An outbreak of Sapovirus gastroenteritis at 2011 Las Vegas Marathon

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Public Health Investigation Report

Southern Nevada Health District
Office of Epidemiology
Las Vegas, Nevada

March 2012
This document was last revised on March 13, 2012

This report represents the findings of the Southern Nevada Health District in the investigation of a gastroenteritis outbreak associated with Sapovirus among participants of the 2011 Rock 'n' Roll Las Vegas Marathon & 1/2 Marathon.

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Acknowledgments

The following individuals are gratefully acknowledged for their contributions to this investigation and for their continuing collaboration.

- Patricia Rowley, Linda Verchick, Devin Barrett, Tami Bruno, Jennifer Harmon, Tony Frederick, Zuwen Qiu-Shultz, Dr. Linh Nguyen, Dr. Nancy Williams, Dr. Tom Coleman, and Jennifer Lucas from the Southern Nevada Health District, Office of Epidemiology for their help in the epidemiologic and disease investigations.

- Pat Armour, Paul Hug, Ken Stottler, Susanne Quianzon, Vincent Abitria, Sharon Johnson, Betsy Sapp, Sumit Das, and Francine Velarde from the Southern Nevada Public Health Laboratory for the collection of clinical specimens and laboratory assistance.

- Dr. Sergey Morzunov from the Nevada State Public Health Laboratory for assistance with submission of samples to Centers for Disease Control and Prevention (CDC).

- Nicole Gregoricus, Leslie Barclay and Dr. Jan Vinje from the CDC National Calicivirus Laboratory for assistance with calicivirus and adenovirus testing.

- Stephanie Bethel, Jennifer Sizemore and Jacci Wilson from the Southern Nevada Health District Public Information Office for their help with the coordination of social and traditional media outreach.

ABSTRACT

Using social media (Facebook and Twitter) the SNHD investigated a gastroenteritis outbreak among participants of 2011 Rock 'n' Roll Las Vegas Marathon & 1/2 Marathon. Of the 44,000 runners, 1,146 responded by submitting an on-line survey. Of 1,082 completed surveys, 528 (49%) met the case definition. Among these 528 cases, 85% had diarrhea, 56% had vomiting, and 31% had fever. Of nine stool specimens submitted by marathon participants, two were positive by rRT-PCR for sapovirus and negative for all other tested pathogens at CDC and the SNPHL. No source of the outbreak was discovered, but based on the incubation period and time of illness onset, it is likely that exposure occurred prior to the onset of the race.

BACKGROUND

On Tuesday, December 6, 2011, the Southern Nevada Health District (SNHD) received a foodborne illness complaint from persons who had travelled to Las Vegas to compete in the Rock 'n' Roll Las Vegas Marathon & 1/2 Marathon on Sunday, December 4, 2011. Through Thursday, December 7, a total of 5 additional complaints were received from marathon participants specifically about gastrointestinal illness occurring during or after the race. In addition, on December 8, 2011, the Las Vegas Review Journal ran a story about runner illness complaints, citing posts on the event's Facebook page from a number of participants reporting gastrointestinal illness [1]. Media reports and participant comments tended to focus on the water provided to runners during the race as the purported source of illness [1,2,3].

On December 8, 2011, SNHD initiated an investigation into the complaints to confirm the existence of an outbreak, identify potential cases, and identify the cause and source of infection. The SNHD Office of Epidemiology (OOE) and Southern Nevada Public Health Laboratory (SNPHL) collaborated on the investigation and response to this outbreak. Additional laboratory testing was requested from the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia.

METHODS

Environmental Investigation

As the race had been completed and cleaned up several days prior to the initiation of the investigation, an environmental field investigation was not conducted. OOE investigators collected information on the course setup and water distribution practices through the event's website, interviews with a water station captain, interviews with race organizers and other responding agencies published in the news media, and comments made on the epidemiology survey.

Epidemiology

A case is defined as a person participating in the marathon who reported developing diarrhea and/or vomiting with an onset between 12pm on December 3, 2011 and 12pm December 7, 2011. A non-case is defined as a person participating in the marathon who reported having none of the following signs or symptoms: diarrhea, vomiting, nausea or abdominal cramps.

