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Something in the Water

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TECHNICAL BULLETIN 1.5

Legionella Bacteria in Environmental Samples: Hazard Analysis and Suggested Remedial Actions

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THE DISEASE

The diseases caused by *Legionella* bacteria, or legionellosis, are currently recognized to occur in two distinct clinical forms: Legionnaires' disease and Pontiac Fever.

Of the two, Legionnaires' disease is the more serious condition, causing a multi-system disease including pneumonia with fatality rates of about 15%. When outbreaks occur, usually less than 5% of exposed individuals develop disease, commonly within 3 to 9 days after exposure.

Pontiac fever is a non-fatal flu-like disease of short duration which does not cause pneumonia. Approximately 95% of exposed individuals develop disease, usually within 2 to 3 days. The number of cases of Legionnaires' disease occuring in the United States each year has been estimated by the Centers for Disease Control and Prevention (CDC) at 10,000 to more than 100,000 per year.

THE BACTERIUM

Legionellosis is caused by *Legionella* bacteria which occur natually in surface waters including lakes, streams, and mud. There are more than 34 known species and more than 50 serogroups of *Legionella*. Many of them have not yet been implicated in human disease. *Legionella pneumophila* serogroup 1 is most frequently implicated in disease and is most frequently found in the environment. It is possible that some species have not yet been associated with human disease beause they occur so rarely in nature; therefore, all strains should be considered potentially pathogenic.

RISK OF INFECTION

To cause disease several factors must occur: the organism must be virulent, it must be in sufficient number to cause disease, the water source must be aerosolized and distributed to the human host, the legionellae must be inhaled by the potential host deeply into the lungs, and the human host's defenses must be unable to stop the infection.

The infectious dose has not been determined, but the larger the dose, the more likely an infection will occur. The risk of infection will be greater if the dose of *Legionella*-containing water is in direct, close contact with the target person (as is the case with humidifiers and foggers) than if the water is distant from the target person {as with cooling towers, (CT), and evaporative condensers, (EC)}. Portable water systems may represent an intermediate category.

The risk of infection is greater and a lower dose is required in those individuals who are older, smokers, heavy drinkers, immunocompromised with other diseases or on immunosuppressive therapy.

BUILDING AND INDUSTRIAL SOURCES

Water in many natural or man-made systems serves as an amplifier of *Legionella* bacteria by providing suitable conditions for growth. Potential sources include cooling towers, evaporative condensers, humidifiers, potable water heaters and holding tanks, pipes containing stagnant warm water, shower heads, faucet aerators, decorative fountains, nebulizers, mister reservoirs, and whirlpool baths. *Legionella* apparently survives in low numbers in routine water treatment used to treat potable water and can be carried in the treated drinking water into buildings, where the bacteria can colonize in the plumbing fixtures, especially in hot water systems.

Therefore, cooling towers and other systems may become contaminated through the make-up water. Well-maintained systems are less likely to be colonized with legionellae than systems that are poorly maintained. Continued vigilance in terms of excellent preventive maintenance and an excellent water treatment program are required to minimize the risk of *Legionella*.

HEALTH HAZARD ANALYSIS

The mere presence of legionellae either in heat rejection systems or water services will not by itself cause disease. High numbers of legionellae have been noted in cooling towers and other sources with no associated disease. However, an epidemiologic link has been established between the legionellae in the environment and the occurrence of legionellosis. Best and co-workers (1983) found that the reduction of legionellae in the environment was linked to a reduction in the incidence of clinical Legionnaires' disease.

Most outbreaks from cooling towers and evaporative condensers have been associated with high numbers of legionellae, at least 1,000 colony-forming units per milliliter (CFU/ml) or more in the implicated source (Shelton and co-workers, 1994). At PathCon Laboratories, we have found numbers of *Legionella* averaging 160 CFU/ ml (range <1 to 1,500) in a potable water system associated with an outbreak; and as few as 10 CFU/ ml of fogger reservoir water that may have caused disease in people in immediate direct contact with the mist. Of utmost importance, most cases of legionellosis occur as sporadic cases, not epidemics, and it is not known how many organisms in a water source may represent an infectous risk for sporadic cases to occur.

Many people with responsibility for maintaining air quality in buildings and industrial settings require programs designed to detect potential problems with legionellae. For this reason, we have developed quantitative legionellae criteria and

corresponding remedial actions. These quantitative *Legionella* data are based on numbers of viable legionellae because health risk from nonviable *Legionella* has not been documented. Although there is honest disagreement among informed scientists on the risks associated with legionellae in the environment, the degree of remedial action suggested in Table 1 is expected to err on the side of safety. Many health authorities discourage the notion of completely eliminating *Legionella* bacteria from environmental waters. Other workers have recommended that immunocompromised patients be completely protected from waters containing *Legionella* (Helms, et al., 1983). It is our opinion that these data in Table 1 are not applicable in areas with immunocompromised individuals or for waters used for therapeutic purposes. In these situations, no level of *Legionella* organisms is acceptable.

Table 1: *Suggested Legionella Remedial Action Criteria*

		Remedial Action if Detected in:	
***Legionella* (CFU/ml)**	**CT/EC ***	**Potable Water**	**Humidifier/Fogger**
Detectable But<1	1	2	3
1 to 9	2	3	4
10-99	3	4	5
100-999	4	5	5
≥ 1,000	5	5	5

* Cooling Tower / Evaporative Condenser

REMEDIAL ACTIONS

Action 1. Review routine maintenance program recommended by the manufacturer of the equipment to ensure that the manufacturer's recommended program is being followed. The presence of barely detectable numbers of legionellae represents a low level of concern.

Action 2. Implement Action 1 (see above). Conduct follow-up legionellae analysis after a few weeks for evidence of further amplification. This level of legionellae represent little concern, but the number of organisms detected indicates that the system is a potential amplifier for legionellae.

Action 3. Implement Action 2. Conduct review of premises for direct and indirect bioaerosol contact with occupants and health risk status of people that may come in contact with the bioaerosols. Depending on the results of the review of the premises, action related to cleaning and/or biocide treatment of the equipment may be indicated. This level of legionellae represents a low but increased level of concern.

Action 4. Implement Action 3. Cleaning and/or biocide treatment of the equipment is indicated. This level of legionellae represents a moderately high level of concern. The level is approaching levels that may cause outbreaks. It is uncommon for samples to contain numbers of legionellae which fall into this category.

Action 5. Immediate cleaning and/or biocide treatment of the equipment is definitely indicated. Conduct post-treatment legionellae analysis to ensure effectiveness of the corrective action. The level of legionellae represent a high level of concern. These numbers are at a level that has the potential for causing an outbreak. It is very uncommon for samples to contain numbers of legionellae which fall in this category.

ANALYTICAL LIMITATIONS

The microbiological analysis may be influenced by many factors including the possibility that *Legionella* bacteria may be harbored and amplified inside the cells of aquatic protozoa or in slime or biofilm. Therefore, a negative test result does not necessarily indicate that the environmental source of a sample is free of *Legionella*. The only way to ensure that legionellosis does not occur is to eliminate *Legionella* bacteria from the environment, but research has shown that, because of the ubiquitous nature of the bacteria, it is unlikely that a water source will always remain free of legionellae. A negative result indicates only that if present, the number of *Legionella* in the sample, at the time the sample was taken, was less than the detection limits of the test. The finding of low numbers of *Legionella*, or even negative findings, does not ensure that an environment will not be the source of legionellosis.

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Review of Legionnaires' Disease

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This review seeks to assist industrial hygienists in the prevention of Legionnaires' disease caused by *Legionella* bacteria. Breathing water droplets contaminated with *Legionella* bacteria, in which the organism has been permitted to amplify, causes this disease. Possible sources of transmission include nearly all manmade building water systems. *Legionella* organisms, found in most natural water sources but at very low concentrations, can thrive under conditions of warmth in these manmade systems. Primary prevention of Legionnaires' disease requires prevention of amplification of *Legionella* in water systems. This, in turn, requires familiarity with the system and all its components, and effective maintenance and water treatment. However, good maintenance and water treatment regimens alone cannot assure that amplification will not occur somewhere in the system. Systematic microbiological testing for *Legionella* and appropriate interpretation of the testing results can be powerful assets in prevention by enabling the detection and control of amplification. The occurrence of a confirmed or suspected case of Legionnaires' disease in a building occupant may indicate transmission within the facility; this poses an immediate crisis for the facility manager. An aggressive intervention is indicated to search for previously unknown additional cases of illness, to detect potential sources of transmission, and to decontaminate any suspected sources of transmission on an emergency basis. Once adequate remediation has been achieved and confirmed by microbiological testing, on-going control measures are essential with periodic microbiological investigation to assure continuing prevention of amplification.

Keywords: HVAC, *Legionella,* monitoring, water systems

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In 1976 a serious outbreak of an unknown disease struck occupants of a hotel in downtown Philadelphia.[1] Approximately 240 cases of pneumonia and 34 deaths resulted from exposure to this previously unknown etiologic agent that panicked the city and much of the nation. Many of the affected individuals of the outbreak were members of the American Legion, who were attending a convention at the hotel; hence, the condition was named Legionnaires' disease.

As a result of this outbreak, a massive investigation spanning many months was initiated. Eventually, this investigation led to the discovery of a previously unknown bacterium,[2] *Legionella pneumophila,*[3] as the causative agent of the outbreak. Today, more than 20 years after the organism was discovered, Legionnaires' disease remains a major public health problem and is the leading cause of death among all indoor air quality issues in North America.[4]

This article provides industrial hygienists with practical information and guidance for minimizing the occurrence of Legionnaires' disease. The role of the industrial hygienist is key to the prevention of Legionnaires' disease because this disease arises exclusively from water-bearing equipment, most often in or near occupied buildings. Legionnaires' disease control and eradication requires a scientific, investigative approach, based on the classical three-tiered method axiomatic to industrial hygiene: recognition, evaluation, and control of environmental hazards. This document addresses the following areas.

- Recognition: including *Legionella* bacteria, Legionnaires' disease, epidemiology, sources, and transmission
- Evaluation: hazard assessment, including use of building surveys and analytical testing
- Control: abatement and treatment strategies

THE *LEGIONELLA* BACTERIA

At least 40 known species and many more serogroups of *Legionella* bacteria have now been identified,[5] and many of these have been implicated in human disease. *Legionella* bacteria

are relatively common waterborne organisms in the environment and usually exist at low levels in nature.[6] Their natural habitat is generally confined to natural fresh waters such as lakes, rivers, and streams. The preferred temperatures for growth of *Legionella* bacteria can vary somewhat by species but are generally between 80–120°F. This temperature range makes certain types of equipment—such as cooling towers, evaporative condensers, hot water systems, and whirlpool hot tubs—ideal incubators and amplifiers for the bacteria, especially when the water temperature is kept within that temperature range. These devices have the potential to allow the organism to flourish in concentrations that are much higher than those normally found in nature.

LEGIONNAIRES' DISEASE

There are two types of diseases caused by the *Legionella* bacteria that are under the umbrella term legionellosis: Legionnaires' disease and Pontiac fever.[7] Pontiac fever is the less severe disease of the two types, is nonfatal, and is accompanied by symptoms similar to a mild flu. It is a self-limiting disease of short duration. Symptoms generally appear from a few hours to a few days after exposure. This document will focus on Legionnaires' disease only, as Legionnaires' disease is the far more serious disease of the two.

