
0 mouthfuls	13	18	57	34
1–2 mouthfuls	22	30	43	26
3 or more mouthfuls	38	52	66	40
Missing	–	–	–	–
Type of diet during past month				
Meat and fish	57	78	134	81
Meat, no fish	9	12	18	11
Fish, no meat	2	3	5	3
No fish, no meat	5	7	7	4
Missing	–	–	2	1
Reported using				
Vitamins	17	23	41	25
Protein supplements	6	8	18	11
Mineral supplements	5	7	17	10
Probiotics	2	3	2	1
Any medicines in general	18	25	22	13
Antacids	2	3	–	–
Hours of sports/week				
<5 h	30	41	69	42
⩾5 h	43	59	97	58
Missing	–	–	–	–

Table 1 (*cont.*)

	Case N = 73		Non-case N = 166	
Used mobile toilet before, during or after the event*	51	70	105	63
Used shower after the event	1	1	4	2
Missing	–	–	–	–
Ate food from the restaurant	12	16	25	15
Missing	–	–	–	–
Consumed from the organiser*				
Pre-mixed energy drink	52	71	91	55
Water	54	74	117	70
Watermelon pieces served from a tray	26	36	68	41
Orange served from a tray	29	40	65	39
Banana served from a tray	31	42	69	42
Swam in open water in the week before the event	37	51	65	39
Missing	–	–	–	–

* Swimmers could mention more than one option.

Table 2. *Univariable risk ratios and corresponding 95% CI of factors associated with AGI (P-value <0·2) among swimmers and non-swimmers adjusted for age and gender*

Risk factor (total respondents)	Exposed to risk factor		Unexposed to risk factor		RR	95% CI	P-value
	Total	Cases (%)	Total	Cases (%)			
Swallowed water while swimming (n = 215)	145	59 (41)	70	13 (19)	2·2	1·3–3·7	0·001
Swam in the event (n = 239)	215	72 (34)	24	1 (4)	8·0	1·2–55·3	0·003
Consumed free energy drink (n = 239)	143	52 (36)	96	21 (22)	1·7	1·1–2·6	0·017
Used medicines (n = 239)	40	18 (45)	199	55 (28)	1·6	1·1–2·5	0·030
Swam in open water in week before the event (n = 239)	102	37 (36)	137	36 (26)	1·4	0·9–2·0	0·100
Used antacids (n = 40)	2	2 (100)	38	16 (42)	2·4	1·6–3·4	0·109
Being male (n = 239)	159	44 (28)	80	29 (36)	0·8	0·5–1·1	0·174

overestimated the number of cases. The questionnaire was accessible between 5 and 9 days after the event, and recall bias on specific risk factors could have occurred (i.e. number of mouthfuls of water swallowed, swimming technique used and consumption of food and drinks).

The risk of illness increased when swimmers ingested more than 3 mouthfuls of water. Other studies have reported comparable findings, where a higher number of mouthfuls of water swallowed was associated with increased risk of illness [5, 6, 9–11]. Our study found that the duration of swimming (i.e. increased duration of exposure) and swimming distance was not significantly independently associated with AGI. This could be an indicator for a contaminated area, such as at the start or the end of the swimming route at the harbour where all swimmers, regardless of swimming distance or duration, passed through when getting in or out of the water.

Faecal contamination of surface waters has been known to occur after heavy rain due to sewage overflow and after discharge of untreated sewage [3]. However, no heavy rains were reported in Utrecht before the event. Regular screening of the canal water for faecal indicator bacteria (*E. coli* and intestinal enterococci) was performed in Utrecht. The

Table 3. *Multivariable risk ratios and corresponding 95% CI of the factors associated with AGI among swimmers and non-swimmers*

	Risk ratio (95% CI)	P-value
Gender		
Male	0·7 (0·5–1·1)	0·115
Female	Reference	–
Age		
<25	Reference	–
25–35	1·2 (0·6–2·4)	0·618
>35	1·0 (0·5–2·0)	0·963
Consumed free energy drink	1·8 (1·1–2·8)	0·013

Table 4. *Multivariable risk ratios and corresponding 95% CI of the factors associated with AGI among swimmers*

	Risk ratio (95% CI)	P-value
Gender		
Female	Reference	–
Male	0·8 (0·6–1·1)	0·191
Age		
<25	Reference	–
25–35	0·8 (0·5–1·6)	0·626
>35	0·7 (0·4–1·3)	0·362
Consumed free energy drink	1·6 (1·0–2·5)	0·039
Mouthfuls water swallowed		
None	Reference	–
1–2 mouthfuls	1·8 (0·9–3·4)	0·073
⩾3 mouthfuls	2·6 (1·5–4·8)	0·001
Minutes swam		
⩽15	Reference	–
>15	1·6 (0·9–2·1)	0·093

routine water quality measurements from the canals in Utrecht showed that *E. coli* and intestinal enterococci levels were within normal limits in July (personal communication from Hoogheemraadschap Stichtse Rijnlanden, July, 2016). However, the levels of faecal indicator bacteria do not always correspond with the presence of other potentially harmful organisms, such as viruses [4, 12]. Many outbreaks of norovirus associated with recreational waters have been described in the literature [11, 13, 14]. Norovirus has been reported to be persistent in the environment; in groundwater it was found to be infectious for humans after 2 months and norovirus RNA was detectable even after 588 days [8]. It has been suggested that GI is less stable on surfaces and more stable in water compared with GII strains [15, 16].