In order to describe the outbreak in terms of person, place and time, investigators developed an online questionnaire for race participants. The survey included questions on demographics, illness presentation, and possible risk factors (including those frequently suggested by media reports and participants). The survey was publicized through the SNHD and marathon Facebook pages, as well as through the SNHD Twitter account.

Descriptive statistics (medians, ranges, and percents) were used to describe demographics and gastrointestinal signs and symptoms. Univariate analysis (relative risk (RR) and 95% confidence intervals) was calculated for each risk factor being investigated using Statcalc (Epi Info, version 6). The p-values ≤ 0.05 were considered significant.

OOE investigators collected information on the course setup and water distribution practices through the event's website, interviews with a water station captain, interviews with race organizers and other responding agencies published in the news media, and comments made on the epidemiology survey [1,2,3,4].

Laboratory

Ill marathon runners and the ill children of symptomatic marathon runners were asked to provide stool specimens for testing. The SNPHL performed cultures for enteric pathogens (*Salmonella, Shigella, Campylobacter*, strain O157 of *Escherichia coli*, and *Yersinia*), and enzyme-linked immunosorbent assay for Shiga toxin-producing *E. coli*

(STEC) and *Cryptosporidium*. Norovirus testing was done by real-time reverse transcriptase-polymerase chain reaction (rRT-PCR).

The SNPHL forwarded stool specimens from ill persons to the CDC to test for the presence of norovirus, astrovirus, adenovirus and sapovirus by rRT-PCR and for small viral particles by electron microscopy.

RESULTS

Environmental Investigation

A total of 44,000 runners signed up for the marathon and half marathon. Runners started running the marathon at 4:00pm, and the half-marathon at 5:30pm. The half-marathon and the second half of the marathon were held on Las Vegas Boulevard, with both races starting and ending at Mandalay Bay. A total of 16 water stations were located throughout the course, located approximately every mile to mile-and-a-half. In addition, every other station provided Cytomax, a sports drink, and two stations provided GU Energy Gel to runners.

Water was provided to runners by groups of volunteers at each water station. The stations were led by a captain who was instructed on the process for handing out water at a training held by race organizers. Lined plastic containers (described as garbage cans by participants) were filled with potable water from fire hydrants, and volunteers were instructed to use plastic pitchers to take water from the containers and fill the individual cups. Cytomax, a sports energy drink, was made by mixing a powder into the lined water containers and was available at several of the water stations

throughout the course. Volunteers were also instructed to use gloves when pouring or distributing water and Cytomax.

A number of participants reported observing volunteers handing out water with ungloved hands and dunking cups directly into the water containers to fill them. Participants also reported that at some stations, it was not clear which containers were to be used for discarded cups and which were to be used for water, resulting in runners disposing of used cups in the water containers.

In addition to the race, a number of race-related events were held over the course of the weekend, including a pre-race concert, pre-and post- race parties, meals, and a health and fitness expo.

The health and fitness expo was open from 12pm to 7pm on December 2, 2011 and 10am to 8pm on December 3, 2011. Over 160 companies and organizations, including footwear, apparel, medical, health food, beverage and energy bar vendors, participated in the expo. Although a complete list of samples being distributed at the expo was unavailable, runners reporting consuming samples of electrolyte drinks, alcoholic beverages, energy bars and gels, yogurt and fresh tomatoes. Although a small number of race packets were distributed on Sunday to runners who paid an additional fee, the majority of the 44,000 race packets were distributed at the expo. The packets included a t-shirt, head lamp, a sample of an energy supplement and a number of printed materials.

Epidemiology

Links to the epidemiology online survey were shared on the marathon's Facebook page (with 25,732 followers) by members of the running community on four consecutive days starting on the day of release of the survey, and a total of 42 times within one week as part of a number of discussions among ill runners. Twenty-two people shared the survey link on Twitter, potentially reaching 17,982 followers. A total of 362 responses had been submitted within 12 hours of the release of the survey.