Legionnaires' disease is a form of pneumonia caused by an acute bacterial infection of *Legionella* bacteria. The onset of illness usually occurs between 2 and 10 days following exposure. Symptoms usually include fever, chills, and a dry or productive cough. Some patients have other symptoms including myalgia, muscle ache, fatigue, abdominal pain, headache, diarrhea, and loss of appetite. Chest X-rays often show evidence of pneumonia; it is impossible to distinguish Legionnaires' disease from other types of pneumonia on the basis of symptoms alone.

Approximately 1 to 5% of all pneumonias are Legionnaires' disease, and an estimated 600,000 cases of community-acquired pneumonia require hospitalization each year in the United States alone.[8] Diagnosis requires laboratory confirmation of the disease. Proper diagnosis typically includes syptoms compatible with the disease along with isolation of the organism from the sputum, and/or the detection of *Legionella* antigen in a urine specimen, and/or a fourfold increase in *Legionella* antibody titer in two blood samples taken 3 to 6 weeks apart over the course of the disease (acute versus convalescent sera).[9] Note that the current test for urine antigen is only for *L. pneumophila* serogroups 1 through 6 and a few other *Legionella* species. Therefore, a negative *Legionella* test should be interpreted with caution. Treatment is usually erythromycin, and a second antibiotic, rifampin, may be prescribed for more severe cases.[10]

Approximately 25,000 cases of Legionnaires' disease occur in the United States each year (range 10,000 to more than 100,000).[11] This corresponds to an estimated 68 cases per day in the United States alone. The case fatality rate is often between 5 and 30%, even with treatment, and is generally higher for persons who are immunocompromised (as with HIV-AIDS).

EPIDEMIOLOGY, SOURCES, AND TRANSMISSION

Since 1976, outbreak investigations have implicated numerous contaminated manmade water sources, including cooling towers and evaporative condensers,[6,12] potable hot water systems, whirlpool hot tubs, decorative display fountains,[13] humidifiers, grocery store misters,[14] industrial process equipment,[15] and respiratory therapy equipment.[16] It should be emphasized that any source with the potential to aerosolize water has the potential to transmit the disease when the water is contaminated with *Legionella*. As with any other environmentally acquired disease, the risk of contracting Legionnaires' disease from a contaminated source is a function of both exposure dose and immune status of the exposed individual. Disease is more likely to occur in the elderly or immunocompromised individual. Other host-specific risk factors for Legionnaires' disease include smoking, kidney failure requiring dialysis, diabetes, AIDS, or other underlying diseases such as cancer. However, even apparently healthy people can acquire Legionnaires' disease if they are exposed to a sufficiently high concentration of organisms.

The most important route of transmission is inhalation of either the bacteria itself or contaminated water droplets and subsequent deposit of the organism into the deepest parts of the lung.[17] Some speculate that Legionnaires' disease can be acquired by drinking and subsequently aspirating contaminated water;[18] however, this route has not been documented. Currently, no evidence of person-to-person transmission exists.

EVALUATION

Facilities need to be evaluated for likely sources of exposure, particularly those sources that provide conditions that enable the growth of the *Legionella* bacteria. As noted previously, *Legionella* is widely distributed in natural water bodies and may be present in the water supply delivered to the building. Chlorination or other water treatments cannot guarantee elimination of the organism or prevention of amplification.[19] Under favorable conditions, harmless amounts of the organism in reservoirs within the building may amplify to high and hazardous concentrations.[6]

As indicated, a primary condition that affects the growth of the organism in building water systems is temperature. Above 140°F, the organism will eventually die. However, temperatures below 80°F will only limit the rate of growth.[6]

Good industrial hygiene practice demands proactive recognition and evaluation of potential *Legionella* sources. Conditions that promote the proliferation of the organism and the aerosolization of contaminated water need to be identified. This step may require an on-site survey and sample collection. The industrial hygienist should perform the tasks shown under the following headings as part of the survey.

Identify and List All Water Systems

Include in the inventory the plumbing systems; heating, ventilating, and air-conditioning (HVAC) systems; and other water reservoirs that have the potential for aerosolization.

The review of the plumbing system should include both hot and cold domestic water systems; water heaters; distribution pipes; water coolers; water treatment equipment; connections to process water systems protected (or unprotected) by backflow preventers; and storage tanks.

The HVAC system review should include cooling towers; evaporative condensers; fluid coolers; humidifiers; direct evaporative air-cooling equipment; indirect evaporative air-cooling equipment; air washers for filtration; etc. The location of the fresh-air intakes of the building's air-handling units, relative to water sources such

as the cooling towers, is of considerable importance, since the air-handling units can transport the organism throughout the building.

The survey also should include other potential sources of employee exposure, such as decorative fountains; plant misters; whirlpools; hot tubs; spas; tepid water systems; eyewashes; showers; humidifiers; and water for cooling industrial processes.

Of particular interest are any areas where water is allowed to stagnate, e.g., storage tanks, unused plumbing pipe sections (i.e., "dead legs"), or infrequently used faucets. Cross connections should be checked between domestic and process water systems, and the condition and type of back-flow prevention devices should be noted.

Details on any recent maintenance or changes in the system's operation should be obtained. Recent or frequent losses of water pressure from the incoming water supply due to line breakage or street repairs should be determined. The failure of back-flow prevention devices under loss of pressure can contaminate the system.

Record Temperatures

Record the temperatures of the various water-bearing systems. Measure the temperature of water drawn from each storage-type water heater in the facility. This temperature may be significantly below the water heater's gauge temperature because of heat stratification in the tank.

Record the maximum temperature of water at faucets connected to each water heater on the system. Record temperatures at locations near, intermediate, and distant from the heaters. Run the water for several minutes before testing, so that is reaches a temperature maximum.

Measure the water temperature of cold water storage tanks that are used for reserve or maintenance of hydrostatic pressure. These tanks should be protected from temperature extremes and covered to prevent contamination. Record the temperature of the domestic cold water lines at various locations within the facility.

Inspect HVAC System

Visually inspect cooling towers, evaporative condensers, and fluid coolers for biofilm growth, scale buildup, and turbidity. Record the location of the cooling tower relative to fresh air intakes and prevailing wind direction.

Review Maintenance Logs

Maintenance records on all waters systems, including water heaters and cooling towers, should be obtained. The records should include temperature checks of domestic water, visual and physical checks of cooling towers, and reports of cooling tower water tests and chemical treatment. The lack of a regular maintenance schedule or water treatment program for cooling tower or evaporative condenser systems creates the potential for unacceptable levels of *Legionella* contamination. However, many outbreaks have been traced to sources with an established ongoing treatment program. Often, implicated devices responsible for disease transmission appear very clean to the eye, yet high numbers of *Legionella* bacteria may be present. At this time, the criteria for a "well-maintained" system are poorly defined and the degree of hazard can be established only by testing specifically for *Legionella* bacteria. A water treatment program determined to be effective in one device may be insufficient in a different but similar device.

SAMPLING

The purpose of water sampling is to accomplish the tasks listed below. Once samples are collected, they should be cultured and analyzed specifically for the *Legionella* bacterium. Reasons for sampling may include:

(1) to evaluate whether *Legionella* is amplifying in building water systems that generate aerosol to which building occupants could be exposed;

(2) to determine the efficacy of water treatment regimens in preventing amplification of *Legionella*; and

(3) to test the hypothesis that *Legionella* may be causing disease in building occupants.

Establish Baseline Levels of *Legionella*

A baseline is established in the absence of disease by microbiological testing for *Legionella* at several times. The baseline provides a reference point for interpreting the results of future tests, for detecting amplification, and for evaluating the efficacy of water treatment programs. Amplification is detected by noting an increase in the concentration of organisms in the periodic samples. The degree of amplification also can be assessed by comparing levels of *Legionella* in the building water system with those in the municipal water supply.

Sampling Strategy

The appropriate sampling strategy should be based on the specific conditions at the building and the objectives of the industrial hygienist. The decision on the frequency of sampling may be based on such factors as (1) the potential for amplification, (2) the concentrations that were established prior to remediation procedures, and (3) the need to verify the efficacy of ongoing treatment programs. Samples should be collected from areas within the system that represent potential exposure. As with any test, a *Legionella* test gives the result of *Legionella* contamination at the time of the test. No single point-in-time test will reliably predict or guarantee future results. The viable culture test specifically for the *Legionella* bacterium is the recommended procedure for testing the samples.

Interpretation of Results

Given that no suspected or confirmed cases of disease have occurred in building occupants, a facility is considered low risk for spreading disease and requires no further immediate action if:

- No potential transmission routes or sources are identified
- The operating temperature at water heaters measures 140°F or above and the delivery temperature at distant faucets is 125°F or higher
- Results of microbiological testing of water (testing) indicate no amplification of *Legionella* bacteria. The suggested levels of *Legionella* from various water sources that are considered uncommonly high are indicated in Table I. Concentrations below these numbers are not usually considered excessively amplified, except in high-risk settings. High-risk settings can include settings in which exposures are of long duration, close proximity, and/or involve highly susceptible individuals.

INVESTIGATION AND CONTROL OF LEGIONNAIRES' DISEASE

All too often, concern about *Legionella* occurs only after a facility is faced with a suspected case or an outbreak of Legionnaires' disease.

TABLE I. Suggested *Legionella* Remediation Criteria from Various Sources

Source of Water Sample	*Legionella* Concentration (CFU/mL)[A]
Humidifiers, foggers, or whirlpool hot tubs	1
Potable water	10
Cooling towers and evaporative condensers	100

Source: Adapted and condensed from the PathCon Technical Bulletin 1.5[20] and *OSHA Technical Manual*.[21]

[A]CFU = colony forming units. These values were developed based on levels associated with outbreaks, as well as those normally expected in similar sources not associated with outbreaks. In areas occupied by highly susceptible individuals, or individuals with close proximity to sources and/or long duration exposures, more stringent levels may apply.

The investigation of an outbreak or a case of Legionnaires' disease involves all the elements previously described, i.e., evaluation of facilities and environmental sampling and testing (see previous sections). A case among occupants of a building may have its origin in the community and not in the building in question. Therefore, a complete investigation also may require linking infected individuals with sources not involving the facility; however, this may be beyond the scope of the investigation. Nonetheless, investigation of one or more suspected cases of Legionnaires' disease should include a search for additional unknown cases of the disease among occupants of the building, as well as immediate scrutiny of building water systems and environmental microbiological testing of potential water sources. To be prudent, provisional control measures to protect building occupants and investigators should be undertaken while the investigation proceeds. A stepwise approach involving these elements is described below.

Search for Additional Cases: Disease Surveillance

Medical surveillance (including review of past illness) should be established to search for additional suspect cases of Legionnaires' disease. Occupants with fever and lower respiratory tract symptoms should be referred for immediate medical evaluation. Employees absent from work due to illness should be contacted to confirm the cause of their absence. Some clinical tests take several weeks to confirm Legionnaires' disease. In the interim it is prudent to assume that all suspect cases are Legionnaires' disease. Symptoms will not appear before 2 to 10 days after exposure; however, investigation of building conditions should not be delayed.