Previous studies have found that the number of norovirus outbreaks in summer is positively correlated with the preceding number of days with a maximum air temperature of 25 °C [4, 17]. The average air temperature measured at the nearby De Bilt weather station for July 2015 was 18·4 °C. Air temperatures exceeding 25 °C were not reported in the days before the event. On the day of the event, the average air temperature was 17·7 °C [18]. The routinely measured temperatures of the canal water in Utrecht were higher than normal during the summer of 2015. The average canal water temperature was 21·3 °C in July and 21·7 °C on 12 July (Hoogheemraadschap Stichtse Rijnlanden, personal communication, July 2016). These water temperatures could have facilitated the outbreak but norovirus is more commonly found in surface waters when the water temperature is higher [17].

The risk of AGI was higher among those who consumed energy drinks. No energy drink was available for laboratory testing. The energy drink was premixed from a concentrate, diluted with tap water, and served free-of-charge to participants from jerry cans by the volunteers. None of the energy drink handlers reported AGI complaints. Based on the analysis, we assume, but cannot rule out, that the energy drink was not a norovirus source. Furthermore, to our knowledge, no study has reported that presence of energy drink in the gut environment could be a risk factor for norovirus infection or AGI in general. However, a literature review on adverse and beneficial effects on consumption of energy drinks reported gastrointestinal and metabolic adverse effects. The study suggests that the high-sugar content in energy drinks may reduce the activity, diversity and gene expression of intestinal bacteria [19]. Although the relationship between illness and the consumption of energy drinks could be influenced by a confounding factor, this finding is interesting and will be explored further in future studies. Energy drink consumption may subsequently have increased the risk for developing AGI, regardless of its possible contamination with norovirus. The mechanism for added risk of drinking certain beverages such as energy drinks shortly before physical exercise is not clear, but may play a role. In our study, the risk among females was not significantly higher than among males, but has been reported to be higher in another study on AGI among triathletes in Denmark [6]. Other studies have reported that different genders report and express symptoms differently [20, 21].

Norovirus belonging to genogroups GI and GII are the most common viruses causing gastroenteritis in

humans among all age groups [22]. Food and water-borne outbreaks have been associated with GI and GII strains and waterborne outbreaks have been more commonly associated with only GI strains [8]. In our study, six stool specimens were positive for norovirus GII, of which four specimens had the same genotype and variant GII.4. They did not match with the norovirus GI that was detected in the water specimens. It is possible that norovirus GII was also present in the water but was not detected in the sampled water. Alternatively, if norovirus GI was ingested by swimmers, it did not replicate sufficiently to cause disease or be detected in stool due to the detection limit of the assay. It is also possible that norovirus GI was present in the stool of a participant for whom no stool specimens was available or contamination appeared with food or energy drink consumption of which no specimens were available to test. The water specimens collected in our study did not meet the recommended amount of water for testing [3]. Because water specimens were collected 1 week after the event, it is possible that norovirus GII was present in the water at the time of the event as water quality in the canals is subject to frequent change. Specimens taken in advance or after the event may not be a good indication of faecal contamination. The routine collecting of water samples for checking for faecal indicator bacteria from unofficial bathing waters is probably not sufficient to predict the risk of viral infections.

Actions and recommendations

The PHS informed the municipality and the event organiser of the results of the investigation in a press release on their website. The participants of the event were informed about the results of the investigation through the event organiser. The PHS repeated previous information to them about the possible risk of contracting illness when exposed to canal water. The event organisers were informed about the various means of norovirus transmission, possible risks when handling and serving pre-cut fruit or drinks from a common container. Because our study found increased risk by ingesting water while swimming, swimmers should be informed about the increased risk for AGI. Providing such information for participants will assist them in making an informed choice about their participation in similar events in the future. Event organisers should discuss health and safety issues with the PHS before the events. The PHS can test the water before any event for both coliform bacteria and noroviruses

and can follow up on health complaints after such an event, to evaluate the adequacy of the preventive measures taken. In 2016, the event organisers of the annual Utrecht triathlon changed the swimming location to a location with official recreational water. No outbreak was notified afterwards.

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