After the survey had been posted for 4 days, a total of 1,146 surveys had been submitted. Of the 1146 surveys, 64 responses were incomplete and included only the demographic information for the respondent, and did not include symptom or risk factor information. Of the 1,082 completed surveys, 578 (53.4%) were from persons who reported developing diarrhea or vomiting. Of these, 528 (91.3%) met the case definition; of the remaining 50 (8.7%) that did not meet the case definition, 19 did not provide an onset date and time, 26 provided an onset date and time outside the range included in the case definition, and 5 were duplicate reports from people who were already included as cases. Of the 504 survey respondents who did not report developing diarrhea or vomiting, 317 (62.9%) met the non-case definition; the remaining 187 (37.1%) reported having either nausea or abdominal cramps, or did not provide an answer to one or more of the sign or symptom questions needed for case classification.

The demographic characteristics of the case population were similar to the demographic characteristics of the non-case population in terms of age, location of

residence, experience, and type of race run (see Table 1). According to a media interview with race management, approximately 38,000 (86%) of runners participated in the half marathon, and about 53% were first-time participants. Among included respondents, 80% of runners participated in the half marathon and 19% were first-time participants.

Among the 528 cases, 85% reported having diarrhea, the most frequently reported clinical sign or symptom. Vomiting and fever were the two least frequently reported clinical signs or symptoms, being reported by 56% and 31% of cases, respectively. A complete list of the frequency of reporting of signs and symptoms can be found in Table 2.

Of the ill cases, 426 (81%) became ill between 6pm and midnight on December 4, 2011, with 325 (62%) becoming ill between 7pm and 10pm. The median onset time of illness was 8:30 pm on December 4, 2011. The complete outbreak curve is present in Figure 1.

Univariate analysis of risk factors identified a significantly-significant elevated risk for persons who consumed water from a water station during the race (RR= 1.75 [1.22, 2.52], p<.0001). Univariate analysis also identified that participation in the Great Santa Run had a statistically-significant protective effect against developing disease (RR= 0.66 [0.44, 0.98], p=.01). No other risk factor had a statistically-significant relative risk.

Laboratory

SNPHL: Seventeen ill local runners were requested to provide stool specimens; specimens were provided by nine marathon runners and two symptomatic children of a symptomatic marathon runner. Specimens were collected between December 9, 2011 and December 11, 2011 (5-7 days after symptom onset), and all specimens submitted were formed stools. All STEC, *Cryptosporidium*, stool cultures, and norovirus tests performed at SNPHL on all eleven specimens provided were negative for the presence of pathogens.

CDC: Seven of the nine specimens provided by marathon participants were negative for all tested pathogens by rRT-PCR (norovirus, astrovirus, sapovirus, and adenovirus). One of these negative specimens was examined by electron microscopy and small particles were observed. The two remaining specimens provided by marathon participants were positive by rRT-PCR for sapovirus and negative for all other tested pathogens. One of these negative specimens was examined by electron microscopy and 20-22nm particles consistent with being a virus were observed. In the two specimens provided by the symptomatic children of an ill marathon participant, both sapovirus and astrovirus were identified.

DISCUSSION

The findings of this investigation point to the source of the sapovirus outbreak among marathon runners as a common exposure on the morning before the race, most

likely at the health and fitness expo. It was not possible to determine which common exposure was responsible for the outbreak. The timing of the exposure and the incubation period of sapovirus resulted in the majority of cases becoming ill during the race or in the hours shortly after; however, exposure during the race was not the cause of the outbreak.

Sapoviruses (genus Sapovirus, family Caliciviridae) are a group of viruses that cause acute gastroenteritis in humans. Sapovirus is not as well-characterized as norovirus, but is thought to be similar to norovirus in that it has a short incubation period (1-2 days), low infectious dose, causes a self-limiting illness that is rarely serious with a significant percentage of asymptomatic infections, and is easily spread from person to person through fecal-oral transmission. Both infections cause diarrhea, although a lesser percentage of sapovirus patients develop vomiting as compared to norovirus patients. Treatment of sapovirus infection is supportive, and includes the prevention of dehydration due to diarrhea [5,6].