It is necessary to review medical records to determine whether cases meet the criteria for case definition developed by the U.S. Centers for Disease Control and Prevention. The environmental investigation of the building should not be delayed pending medical and laboratory confirmation of disease. If suspect cases are later confirmed, the investigation will have been well underway to the advantage of all concerned.

The industrial hygienist should always bear in mind that the outbreak may be associated with sources unrelated to the building; it may have its origin in the community. Therefore, as the investigation proceeds, all potential sources of exposure with which patients came in contact during the incubation period should be considered, even those outside the building. A complete investigation may require identifying other potentially infected individuals, whether or not they have been in or around the building. It is often the goal of the facilities' management to rule out potential sources at the facility itself; the responsibility of the health department is to rule out all potential exposure sources. Again, it should be remembered that Legionnaires' disease is significantly underdiagnosed by physicians.

Locate, Test, and Decontaminate Facility Water Sources: Hazard Surveillance and Control

Cautionary note: All sources of aerosolized water should be considered suspect as potential sources of transmission and, therefore, potentially hazardous.

When any evidence suggests that one or more cases of Legionnaires' disease may have occurred at a site, it should be assumed that an outbreak is occurring. One should not assume that the source is elsewhere. The treating physician is usually required to report a case of Legionnaires' disease to the appropriate health authority (usually the state or county health department). A qualified firm with experience investigating Legionnaires' disease should be contacted for advice and possible assistance in investigation and control. The water samples should be collected from all water systems with potential for exposing building occupants and tested for *Legionella* bacteria. Measures should be initiated to prevent additional exposures of building occupants. All high-risk water systems with the potential for disease transmission should then be treated immediately; they should remain under suspicion until results confirm that remediation efforts have been effective. These temporary provisions may be instituted to allow the facility to continue to operate. It is rarely necessary to shut down or evacuate an entire facility because of Legionnaires' disease if potential exposure sources are immediately identified and controlled.

Water sampling must be conducted. At a minimum, the necessary sites to sample and culture for *Legionella* bacteria should include (1) water from the incoming water supply; (2) water in each storage tank and water heater; (3) water drawn from representative faucets, and faucets that may have been used by affected occupants for both hot and cold systems; (4) water in all cooling towers, evaporative condensers, humidifiers, spas, and showers, etc.; (5) water entering or leaving any suspect fitting or other equipment; and (6) water from all other potential aerosolizing devices with potential for exposure to building occupants. Decisions as to the number of samples to be collected should be based on conditions at the site.

The characterization of an isolate of *Legionella* bacteria recovered from a patient may be of considerable value in determining the source of transmission if a match exists between the organism from the patient and the environment. Record keeping will become increasingly important as the investigation unfolds.

Water suspect of being the source(s) of transmission must be decontaminated using effective decontamination protocols. The industrial hygenist must be aware of any regulations or guidelines that apply to the decontamination process and ensure that those requirements are met. Because of the complexities of various water systems, the industrial hygenist should consult with professional engineers having experience in decontamination of *Legionella*. Decontamination should always be conducted by a qualified remediation contractor supported by a qualified water treatment company.

In preparation for decontamination, controls must be instituted to prevent the release of *Legionella* bacteria from the devices being treated; for example, circulating fans in cooling towers should be shut down and locked out for the duration of decontamination.

Important elements of decontamination are the removal of sediment and scale and thorough cleaning of all parts of the system,

including relatively inaccessible parts. Improper cleaning can liberate *Legionella* by disruption of the sediment and biofilm; therefore, cleaning (removal of sediment and scale) and disinfection always should be conducted simultaneously. Most water treatment experts feel that chlorine is the most effective biocide for *Legionella* when used correctly. However, chlorine can be corrosive to metal and must be applied with appropriate precautions.

It is prudent for the industrial hygienist and the facility manager to participate with the remediation contractor in decisions about chemicals to be used for water treatment. All chemicals used in cleaning and treatment should be compatible with the system components to prevent serious degradation.

Once the remediation contractor has completed decontamination and applied any chemicals indicated, follow-up sampling of the water is critical to determine that the decontamination has been effective. Until the analytical data show no (or only low concentrations of) *Legionella* bacteria, every possible effort should be taken to prevent releases for the system. Also, equipment for water treatment should be kept in place in case additional action is required. Events that allowed *Legionella* bacteria to amplify at one time may do so again. Changes in the maintenance program may be required to prevent recurrence.

The decontamination sequence should be recorded, listing the dates of inspections and cleaning, types and quantities of chemicals used, contact information for the water treatment contractor, water quality results, and maintenance procedures.

CONTINUING CONTROL AND PREVENTIVE MEASURES

Control and preventive measures need to be assessed on a case-by-case basis, as different facilities will have different design considerations. The following are general suggestions that should be considered.

Once the emergency decontamination is completed as documented by follow-up testing, the existing treatment program (if any) for all water-bearing equipment should be reevaluated. This may involve consultation with the equipment manufacturers, as well as water treatment companies, particularly those individuals experienced in the control of *Legionella* bacteria.

Treatment equipment and chemicals should be carefully selected to control microbial growth and to prevent corrosion damage and scale formation for the long-term operation of the system. As with emergency decontamination, records of treatment schedules and procedures should be maintained. Also, standard operating procedures should be modified to include specific techniques to keep the system as clean as possible.

The effectiveness of routine treatment should be periodically evaluated by testing water samples. The frequency of testing water samples should be based on such factors as environmental conditions and the probability of exposure to "high-risk" individuals.

There are many water treatment programs available, and the performance of such programs should be evaluated under the conditions of actual use.

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Sections on the investigation of buildings and building systems included material from the OSHA Technical Manual, Section II, Chapter 7 (May 24, 1996). The reader is referred to this document for additional information.

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ORIGINAL CONTRIBUTIONS

Outbreak of Legionnaire's Disease Linked to a Decorative Fountain by Molecular Epidemiology

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The incubation period of Legionnaires' disease in five patients was traced to attendance at conventions in a hotel in the Orlando, Florida, area between January 6 and February 2, 1992. The five case patients (mean age, 69 years) were older than 55 randomly chosen controls (mean age, 53 years) who had also attended one of the same conventions ($p = 0.007$). All case patients were males, as were 40% of the controls ($p = 0.01$). No significant differences in exposures were found between case patients and controls, but all case patients and 65% of the controls reported exposure to a decorative fountain in the hotel lobby. Water from the fountain was the only one of 55 environmental specimens to test positive for *Legionella*. Both the environmental isolate and the only clinical isolate were *Legionella pneumophila* serogroup 1, with identical patterns identified on monoclonal antibody subtyping and pulsed-field gel electrophoresis (PFGE) of genomic restriction fragments. The fountain's recirculating system had been irregularly maintained, and water in the fountain may have been heated by submersed lighting. These findings demonstrate the utility of monoclonal antibody subtyping and PFGE of genomic restriction fragments in assessing the significance of environmental isolates of *L. pneumophila*, especially when other epidemiologic findings are inconclusive. They also show that decorative fountains may be a potential source of infection with *L. pneumophila*, and emphasize the need for standard maintenance and disinfection procedures. *Am J Epidemiol* 1993;138:555–62.

antibodies, monoclonal; biological markers; disease outbreaks; electrophoresis, gel, pulsed-field; epidemiologic methods; legionellosis; Legionnaires' disease

Outbreaks of Legionnaires' disease have been linked to potable water systems (1–4), cooling towers (5–10), respiratory devices (11), showers (12), whirlpool spas (13), and ultrasonic humidifiers (14). This is the first report of an outbreak of Legionnaires' disease linked to a decorative water fountain, and the first where the epidemiologic association was confirmed by both monoclonal antibody subtyping and pulsed-field gel

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Abbreviation: PFGE, pulsed-field gel electrophoresis.

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electrophoresis (PFGE) of genomic restriction fragments from clinical and environmental isolates of the causative organism.

The causative organism of Legionnaires' disease is *Legionella pneumophila*, a ubiquitous hydrophilic bacterium with growth inhibited at water temperatures above 50°C. *L. pneumophila* may cause two clinical syndromes when aerosolized and inhaled: Pontiac fever, a self-limited febrile illness resembling an acute hypersensitivity reaction; and Legionnaires' disease, a bacterial pneumonia affecting mostly elderly and immunocompromised individuals, with an incubation period of 2–10 days. Legionnaires' disease is not spread from person to person (15).

On January 27, 1992, a physician in Montana reported that he suspected Legionnaires' disease in one of his patients, with onset of the illness on January 14. The patient had attended a convention at a hotel in the Orlando, Florida, area on January 6–12 (convention A). The patient also stated that he had heard of several other individuals with similar illness among those who attended the convention. On the basis of this information, an epidemiologic investigation was begun.

MATERIALS AND METHODS

Case identification

On January 29, a letter was sent to all 564 convention A registrants advising them that Legionnaires' disease was strongly suspected in one of the conference attendees, and that they should seek medical attention for any fever, cough, or flu-like illness. Registrants who had attended the convention were requested to have their physicians report cases of suspected Legionnaires' disease to their state health departments and the Florida Department of Health and Rehabilitative Services. In addition, approximately 450 people who attended a convention at the hotel on January 28–30 (convention B) and 150 people who attended another event at the same hotel on January 27–February 2 (convention C) were similarly notified.

Because conference attendees resided in at least 48 states, all state epidemiologists were notified of the possibility that an outbreak had occurred and were requested to report any patients with Legionnaires' disease who had a history of travel to the Orlando area at any time during the 2 weeks preceding the onset of their illness. Also, all 18 patients from the Orlando area who had been reported as having Legionnaires' disease during 1991 or 1992 were interviewed again regarding possible exposure to the hotel where conventions A, B, and C were held.

A case patient was defined as any person with exposure to the hotel during January or February of 1992 who had onset of a respiratory illness with cough and fever within 2 weeks of exposure, and whose illness was confirmed as Legionnaires' disease either by culture of *L. pneumophila* from sputum, detection of *L. pneumophila* antigen (serogroup 1) in urine by radioimmunoassay, or a fourfold rise in *L. pneumophila*–specific immunoglobulin-γ (IgG) antibodies in paired sera collected at least 10 days apart (16). For the purpose of calculating an incubation period, the midpoint of each convention period was used as an estimate of the date of exposure.

Control definition and selection

Controls were defined as persons exposed to the hotel with no history of respiratory illness or fever within 2 weeks of exposure. A random number table was used to select 55 controls from the list of registrants to convention A. They were interviewed by telephone regarding illness, travel, and exposures to potential sources of infection.

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Case-control analysis

Standard methods were used to evaluate the significance of differences in age and sex between case patients and controls (17). Odds ratios and confidence intervals were calculated using Epi Info software (18). Fisher's exact test was used to calculate p values and confidence intervals for the odds ratio when the expected value of a cell was <5.

Environmental investigation

The hotel's water systems and air cooling systems were inspected on January 31, 1992. A private laboratory hired by the hotel (PathCon Laboratories, Norcross, GA) collected 55 water samples of 250 ml each for bacterial culture, including initial and post-flush samples from four taps and four showers connected to each of four separate hot water systems serving 924 guest rooms. Other sites tested included the taps and showers in the three rooms where the case patients had stayed; hot water tanks; washrooms in the lobby, convention center, and restaurant; swimming pools and hot tubs; lawn irrigation systems; and three decorative water fountains, one outdoors and two in the hotel lobby. One hundred milliliters of water from each sample was filtered, and the filtrate was resuspended in 1 ml of sterile water. One-tenth milliliter of this solution was then streaked on a culture plate and incubated at 35°C for 10 days. This method has a theoretical sensitivity of 10 colony-forming units per 100 ml of water sampled.

The hotel operated on a private water system supplied by two wells. Maintenance logs for the water chlorination system were reviewed, and water temperatures were measured in all hot water tanks and in the two decorative fountains in the hotel lobby. Water specimens collected from nine decorative fountains not known to be associated with disease in three eastern US cities were also examined as described above, for purposes of comparison.

Bacteriologic studies

Environmental and clinical isolates were characterized by serogroup, monoclonal antibody subtyping, PFGE, and plasmid analysis. There are 15 distinct serogroups of *L. pneumophila*, with serogroup 1 being the most frequent etiologic agent of Legionnaires' disease (15). At least 10 patterns of seven monoclonal antibodies have been recognized as defining subtypes of *L. pneumophila* serogroup 1, the 1,2,5,6 pattern being the one most commonly associated with outbreaks of Legionnaires' disease (19). Further differentiation of strains within serogroup 1 has been shown with both PFGE and plasmid analysis (20, 21).

PFGE of genomic restriction fragments obtained by digestion of chromosomal DNA from clinical, environmental, and control isolates was performed according to the method of Ott et al. (22). Restriction endonuclease digestion was accomplished by incubation of intact genomic DNA with *Not*I or *Sfi*I enzymes. Genomic fragments resulting from each digestion were then separated by PFGE, stained with ethidium bromide, destained, and photographed under ultraviolet illumination.

Plasmid analysis of environmental and clinical isolates was performed using the methods described by Mintz et al. (23). A well-characterized serogroup 1 strain of *L. pneumophila* that harbors an 85-megadalton plasmid designated pCH1 was included as a positive control. A serogroup 1 strain without plasmids, Philadelphia-1, was included as a negative control.

RESULTS

Case-control study

Five case patients were identified (figure 1); the mean incubation period was 4.8 days (range, 4–7 days). One of the case patients was found to have occult colon cancer. None of the others had underlying illness or were taking medications that would suggest they were immunocompromised. All case pa-

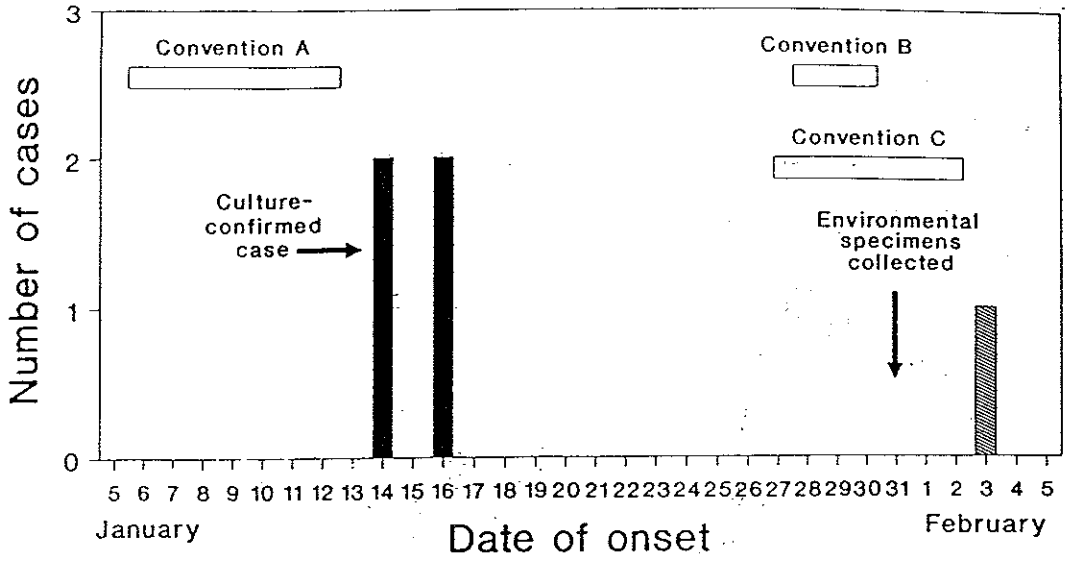

FIGURE 1. Outbreak of Legionnaires' disease associated with a hotel in the Orlando, Florida, area (■, convention A attendees; ▨, convention C attendees).

tients had fever, cough, and a positive urine antigen test for *L. pneumophila* serogroup 1. One case patient also had positive serologic evidence of infection (the others were not tested), and *L. pneumophila* was isolated from another of the case patients by culture of a bronchial washing.

The case patients ranged in age from 60 to 77 years. Their mean age was 69 years, compared with a mean age of 53 years for the controls ($p = 0.007$). All case patients and 40 percent (22 of 55) of the controls were males ($p = 0.01$). The case patients shared no exposures other than that of the hotel. Although one of the case patients did not stay overnight at the hotel, all case patients and 65 percent (36 of 55) of the controls reported lingering near the decorative fountain (fountain 1) in the hotel lobby located nearest the entrance (odds ratio undefined, $p = 0.2$). There were no differences between case patients and controls with regard to the area of the hotel in which they stayed, their activities outside the hotel, or their use of swimming pools, drinking fountains, showers, spas, or restaurants. Also, none of the 18 patients from the Orlando area who had been reported as having Legionnaires' disease during 1991 or 1992 reported any exposure to the hotel.

Environmental findings

Water chlorination records indicated that chlorine levels at the well heads had consistently been maintained at ≥1 part per million. Temperatures in hot water tanks were all between 50°C and 60°C. Four hot water systems, with separate storage tanks and plumbing, served the hotel guest rooms. Only two of the rooms occupied by the five case patients were served by the same hot water system, and one case patient had no exposure to any of the hotel guest rooms.

Only one of the water samples, from fountain 1, was positive for *L. pneumophila*, with a concentration of 400 colony-forming units per milliliter. Fountain 1 operated on a recirculating system with a sand filter. The water was occasionally treated with bromine, but there was no regular maintenance schedule, and no maintenance records were kept. The fountain appeared clean and free of any visible microbial growth or debris. The base

of the fountain stood approximately 75 cm above floor level, with four short (15 cm), thick (4 cm), vertical spouts. A similar spout issued from a raised pool 90 cm above the center of the base. Water from the raised pool fell by two 20-cm wide spillways to the base pool. The fountain was surrounded by tables and chairs that were spattered with water from the spillways, but there was no obvious mist generation. The fountain was illuminated by submersed lights, and the water temperature was 29°C.

The second fountain in the hotel lobby (fountain 2) had similar spouts but no free-falling water. It also operated on a closed, sand-filtered system that had not been regularly maintained. Fountain 2 had no submersed lighting, and the water temperature was 28°C. Fountain 2 was located in a traffic area of the lobby, with no nearby seating.

Legionella was isolated from two of the nine fountains tested for comparison. Both positive fountains contained *L. bozemanii* at concentrations of 130 and 10 colony-forming units per milliliter, respectively. None of the comparison fountains contained detectable levels of *L. pneumophila*.

Characterization of isolates

The single clinical isolate of *L. pneumophila* was serogroup 1, with a monoclonal antibody pattern of 1,2,5,7. Two subtypes of *L. pneumophila* serogroup 1 were isolated from the single positive environmental sample, one with a monoclonal antibody pattern of 1,2,5,7 and the other with a 1,6 pattern.

As shown in figure 2, the clinical and environmental isolates with identical serogroup and monoclonal subtype also exhibited identical restriction fragment patterns after PFGE of *Not*I- or *Sfi*I-digested genomic DNA. The restriction fragment patterns exhibited by these strains were distinct from the restriction fragment patterns exhibited by the serogroup 1 strain Philadelphia-1 (figure 2, lanes 5 and 9). Philadelphia-1 was included in these experiments because its *Not*I and *Sfi*I restriction fragment patterns have been well characterized (20, 22). PFGE analysis of inserts prepared from each strain on two separate occasions yielded results identical to those shown in figure 2. None of the isolates characterized in this study contained detectable plasmid DNA.

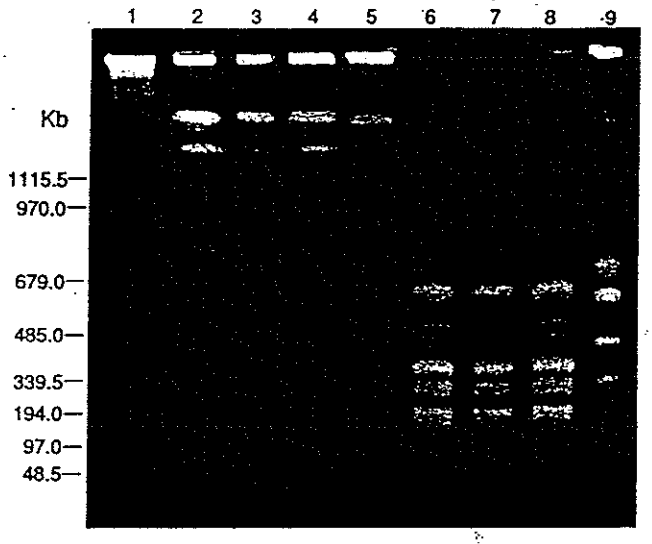

FIGURE 2. Pulsed-field gel electrophoresis of *Not*I- and *Sfi*I-digested genomic DNA from *L. pneumophila* serogroup 1 clinical and environmental isolates (kb, kilobases). Lanes 2–5 were digested with *Not*I and lanes 6–9 with *Sfi*I, as described in the text. Lanes 2 and 6 are clinical isolate; lanes 3 and 7, environmental isolate 1; lanes 4 and 8, environmental isolate 2; and lanes 5 and 9, the Philadelphia-1 strain. Bacteriophage lambda ladders (Bio-Rad Laboratories, Hercules, CA) were used as molecular size standards in lane 1.

DISCUSSION

This outbreak of Legionnaires' disease demonstrates the utility of new subtyping techniques in identifying the likely source of infection in an outbreak situation where traditional epidemiologic methods proved inconclusive. Because of its location, nearly all hotel visitors were exposed at least briefly to fountain 1. All visitors who contracted Legionnaires' disease had lingered near the fountain, but because the number of case patients was small and many controls had also lingered in the fountain area, a statistically significant association with disease could not be demonstrated. The observed association of the illness with elderly males is typical of Legionnaires' disease (24).

Although the case-control study could not focus the investigation on a few suspected sources, a general environmental investigation proved fruitful when combined with clinical and epidemiologic information. Fountain 1 was the only potential source of infection identified. Negative microbiologic findings from other water sources in the hotel, combined with the facts that only two of the rooms of the case patients shared the same hot water system and that another of the case patients was only exposed to the hotel's convention hall and lobby areas, make another undetected source unlikely. Even if another potential source of infection had been found, the characterization of *L. pneumophila* by PFGE, in combination with serogroup and monoclonal antibody subtyping, could have allowed precise matching with clinical isolates. This combination of tests, therefore, appears to be very useful in assessing the epidemiologic significance of positive environmental isolates.