Outbreaks of sapovirus have been reported in the literature, but reports of foodborne outbreaks and outbreaks among adults outside long-term care are rare and the majority of cases occur in children under 5 years of age [6,7,8]. This outbreak represents the first outbreak of sapovirus in Southern Nevada and the first time the virus has been identified in the local population. However, sapovirus testing is not available locally and has not been previously ordered during an outbreak. Rather than representing a newly-introduced disease, the identification of the virus likely indicates that sapovirus circulates at low levels in the population but goes unidentified.

Using a median incubation of 34 hours for sapovirus and the median onset time of 8:30 pm on December 4 places the exposure time at approximately 10:30 am on December 3. The health and fitness expo, attended by most participants as it was the venue at which the runners' race packets were distributed, opened at 10am on December 3, 2011. The expo provided ample opportunities for disease transmission directly from ill source participants, through fomites, and through food and drink samples distributed by exhibitors. Attendance of the health and fitness expo was not a statistically-significant independent risk factor for developing disease. Participants were not asked about activities at the expo on the survey, so a more-detailed analysis to determine a specific exposure at the expo was not conducted.

A source at the expo is consistent with a statistically-significant protective effect associated with participation in the Las Vegas Great Santa Run, which started at 10am on December 3 (participants in the Santa Run would not have been present at the health and fitness expo at the time of greatest exposure risk).

Although the investigation identified an elevated risk of disease associated with consumption of water, the causality of this association cannot be established; runners likely consumed water after becoming ill in an effort to stay hydrated. Also, there was no increased risk associated with the consumption of the sports drink, which was made from the same water and would be expected to have a similar elevated risk if contamination of the water caused the outbreak.

This investigation was also the health district's foray into using social media as an investigative tool, rather than just as a method of disseminating information to the

public. Using the active community of runners on Facebook and Twitter allowed for the rapid dissemination of the survey directly to the exposed population without a delay in requesting participant information from the race organizers. Comments posted to social media sites provided ongoing, real-time insight into the needs and concerns of the ill population, and provided a feel for the efficacy of health district investigation efforts. Comments about SNHD were overwhelmingly positive, and indicated a level of trust and willingness to cooperate from the community.

Ill and non-ill runners quickly responded to the survey, which allowed SNHD staff to rapidly identify ill persons for laboratory testing. It also allowed for a preliminary data analysis to be quickly completed, which allowed the water provided by race organizers, an early focus of complaints by runners, to be ruled out as a source of the outbreak. The water provided in the race was the same potable water that is distributed throughout Southern Nevada, and it was important to quickly determine if the general population was at risk of disease.

The ill persons identified by SNHD staff complied very quickly with the request to submit specimens for laboratory testing. The submission of stool samples for testing is often a difficult task due to the type of sample requested and the handling requirements. The ill persons were highly motivated to provide samples that could be used to identify the causative agent of the outbreak.

There were several limitations in our investigation. It was not possible to conduct an on-site environmental investigation, as the race had been completed and cleaned up several days prior to the initiation of the investigation. Races or other athletic events

are not required to obtain a permit from SNHD prior to the event, so the race setup was not inspected by SNHD at any time. Also, although a list of vendors from the expo was available, sufficient details about samples handed out by the vendors was not available to allow for the development of a detailed questionnaire specific to the expo. Vendors are not required to obtain a permit from SNHD to hand out samples, thus no on-site inspections were conducted before or during the expo and no information about potential risks at individual vendor booths was available. This prevented investigators from being able to conduct a detailed investigation into the exact source of the outbreak.

As the survey respondents were self-selected, it was not possible to calculate an overall attack rate for the marathon participants. Additionally, laboratory specimens were not collected until approximately one week after the onset of illness, which may have contributed to the low positivity rate on sapovirus testing performed on ill runners.