The array of tests available to characterize strains of *L. pneumophila* includes serogrouping, monoclonal antibody subtyping, ribotyping, plasmid analysis, PFGE, and a variety of other genetic typing methods (20, 25). The relative utility of these tests in outbreak investigations will depend on their practicality and their ability to distinguish closely related strains, as well as on knowledge of the distribution of strains in the environment.

PFGE is a powerful technique that has been used to analyze outbreaks of disease caused by a variety of microorganisms (20). Recently, several investigators have successfully used PFGE to investigate outbreaks of Legionnaires' disease (20, 22). In a study by Ott et al. (22), PFGE analysis of a group of 10 clinical and environmental *L. pneumophila* serogroup 1 isolates obtained during a nosocomial outbreak of Legionnaires' disease resulted in the identification of five unique restriction fragment patterns among the isolates. Of interest, three clinical isolates and three independently isolated environmental strains exhibited an identical restriction fragment pattern. The authors concluded that the environmental strains were the likely source of disease in that outbreak. In a similar study, Schoonmaker et al. (20) identified six distinct restriction fragment patterns among a group of nine serogroup 1 clinical and environmental isolates associated with nosocomial Legionnaires' disease. Although three of the clinical isolates had an identical restriction fragment pattern, the authors did not observe that pattern in any of the environmental strains they tested. Consequently, the authors stated they were unable to identify the environmental source of infection. It is evident from the results of these studies that there is substantial genomic restriction fragment polymorphism among clinical and environmental isolates of *L. pneumophila* serogroup 1. Thus, it is reasonable to conclude that clinical and environmental serogroup 1 isolates that exhibit identical genomic restriction fragment patterns are likely to have been derived from a common source.

In the present study, the restriction enzymes *Not*I and *Sfi*I were used in PFGE analysis. Results from other studies have shown that digestion of *L. pneumophila* serogroup 1 genomic DNA with *Not*I usually yields five to 10 restriction fragments, whereas digestion with *Sfi*I usually yields eight to 23 restriction fragments (20, 22).

Similar results were obtained in our study (figure 2). More importantly, *Not*I digestion of genomic DNA from the single clinical isolate and two environmental isolates employed in this study yielded identical restriction fragment patterns (figure 2). Identical patterns were also observed when genomic DNA from each of the three strains was digested with *Sfi*I. These findings, along with monoclonal antibody subtyping results, strongly suggest that the decorative fountain was the source of infection during this outbreak of Legionnaires' disease. The 1,2,5,7 monoclonal antibody pattern we found in *L. pneumophila* serogroup 1 isolates has been linked to one other reported outbreak of Legionnaires' disease (26).

The concentration of *Legionella* in fountain 1 (400 colony-forming units per milliliter) was well above levels found in the nine comparison fountains (none of which contained *L. pneumophila*). Other studies have suggested that water sources with higher concentrations of *Legionella* may be more likely to be associated with outbreaks of disease (27, 28).

Although this is the first report of Legionnaires' disease resulting from exposure to a contaminated fountain, an outbreak of Pontiac fever due to *L. anisa* was also linked to a decorative fountain (29), suggesting that decorative fountains colonized with *Legionella* may be a public health hazard. The fountain associated with this outbreak of Legionnaires' disease was drained and cleaned, and intermittent chlorination is now used to maintain residual chlorine levels of at least two parts per million. *L. pneumophila* was absent in follow-up specimens from the fountain submitted for culture, and no new patients with Legionnaires' disease have been identified. There remains a need for standard recommendations for disinfection and maintenance of water sources associated with outbreaks of legionellosis (30).

In summary, our findings suggest that a decorative water fountain was the source of an outbreak of Legionnaire's disease. Five patients with Legionnaires' disease were all exposed to a contaminated decorative water fountain during the incubation periods for their disease. All patients were infected with *L. pneumophila* serogroup 1, and the only clinical isolate appeared identical to an isolate found in high concentration in the fountain. This investigation demonstrates the utility of molecular methods in matching epidemiologically linked environmental and clinical isolates of *L. pneumophila* and suggests that decorative water fountains may be potential sources of infection.

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CDC Answers Your Questions About

Noroviruses: Q&A

What are noroviruses?

Noroviruses are a group of viruses that cause the "stomach flu," or gastroenteritis (GAS-tro-en-ter-I-tis), in people. The term norovirus was recently approved as the official name for this group of viruses. Several other names have been used for noroviruses, including:

- Norwalk-like viruses (NLVs)
- caliciviruses (because they belong to the virus family *Caliciviridae*)
- small round structured viruses.

Viruses are very different from bacteria and parasites, some of which can cause illnesses similar to norvirus infection. Viruses are much smaller, are not affected by treatment with antibiotics, and cannot grow outside of a person's body.

What are the symptoms of illness caused by noroviruses?

The symptoms of norovirus illness usually include nausea, vomiting, diarrhea, and some stomach cramping. Sometimes people additionally have a low-grade fever, chills, headache, muscle aches, and a general sense of tiredness. The illness often begins suddenly, and the infected person may feel very sick. The illness is usually brief, with symptoms lasting only about 1 or 2 days. In general, children experience more vomiting than adults. Most people with norovirus illness have both of these symptoms.

What is the name of the illness caused by noroviruses?

Illness caused by norovirus infection has several names, including:

- stomach flu – this "stomach flu" is ***not*** related to the flu (or influenza), which is a respiratory illness caused by influenza virus.
- viral gastroenteritis – the most common name for illness caused by norovirus. Gastroenteritis refers to an inflammation of the stomach and intestines.
- acute gastroenteritis
- non-bacterial gastroenteritis
- food poisoning (although there are other causes of food poisoning)
- calicivirus infection

How serious is norovirus disease?

Norovirus disease is usually not serious, although people may feel very sick and vomit many times a day. Most people get better within 1 or 2 days, and they have no long-term health effects related to their illness. However, sometimes people are unable to drink enough liquids to replace the liquids they lost because of vomiting and diarrhea. These persons can become dehydrated and may need special medical attention. This problem with dehydration is usually only seen among the very young, the elderly, and persons with weakened immune systems. There is no evidence to suggest that an infected person can become a long-term carrier of norovirus.

How do people become infected with noroviruses?

Noroviruses are found in the stool or vomit of infected people. People can become infected with the virus in several ways, including:

- eating food (see food handler fact sheet) or drinking liquids that are contaminated with norovirus;
- touching surfaces or objects contaminated with norovirus, and then placing their hand in their mouth;
- having direct contact with another person who is infected and showing symptoms (for example, when caring for someone with illness, or sharing foods or eating utensils with someone who is ill).

Persons working in day-care centers or nursing homes should pay special attention to children or residents who have norovirus illness. This virus is very contagious and can spread rapidly throughout such environments.

When do symptoms appear?

Symptoms of norovirus illness usually begin about 24 to 48 hours after ingestion of the virus, but they can appear as early as 12 hours after exposure.

Are noroviruses contagious?

Noroviruses are very contagious and can spread easily from person to person. Both stool and vomit are infectious. Particular care should be taken with young children in diapers who may have diarrhea.

How long are people contagious?

People infected with norovirus are contagious from the moment they begin feeling ill to at least 3 days after recovery. Some people may be contagious for as long as 2 weeks after recovery. Therefore, it is particularly important for people to use good handwashing and other hygienic practices after they have recently recovered from norovirus illness.

Who gets norovirus infection?

Anyone can become infected with these viruses. There are many different strains of norovirus, which makes it difficult for a person's body to develop long-lasting immunity. Therefore, norovirus illness can recur throughout a person's lifetime. In addition, because of differences in genetic factors, some people are more likely to become infected and develop more severe illness than others.

What treatment is available for people with norovirus infection?

Currently, there is no antiviral medication that works against norovirus and there is no vaccine to prevent infection. Norovirus infection cannot be treated with antibiotics. This is because antibiotics work to fight bacteria and not viruses.

Norovirus illness is usually brief in healthy individuals. When people are ill with vomiting and diarrhea, they should drink plenty of fluids to prevent dehydration. Dehydration among young children, the elderly, the sick, can be common, and it is the most serious health effect that can result from norovirus infection. By drinking oral rehydration fluids (ORF), juice, or water, people can reduce their chance of becoming dehydrated. Sports drinks do not replace the nutrients and minerals lost during this illness.

Can norovirus infections be prevented?

Yes. You can decrease your chance of coming in contact with noroviruses by following these preventive steps:

- Frequently wash your hands, especially after toilet visits and changing diapers and before eating or preparing food.
- Carefully wash fruits and vegetables, and steam oysters before eating them.
- Thoroughly clean and disinfect contaminated surfaces immediately after an episode of illness by using a bleach-based household cleaner.
- Immediately remove and wash clothing or linens that may be contaminated with virus after an episode of illness (use hot water and soap).
- Flush or discard any vomitus and/or stool in the toilet and make sure that the surrounding area is kept clean.

Persons who are infected with norovirus should not prepare food while they have symptoms and for 3 days after they recover from their illness (see food handler information sheet). Food that may have been contaminated by an ill person should be disposed of properly.

CDC Answers Your Questions About

Noroviruses and Food Handlers

What are noroviruses?

Noroviruses are members of a group of viruses called caliciviruses also known previously as "Norwalk-like viruses." Infection with norovirus affects the stomach and intestines, causing an illness called gastroenteritis, or "stomach flu." This "stomach flu" is ***not*** related to the flu (or influenza), which is a respiratory illness caused by influenza virus. In addition, noroviruses are not related to bacteria and parasites that can cause gastrointestinal illnesses. Norovirus is not a "new" virus, but interest in it is growing as more is learned about how frequently noroviruses cause illness in people (see – "Why is norovirus infection important for food handlers?").

What are the symptoms of infection with norovirus?

Norovirus infection causes gastroenteritis, which is an inflammation of the stomach and the small and large intestines. The symptoms of gastroenteritis are nausea, vomiting, and/or diarrhea accompanied by abdominal cramps. Some people also complain of headache, fever/chills, and muscle aches. Symptoms are usually brief and last only 1 or 2 days. However, during that brief period, people can feel very ill and vomit, often violently and without warning, many times a day. Symptoms usually begin 24 to 48 hours after ingestion of the virus, but can appear as early as 12 hours after exposure (see – "How is norovirus spread?"). There is no evidence that sick persons can become long-term carriers of the virus, but the virus can be in the stool and vomit of infected persons, from the day they start to feel ill to as long as 2 weeks after they feel better.

Other infectious and non-infectious agents can cause symptoms similar to those of norovirus gastroenteritis; people who have these symptoms and have questions about the cause of their illness should consult a physician.

How serious is norovirus gastroenteritis?

Norovirus gastroenteritis is usually not a serious illness, and other than drinking liquids to prevent dehydration, there is no specific treatment. Most people recover completely within 1 to 2 days, with no long-term complications of norovirus illness. However, persons who are unable to drink enough liquids to replace those lost with vomiting and/or diarrhea may become dehydrated and require special medical attention. These people include young children, the elderly, and persons of any age unable to care for themselves.

How is norovirus spread?

Noroviruses are found in the stool or vomit of infected people. People can become infected with the virus in several ways, including:

- eating food (see food handler fact sheet) or drinking liquids that are contaminated with norovirus;
- touching surfaces or objects contaminated with norovirus, and then placing their hand in their mouth;
- having direct contact with another person who is infected and showing symptoms (for example, when caring for someone with illness, or sharing foods or eating utensils with someone who is ill).

Food and drinks can very easily become contaminated with norovirus because the virus is so small and because it probably takes fewer than 100 norovirus particles to make a person sick. Food can be contaminated either by direct contact with contaminated hands or work surfaces that are contaminated with stool or vomit, or by tiny droplets from nearby vomit that can travel through air to land on food. Although the virus cannot multiply outside of human bodies, once on food or in water, it can cause illness.

Some foods can be contaminated with norovirus ***before*** being delivered to a restaurant or store. Several outbreaks have been caused by the consumption of oysters harvested from contaminated waters. Other produce such as salads and frozen fruit may also be contaminated at source.

Why is norovirus infection important for food handlers?

People working with food who are sick with norovirus gastroenteritis are a particular risk to others, because they handle the food and drink many other people will consume. Since the virus is so small, a sick food handler can easily – without meaning to – contaminate the food he or she is handling. Many of those eating the contaminated food may become ill, causing an outbreak.

Outbreaks of norovirus gastroenteritis have taken place in restaurants, cruise ships, nursing homes, hospitals, schools, banquet halls, summer camps, and family dinners – in other words, places where often people have consumed water and/or food prepared or handled by others. It is estimated that as many as half of all food-related outbreaks of illness may be caused by norovirus. In many of these cases, sick food handlers were thought to be implicated.

What can I do to prevent norovirus gastroenteritis?

Many local and state health departments require that food handlers and preparers with gastroenteritis ***not*** work until 2 or 3 days after they feel better. In addition, because the virus continues to be present in the stool for as long as 2 to 3 weeks after the person feels better, strict hand washing after using the bathroom and before handling food items is important in preventing the spread of this virus. Food handlers who were recently sick can be given different duties in the restaurant so that they do not have to handle food (for example, working the cash register or hostessing).

People who are sick with norovirus illness can often vomit violently, without warning, and the vomit is infectious; therefore, any surfaces near the vomit should be promptly cleaned and disinfected with bleach solution and then rinsed. Furthermore, food items that may have become contaminated with norovirus should be thrown out. Linens (including clothes, towels, tablecloths, napkins) soiled to any extent with vomit or stool should be promptly washed at high temperature. Oysters should be obtained from reputable sources and appropriate documentation kept. Washing raw vegetables thoroughly before eating and appropriate disposal of sewage and soiled diapers also help to reduce the spread of norovirus and prevent illness. In small home-based catering businesses or family owned or operated restaurants, sick children and infants in diapers should be excluded from food preparation areas.

How is norovirus gastroenteritis diagnosed?

In special cases, when there is an outbreak of gastroenteritis there is a need to identify norovirus as the cause of the illness. In these cases, norovirus can often be found in stool samples of infected persons by using special tests. Sometimes blood tests looking for antibodies against norovirus are also performed, when the stool tests are inconclusive or were not done. Food handlers will often be asked for a stool sample or even a blood sample to help investigate the cause of an outbreak.

Can a person have norovirus gastroenteritis more than once?

Yes, a person can be infected with norovirus more than once in their lifetime. This is because there are many different noroviruses, and being infected with one type does not prevent infection from another type later. For this reason, it is difficult to develop a vaccine against norovirus.

CDC Technical Fact Sheet About

Noroviruses

Noroviruses (genus *Norovirus*, family *Caliciviridae*) are a group of related, single-stranded RNA, nonenveloped viruses that cause acute gastroenteritis in humans. Norovirus was recently approved as the official genus name for the group of viruses provisionally described as "Norwalk-like viruses" (NLV). This group of viruses has also referred to as caliciviruses (because of their virus family name) and as small round structured viruses, or SRSVs (because of their morphologic features). Another genus of the calicivirus family that can cause gastroenteritis in humans is *Sapovirus*, formerly described as "Sapporo-like virus" (SLV) and sometimes referred to as classic or typical calicivirus.

Noroviruses are named after the original strain "Norwalk virus," which caused an outbreak of gastroenteritis in a school in Norwalk, Ohio, in 1968. Currently, there are at least four norovirus genogroups (GI, GII, GIII and GIV), which in turn are divided into at least 20 genetic clusters.

Clinical Presentation

The incubation period for norovirus-associated gastroenteritis in humans is usually between 24 and 48 hours (median in outbreaks 33 to 36 hours), but cases can occur within 12 hours of exposure. Norovirus infection usually presents as acute-onset vomiting, watery non-bloody diarrhea with abdominal cramps, and nausea. Low-grade fever also occasionally occurs, and vomiting is more common in children. Dehydration is the most common complication, especially among the young and elderly, and may require medical attention. Symptoms usually last 24 to 60 hours. Recovery is usually complete and there is no evidence of any serious long-term sequelae. Studies with volunteers given stool filtrates have shown that asymptomatic infection may occur in as many as 30% of infections, although the role of asymptomatic infection in norovirus transmission is not well understood.

Virus Transmission

Noroviruses are transmitted primarily through the fecal-oral route, either by consumption of fecally contaminated food or water or by direct person-to-person spread. Environmental and fomite contamination may also act as a source of infection. Good evidence exists for transmission due to aerosolization of vomitus that presumably results in droplets contaminating surfaces or entering the oral mucosa and being swallowed. No evidence suggests that infection occurs through the respiratory system.

Noroviruses are highly contagious, and it is thought that an inoculum of as few as 10 viral particles may be sufficient to infect an individual. During outbreaks of norovirus gastroenteritis, several modes of transmission have been documented; for example, initial foodborne transmission in a restaurant, followed by secondary person-to-person transmission to household contacts. Although presymptomatic viral shedding may occur, shedding usually begins with onset of symptoms and may continue for 2 weeks after

recovery. It is unclear to what extent viral shedding over 72 hours after recovery signifies continued infectivity.

Immunity to Norovirus

Mechanisms of immunity to norovirus are unclear. It appears that immunity may be strain-specific and lasts only a few months; therefore, given the genetic variability of noroviruses, individuals are likely to be repeatedly infected throughout their lifetimes. This may explain the high attack rates in all ages reported in outbreaks. Recent evidence also suggests that susceptibility to infection may be genetically determined, with people of O blood group being at greatest risk for severe infection.

Disease burden of Norovirus Gastroenteritis

CDC estimates that 23 million cases of acute gastroenteritis are due to norovirus infection, and it is now thought that at least 50% of all foodborne outbreaks of gastroenteritis can be attributed to noroviruses.
Among the 232 outbreaks of norovirus illness reported to CDC from July 1997 to June 2000, 57% were foodborne, 16% were due to person-to-person spread, and 3% were waterborne; in 23% of outbreaks, the cause of transmission was not determined. In this study, common settings for outbreaks include restaurants and catered meals (36%), nursing homes (23%), schools (13%), and vacation settings or cruise ships (10%).

Most foodborne outbreaks of norovirus illness are likely to arise though direct contamination of food by a food handler immediately before its consumption. Outbreaks have frequently been associated with consumption of cold foods, including various salads, sandwiches, and bakery products. Liquid items (e.g., salad dressing or cake icing) that allow virus to mix evenly are often implicated as a cause of outbreaks. Food can also be contaminated at its source, and oysters from contaminated waters have been associated with widespread outbreaks of gastroenteritis. Other foods, including raspberries and salads, have been contaminated before widespread distribution and subsequently caused extensive outbreaks.

Waterborne outbreaks of norovirus disease in community settings have often been caused by sewage contamination of wells and recreational water.

Diagnosis of Norovirus

Human. In the last 10 years, diagnosis of norovirus illness in outbreaks has improved with the increasing use of reverse transcriptase polymerase chain reaction (RT-PCR). Currently, 27 state public health laboratories have the capability to test for noroviruses by RT-PCR. RT-PCR can be used to test stool and emesis samples, as well as to detect the presence of noroviruses on environmental swabs in special studies. Identification of the virus can be best made from stool specimens taken within 48 to 72 hours after onset of symptoms, although good results can be obtained by using RT-PCR on samples taken as long as 5 days after symptom onset. Virus can sometimes be found in stool samples taken as late as 2 weeks after recovery.

Older methods for diagnosis include direct and immune electron microscopy of fecal specimens, and detection of a fourfold increase of specific antibodies in acute- and convalescent-phase blood samples. An enzyme-linked immunosorbent assay for detection of virus in stools is under development.

Sequencing of noroviruses found in clinical samples has helped in conducting epidemiologic investigations by linking cases to each other and to a common source and by differentiating outbreaks that were mistakenly connected. Sequences can be entered into CaliciNet, a database used to store the different sequences of norovirus that cause disease throughout the United States, thereby allowing rapid assessment of the relationships between strains.

In addition to microbiological techniques, several epidemiologic criteria have been proposed for use in determining whether an outbreak of gastroenteritis is of viral origin. Kaplan's criteria for this purpose are as follows: 1) a mean (or median) illness duration of 12 to 60 hours, 2) a mean (or median) incubation period of 24 to 48 hours, 3) more than 50% of people with vomiting and 4) no bacterial agent previously found." Although quite specific, these criteria are not very sensitive, and therefore the possibility of a viral etiology should not be discarded if the criteria are not met.

Environmental. Assays to detect virus in food need to be adapted for each food substance; these have been only rarely used, with the exception of assays to detect virus in shellfish. Water can be tested for noroviruses by using RT-PCR to detect virus when large volumes of water are processed through specially designed filters.

Management of Norovirus Infection

No specific therapy exists for viral gastroenteritis. Symptomatic therapy consists of replacing fluid losses and correcting electrolyte disturbances through oral and intravenous fluid administration.

Prevention

Prevention of foodborne norovirus disease is based on the provision of safe food and water. Noroviruses are relatively resistant to environmental challenge: they are able to survive freezing, temperatures as high as 60°C, and have even been associated with illness after being steamed in shellfish. Moreover, noroviruses can survive in up to 10 ppm chlorine, well in excess of levels routinely present in public water systems. Despite these features, it is likely that relatively simple measures, such as correct handling of cold foods, frequent handwashing, and paid sick leave, may substantially reduce foodborne transmission of noroviruses.

Surveillance of Norovirus Infection in the United States

CDC currently does not conduct active surveillance to monitor outbreaks of gastroenteritis caused by noroviruses. Outbreaks are reported to CDC's Viral Gastroenteritis Section, Respiratory and Enteric Viruses Branch, Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases (NCID) when states send

specimens for testing or sequencing, or outbreaks are reported directly by states to the database maintained by the Foodborne Diarrheal Diseases Branch, Division of Bacterial and Mycotic Diseases, NCID.