There are also concerns about the misclassification of disease affecting the internal validity of the results and self-selection bias affecting the generalizability of the results. Distance runners often become ill with gastrointestinal illnesses due to the stresses placed on their bodies during the competition. Through the use of a questionnaire, it was not possible to differentiate vomiting due to sapovirus infection from that caused by competing in the race. Any bias introduced as a result would be non-differential in relation to exposure, so it would result in an underestimation of the magnitude of risk.

In terms of generalizability, the self-selected study population differed from the overall population of participants were slightly more likely to participate in the marathon and were much more likely to be experienced runners. As a result, the degree to which the results can be generalized to all marathon participants is unknown.

In the future, several steps should be implemented to improve the investigative process and to prevent disease at similar events. First, although the survey was developed quickly, a standard template should be developed to allow the rapid deployment of standardized surveys for illness. In addition, corresponding standard analytic tools should be developed to allow for the rapid analysis of survey data.

Next, SNHD should consider using social media more frequently to administer surveys given the appropriate audience; in this case, the use of Facebook was effective because there was an active community of marathon frequently posting and reading the marathon's page. During a large event, it might be appropriate to set up a social media site for the event response. This would provide an additional avenue for SNHD to share information from the public, and following discussions would allow for real-time feedback on the needs and concerns of the public. However, the decision to launch a social media site should be thoroughly discussed prior to launch, as it would place SNHD in the role of moderating the discussion on the topic (for example, removing libelous comments or threats against employees). It would also necessitate the development of policies on the participation in such discussion by staff members on work time or personal time.

Finally, there appeared to be confusion on the part of the volunteers at the race as to the proper method of handling and distributing water; although it wasn't the source of the outbreak at this event, the environmental health concerns should be addressed prior to next year's event to eliminate the potential risk of disease transmission.

This outbreak serves as an example to the public health community of the potential for disease transmission during large athletic events. Clearly, environmental oversight is needed to ensure the protection of the participants. The SNHD has started evaluating the development of regulations for the appropriate oversight and monitoring of the health of the public at events such as these.

TABLES AND FIGURES

Table 1. Demographic characteristics of cases and non-cases

Category	Cases	Non-Cases	Total
Responses			
n (%)	528 (62.5)	317 (37.5)	845
Age			
Median (years)	37	38	37
Minimum (years)	15	24	15
Maximum (years)	77	71	77
Residence			
International n (%)	39 (7.4)	19 (6.0)	58 (6.9)
US, Non-local n (%)	418 (79.2)	249 (78.5)	667 (79.0)
Local n (%)	54 (10.2)	36 (11.4)	90 (10.7)
Unknown n (%)	17 (3.2)	13 (4.1)	30 (3.6)
Race			
Full Marathon n (%)	84 (15.9)	54 (17.0)	138 (16.3)
Half Marathon n (%)	429 (81.3)	256 (80.8)	685 (81.1)
Unknown n (%)	15 (2.8)	7 (2.2)	22 (2.6)
Experience			
First-timer n (%)	78 (14.8)	55 (17.4)	133 (15.7)
Some experience n (%)	147 (27.8)	112 (35.3)	259 (30.7)
Experienced n (%)	284 (53.8)	141 (44.5)	425 (50.3)
Unknown n (%)	19 (3.6)	9 (2.8)	28 (3.3)

Table 2. Signs and Symptoms reported by cases (N=528)

Sign/Symptom	N	%*
Diarrhea	443	85.4
Nausea	439	84.7
Abdominal Cramps	427	83.4
Fatigue	376	76.9
Chills or Sweats	309	63.4
Dizziness	275	57.3
Headache	271	56.9
Vomiting	274	54.8
Fever	112	31.4