Recently, a system called CaliciNet has been developed on the basis of the PulseNet model. CaliciNet is a database of norovirus sequences identified from outbreaks of norovirus that can then help to determine links between outbreaks. For further details please email calicinet@cdc.gov

The Southern Nevada Health District has developed these guidelines in order to provide direction for hotel/casinos in the prevention and control of norovirus outbreaks. This document does not present formal recommendations, but provides areas of consideration for properties in the prevention of outbreaks. The recommendations are made in addition to the Southern Nevada Health District regulations entitled "Regulations Governing the Health and Safety of Public Accommodation Facilities".

Proper handwashing is an effective, simple, and inexpensive method of preventing disease, and is one of the most important steps in preventing an outbreak from spreading. Because each outbreak of norovirus is unique to the circumstances and the property, it is not possible to predict which of the environmental controls would be most important in preventing the spread of disease. However, following as many of the recommendations as possible will increase the chances of preventing and/or controlling an outbreak.

During an outbreak, a number of these recommendations, as well as other items not on this list, may be formally required by the Health District. Many of the items in the recommendations will not be appropriate for a particular property, and thus would not be required. The columns labeled "SOP" and "Date Implemented" are intended to assist in complying with these requirements, allowing a facility to identify parts of the recommendations that are part of the Standard Operating Procedure (SOP) of the facility, or the date on which the item was implemented.

There are two appendices to these recommendations. The first is a list of products that are approved by the EPA as effective against norovirus. The second is a standardized illness questionnaire that can be used to track guest or employee illness.

Representatives from the Southern Nevada Health District are available to help answer any questions about norovirus, these guidelines, or the process of surveillance and outbreak investigation/control. For additional information, contact the Environmental Health Specialist assigned to your facility, or the Office of Epidemiology at 759-1300. Office of Epidemiology staff are available 24/7/365 to take reports of outbreaks.

Section 1: General Recommendations	**SOP**	**Date Implemented**
1.1 Increase employee hand washing in **all** employees to:	☐	_____
1.1.1 At least once per hour		
1.1.2 Upon entering a kitchen		
1.1.3 After using the restroom		
1.1.4 After shaking hands or other physical contact with peers and guests		
1.1.5 After sneezing		
1.1.6 After touching the face		
1.1.7 After blowing the nose		
1.1.8 After rubbing hands on clothing and similar activities		
1.1.9 After handling raw foods		
1.1.10 After handling dirty kitchen utensils and kitchenware		
1.1.11 After cleaning, sweeping, or mopping		
1.1.12 After a break		
1.1.13 After smoking, eating or drinking		
1.1.14 Before handling any food, especially ready-to-eat foods and ice		
1.1.15 After handling money (tips)		
1.1.16 When entering and leaving the gaming floor		
1.1.17 Before going on break		

	1.1.18 Before starting a shift		
	1.1.19 After ending a shift		
	1.1.20 After using a common-use telephone		
1.2	Inform all employees of the need for handwashing and provide instructions on proper handwashing.	☐	_____
1.3	Maintain employee hand washing vigilance through active management reminders and correction.	☐	_____
1.4	Consider strict glove use policy for all food preparation. Ensure that gloves are worn properly, changed frequently, and that hands are washed between glove changes.	☐	_____
1.5	Discontinue the practice of having cocktail servers handle ashtrays and used drink cups. Have a designated person, who is not a cocktail, server perform this task.	☐	_____
1.6	Contact transportation companies affiliated with the hotel/casino to implement similar clean-up and sanitizing/disinfecting procedures as those implemented in the hotel properties.	☐	_____
1.7	Regularly inspect all areas of the property (including, but not limited to, elevators, bathrooms, walkways, garages and parking lots, casino floor, and employee break rooms) for evidence of biohazardous accidents. Any accidents should be cleaned up following the procedures as outlined in Section 8.	☐	_____
1.8	Use single-use ticket system for automobile valet check-in and pick-up, in place of using tickets that are reused multiple times.	☐	_____
1.9	Switch to auto-dispensing paper towel dispensers throughout the hotel, including all patron restrooms, employee restrooms, kitchens, and locker rooms.	☐	_____
1.10	Use disposable ice buckets and drink cups in all guest rooms, and discard when visibly soiled and between guests.	☐	_____
1.11	Review existing SOPs and protocols for general cleaning to ensure that they are consistent with these guidelines.	☐	_____
1.12	Ensure that the SOPs and protocols are being properly implemented by staff through observation and training.	☐	_____
1.13	Provide and encourage use of ethanol hand towelettes on the casino floor.	☐	_____
1.14	Install hand sanitizer stations in dining facilities and restaurants, restrooms, break areas, and on the casino floor.	☐	_____
1.15	Install polite reminders in all restrooms on the need for proper hand washing.	☐	_____

Section 2: Basic Clean-up and Sanitization Recommendations		**SOP**	**Date Implemented**
2.1	Implement recommendations in addition to routine cleaning activities.	☐	_____
2.2	Increase frequency of cleaning and sanitizing/disinfecting the handles of hand sinks and doors in public restrooms, employee restrooms and throughout all kitchens to at least once per hour during periods of frequent use.	☐	_____
2.3	Increase frequency of cleaning and sanitizing/disinfecting employee restrooms to at least once per hour during periods of frequent use.	☐	_____
2.4	Use disposable cleaning cloths and mop heads for all cleaning and sanitizing/disinfection.	☐	_____

2.5 Frequently clean and sanitize/disinfect high-touch surfaces such as (but not limited to): ☐ _____

- 2.5.1 ATM machines
- 2.5.2 Slot and video machine buttons and handles
- 2.5.3 Coin trays
- 2.5.4 Self-serve coin redemption kiosks
- 2.5.5 Drinking fountains
- 2.5.6 Door handles and push plates (both in public areas and staff areas)
- 2.5.7 Escalator roller bars
- 2.5.8 Elevator buttons and panel (service and public)
- 2.5.9 Stair rails
- 2.5.10 Balcony rails
- 2.5.11 Bar rails
- 2.5.12 Validation and time clocks
- 2.5.13 Public telephones, courtesy phones, and common-use phones in employee areas
- 2.5.14 Light switches
- 2.5.15 Restaurant menus
- 2.5.16 Casino cage counters
- 2.5.17 Gaming chair backs
- 2.5.18 Contact areas of gaming tables
- 2.5.19 Table game cup holders
- 2.5.20 Counters in public areas (e.g. Registration, Bell Desk, Concierge)
- 2.5.21 Counters in staff areas (e.g. Assignment Desks, Uniform Counters)

2.6 Spray or hand wipe as applicable the entire casino gaming area including high frequency human contact equipment and employee areas with an appropriate sanitizer at least daily. Carefully follow all manufacturer instructions on cleaning, rinsing, and sanitizing/disinfecting equipment being careful not to damage sensitive electronic components. Although this is a labor intensive effort, it is essential to breaking the chain of environmental contamination by ill guests and employees over time. ☐ _____

2.7 Clean and sanitize/disinfect the inside of all dish and glass washers once per shift. The currently recommended sanitizers for non-high-temperature dishwashers are not effective against norovirus. Therefore if any contaminated item has been placed in the dishwasher, the equipment may be contaminated with Norovirus. ☐ _____

2.8 Discontinue the use of any dish or glass washing machine for ashtray cleaning/sanitizing unless the machine is dedicated solely for that purpose. ☐ _____

2.9 Clean and sanitize floor surfaces in all public areas at least once per shift. ☐ _____

2.10 Wash, rinse, and then sanitize/disinfect coin cups daily (if applicable). ☐ _____

2.11 Discard the ice in all ice machines once per week throughout all kitchen facilities followed by thorough cleaning and sanitizing/disinfection of the machine. Discard ice stored in bins, sinks used to store ice, and other associated equipment once per day followed by a thorough sanitizing of the bin or sink. Sanitize/disinfect all such bins and sinks again prior to use. ☐ _____

Section 3: Routine Guest Room Cleaning Procedure		SOP	Date Implemented
3.1	Use disposable cleaning cloths.	☐	_____
3.2	Use one cloth for cleaning and a new cloth for sanitizing/disinfecting surfaces.	☐	_____
3.3	Use separate colored cleaning cloths in toilet areas.	☐	_____
3.4	Use a new set of cleaning cloths for each guest room.	☐	_____
3.5	Clean and sanitize/disinfect high touch areas such as taps, faucets, door and drawer handles, door latches, toilet or bath rails, telephones, rails on balconies, light and lamp switches, thermostats, remote controls, curtain pulls and wands, covers on guest information books, alarm clocks, hair dryers, irons, and pens.	☐	_____

Section 4: Guest Room Cleaning Procedures for Rooms with Known Ill Guests		SOP	Date Implemented
4.1	Treat all areas of rooms with known ill guests as if they are contaminated with a highly infectious organism.	☐	_____
4.2	Staff entering the room should wear appropriate personal protective equipment (PPE), including a disposable mask, gloves, eye shield, disposable shoe covers, and plastic disposable apron.	☐	_____
4.3	Emetic or fecal accidents should be reported and cleaned as per Section 8.	☐	_____
4.4	Once the ill guest has checked out, treat the room as a "hot room" and deep clean to ensure that any contamination has been removed.	☐	_____
4.4.1	Consideration should be given to having a specially trained team available for cleaning of rooms with known ill guests.		
4.4.2	Discard all disposable paper products (e.g. tissues or toilet paper).		
4.4.3	Remove all towels, linens, pillows, bedspreads, and blankets, and launder in accordance with Section 9.1.		
4.4.4	Examine the mattresses for fecal or emetic accidents, and discard in accordance with Section 9.3 if visibly soiled.		
4.4.5	Clean and sanitize/disinfect all high touch surfaces throughout the room as described in Section 3.5.		
4.4.6	Clean the carpet in accordance with Section 9.4.		
4.4.7	Use an aerosol or fogging device to sanitize/disinfect all surfaces in the room.		

Note: A sample response plan can be found in the Southern Nevada Health District regulations entitled "Regulations Governing the Sanitation and Safety of Public Accommodation Facilities 2006 Appendix G: Example Guest Room Clean-up Standard Operating Procedure (SOP)"

Section 5: Surveillance for Employee and Guest Illness		SOP	Date Implemented
5.1	Monitor employee illness logs and interview employees to identify potential cases of norovirus.	☐	_____
5.2	Have managers look for obvious signs of employee illness such as increased frequency of restroom use. Send ill employees home as per the recommendations in Section 7.	☐	_____
5.3	Use a standardized illness questionnaire (Appendix B) to collect information	☐	_____

on employee and guest illness symptoms.