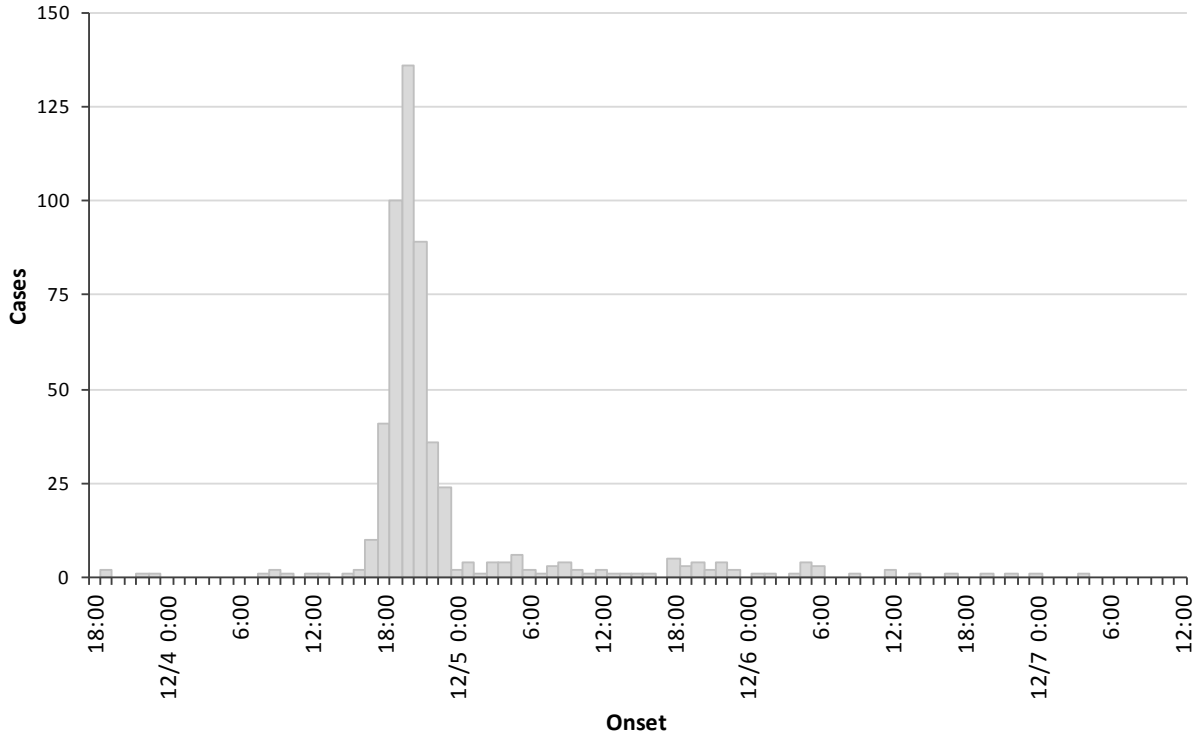
* Percentages calculated of all cases who provided an answer to this question

Table 3. Risk factor evaluation

Risk factor	RR (95% CI)	p-value
Events		
Health & Fitness Expo, Friday, December 2nd	0.95 (0.84, 1.06)	
Health & Fitness Expo, Saturday, December 3nd	1.04 (0.92, 1.17)	
Pasta Party on Saturday, December 3	1.00 (0.79, 1.26)	
Las Vegas Great Santa Run on Saturday, December 3	0.66 (0.44, 0.98)	p<.0001
Kick Off Party at TAO Nightclub on Saturday, December 3	1.00 (0.65, 1.54)	
Pre-Race Brunch on Sunday, December 4	0.94 (0.58, 1.52)	
Pre-Race Concert (Cheap Trick) on Sunday, December 4	0.89 (0.77, 1.02)	
Race-Related		
Consumed water provided by the race at the starting line	1.75 (1.22, 2.52)	p=0.01
Consumed water provided by the race during the race	1.01 (0.90, 1.15)	
Consumed water provided by the race at the finish line	0.89 (0.76, 1.04)	
Consumed Cytomax provided by the race	0.99 (0.89, 1.10)	
Consumed GU Gel provided by the race	0.99 (0.89, 1.10)	
Competed in the full marathon	0.97 (0.84, 1.12)	
Compete in a marathon or half-marathon for the first time	0.93 (0.80, 1.09)	
Out-of-town residence	1.05 (0.88, 1.25)	

** Significant at the p<.05 level

Figure 1. Las Vegas Marathon Outbreak Curve (n=528)



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