5.4	Use room service orders to identify potentially ill guests. Provide a questionnaire to any guest reporting not feeling well or ordering items such as ginger ale, broth, or dry toast.	☐	_____
5.5	Distribute illness questionnaires to guests purchasing medications for gastroenteritis (e.g. anti-diarrheals, antacids, upset stomach relief) at gift shops.	☐	_____
5.6	Monitor gift shop sales of over the counter medications for gastroenteritis (e.g. anti-diarrheals, antacids, upset stomach relief) and beverages such as ginger ale to identify potential outbreaks.	☐	_____

Section 6: Dealing with Guests During Outbreaks		SOP	Date Implemented
6.1	Provide information* to guests upon check-in, in guest rooms and through signs on: 6.1.1 The symptoms and transmission of norovirus 6.1.2 Prevention of norovirus, including proper handwashing 6.1.3 The procedure for reporting illness to the hotel and or health district 6.1.4 How to obtain medical assistance, if necessary * Southern Nevada Health District staff are available to work with hotel management to develop appropriate messages for guests, and to assist in the development of educational materials.	☐	_____
6.2	Encourage ill guests to stay in their rooms if they become ill by: 6.2.1 Staff taking illness reports should request that ill guests stay in their rooms while symptomatic. 6.2.2 Send a room service tray containing fluids (hot tea, water, electrolyte maintenance solutions such as Pedialyte®) and foods such as crackers, dry toast, and/or broth to any person reporting an ongoing illness. 6.2.3 Provide a mechanism by which ill guests can get items from the gift shop (newspapers, magazines, light snacks, over-the-counter medications, etc.) without leaving their rooms.	☐	_____
6.3	Where appropriate, and space permitting, relocate non-ill guests sharing the room with the ill guest to a different room	☐	_____

Section 7: Dealing with Employees During Outbreaks		SOP	Date Implemented
7.1	During an outbreak, provide regular updates to employees, providing: 7.1.1 The status of the outbreak response 7.1.2 Talking points to be used in dealing with guests 7.1.3 Reminders on proper handwashing 7.1.4 Procedures for reporting illness	☐	_____
7.2	Require that all employees, *regardless of job duty*, who report having experienced vomiting, diarrhea, or "stomach flu" symptoms, remain off duty for 72 hours after their symptoms end.	☐	_____
7.3	Evaluate policies for the compensation and medical evaluation of ill employees.	☐	_____

7.4	Prohibit employee potlucks, and do not allow employees to bring in food (either prepared at home or commercially) to share with others for the duration of the outbreak. Temporarily remove candy dishes and fruit baskets at individual desks or common areas. *Note: This recommendation does not include removing office coffee pots.*	☐	_____

Section 8: Emesis and Feces Removal, and Follow-up Environmental Contact Surface Clean-up and Disinfection		**SOP**	**Date Implemented**
8.1	Treat all fecal and vomitus events as if they are contaminated with a highly infectious organism.	☐	_____
8.2	Consideration should be given to having a specially trained cleaning team available at all times.		
8.3	Ensure that all biohazardous accidents are only remediated by staff trained and properly protected for such clean-up activities.	☐	_____
8.4	Have staff report all biohazardous accidents to management. Document all biohazardous events in a log including date, time, location, persons affected (if known), the names of the persons reporting the event, a short description of the incident, the names of the responders, and how a short description of the response to the accident.	☐	_____
8.5	In the event of an emetic or fecal accident, the area must be cleaned as a matter of urgency. Because of the potential for the aerosolization of the virus, the area where such an incident has occurred should be closed, or cordoned off in a 25 foot radius from the site of the incident. Guests and non-essential staff should be excluded from these areas for the duration of the cleanup.	☐	_____
8.6	Individuals,who clean up emesis or feces should use the following procedures:	☐	_____
8.6.1	Wear appropriate personal protective equipment (PPE), including a disposable mask, gloves, eye shield, disposable shoe covers, and plastic disposable apron.		
8.6.2	Use disposable cleaning cloths or paper towels to soak up excess liquid. Transfer these and any solid matter directly into a Biohazard bag.		
8.6.3	To remove gross debris, clean the soiled area with detergent and hot water, using a disposable cloth.		
8.6.4	Disinfect the contaminated area.		
8.6.5	Dispose of mop heads, cleaning cloths, other materials used in the cleanup, and PPE into the Biohazard waste bag.		
8.6.6	Wash hands thoroughly after completing the clean-up procedure and again after completing the disposal procedure.		

Note: A sample response plan can be found in the Southern Nevada Health District regulations entitled "Regulations Governing the Sanitation and Safety of Public Accommodation Facilities 2006 Appendix I: Biohazard Event Response Plan for Public Areas"

Section 9: Treatment of Contaminated Materials		SOP	Date Implemented
9.1	Contaminated linen and other fabric materials should be placed carefully into separate laundry bags. They should be washed separately in a hot wash, and dried separately at 170°F. If an outside laundry is used, they should be advised that the laundry is potentially infectious.	☐	_____
9.2	Soft furnishings should be removed for appropriate sanitization/disinfection.	☐	_____
9.3	Soiled mattresses should be wrapped in heavy gauge plastic and discarded via normal solid waste disposal procedures.	☐	_____
9.4	Contaminated carpets should be cleaned in a three step process. First, carpets must be cleaned with carpet detergent and hot water. Second, carpets must be disinfected by applying an appropriate disinfectant. Finally, carpets should be steam cleaned (158°F for 5 minutes or 212°F for 1 minute is needed for complete inactivation).	☐	_____
9.5	Contaminated hard surfaces should be washed with detergent and hot water, using a disposable cloth, and then disinfected. Cleaning cloths should be disposed of as biohazardous waste. Mop heads should be discarded after use.	☐	_____

Section 10: Responding to Emetic Events in Food Preparation or Service Areas		SOP	Date Implemented
10.1	Stop all food preparation and service until clean-up is completed.	☐	_____
10.2	Follow the procedures outlined in Section 6 for cleaning.	☐	_____
10.3	Destroy all exposed food, food that may have been contaminated, and food that has been handled by the infected person.	☐	_____

Appendix A
Products Approved by the EPA for use Against Norovirus

A number of commercially-available products have been approved by the EPA for use against norovirus. Because norovirus is difficult to grow in laboratory conditions, these products have been tested against Feline Calicivirus (FCV), a surrogate for norovirus. The complete EPA testing methodology can be found at http://www.epa.gov/oppad001/pdf_files/confirmatory_virucidal_test.pdf.

This list is provided solely as a courtesy to hotel/casinos. The Southern Nevada Health District does not endorse or recommend any particular product or manufacturer, and inclusion on this list should not be taken as such an endorsement. This list is based on products known to staff of the Health District at the time this document was created, and should not be assumed to be comprehensive. These products vary in their cost, contact time needed, ability to clean and sanitize/disinfect, and shelf life. Each product must be used in accordance with the manufacturer's instructions and state/local regulations, and appropriate training and personal protective equipment must be provided to staff before they are used. If you have questions or concerns about the use of a particular product, please contact the Environmental Health Specialist assigned to your facility.

Method/Chemical	Product and Manufacturer
Bleach (Sodium hypochlorite)	Generic – 1000 ppm
Ethanol	Generic – 75% Ethanol
Heat	> 170°F
Hydrogen peroxide	Accelerated Hydrogen Peroxide™ (Virox Technologies)
Hypochlorous acid	Sterilox (PuriCore)
Phenols	Mikro-Bak® II (Ecolab)
Parachlorometaxylenol (PCMX)	EcoTru® (EnviroSystems)
Potassium peroxomonosulphate	Virkon® (Antec International)
Quaternary Ammonia (hospital grade)	HB or TB Quat Disinfectant Cleaner (3M™) ** Note: regular quaternary ammonia is not effective against norovirus **

Standardized Visitor Illness Report

Demographic Information

Name		
Address		
City	State	Zip
Date of Birth / Age	Gender ☐ Female ☐ Male	
Home Phone	Occupation	

Travel Information

Arrival Date	Departure Date
Travel Method ☐ Plane ☐ Car ☐ Bus	Travel Method ☐ Plane ☐ Car ☐ Bus
If Plane, Airline Name	If Plane, Airline Name
Flight/Bus Number	Flight/Bus Number
Hotel Name	Room Number
Events Attended (with Dates) Conferences, Meetings, Weddings etc.	

Medical History

Did you seek medical care for your illness?	☐ Yes ☐ No
If yes, when and where was care sought?	
Do you have any underlying medical conditions?	☐ Yes ☐ No
If yes, please list	
Did any of your travel companions have a similar illness?	☐ Yes ☐ No
If yes, provide names and phone numbers	

Hotels and Restaurants Visited

List all hotels and restaurants visited in the 72 hours before the illness started

Illness Information

Have you recently had any of the following symptoms?	Yes	No	Don't Know	If yes, when did they begin? Before Arrival	In Las Vegas	After Departing	Date	If yes, how long did they last? <1 Day	1 Day	2 Days	3 or More Days	Ongoing
General												
Fever	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Chills	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Body Ache	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Joint Pain	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Chest Pain	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Back Pain	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Anxiousness	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Gastrointestinal												
Nausea	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Vomiting	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Diarrhea	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Bloody Diarrhea	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Abdominal Cramps	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Abdominal Pain	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Yellow skin or eyes	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Dermatologic												
Rash	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Itchy Rash	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Itchy Skin	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Hives	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Neurologic												
Headache	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Confusion	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Paralysis	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Loss of Consciousness	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Vision Problems	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Weakness	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Numbness	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Dizziness	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Memory Loss	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Respiratory												
Shortness of Breath	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Difficulty Breathing	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Cough	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Sore Throat	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Congestion	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Runny Nose	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Sneezing	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐
Itchy/Watery Eyes	☐	☐	☐	☐	☐	☐	_____	☐	☐	☐	☐	☐

Cryptosporidium Infection—General Public

What is cryptosporidiosis?

Cryptosporidiosis is a diarrheal disease caused by microscopic parasites, *Cryptosporidium*, that can live in the intestine of humans and animals and is passed in the stool of an infected person or animal. Both the disease and the parasite are commonly known as "Crypto." The parasite is protected by an outer shell that allows it to survive outside the body for long periods of time and makes it very resistant to chlorine-based disinfectants. During the past 2 decades, Crypto has become recognized as one of the most common causes of waterborne disease (recreational water and drinking water) in humans in the United States. The parasite is found in every region of the United States and throughout the world.

How is cryptosporidiosis spread?

Cryptosporidium lives in the intestine of infected humans or animals. An infected person or animal sheds Crypto parasites in the stool. Millions of Crypto germs can be released in a bowel movement from an infected human or animal. Shedding of Crypto in the stool begins when the symptoms begin and can last for weeks after the symptoms (e.g., diarrhea) stop. You can become infected after accidentally swallowing the parasite. *Cryptosporidium* may be found in soil, food, water, or surfaces that have been contaminated with the feces from infected humans or animals. Crypto is not spread by contact with blood. Crypto can be spread:

- By putting something in your mouth or accidentally swallowing something that has come into contact with stool of a person or animal infected with Crypto.
  Note: You may not be able to tell by looking whether something has been in contact with stool.
- By swallowing recreational water contaminated with Crypto. Recreational water is water in swimming pools, hot tubs, Jacuzzis, fountains, lakes, rivers, springs, ponds, or streams. Recreational water can be contaminated with sewage or feces from humans or animals.
- By swallowing water or beverages contaminated with stool from infected humans or animals.
- By eating uncooked food contaminated with Crypto. Thoroughly wash with uncontaminated water all vegetables and fruits you plan to eat raw. See below for information on making water safe.
- By touching your mouth with contaminated hands. Hands can become contaminated through a variety of activities, such as touching surfaces (e.g., toys, bathroom fixtures, changing tables, diaper pails) that have been contaminated by stool from an infected person, changing diapers, caring for an infected person, changing diapers, caring for an infected person, and handling an infected cow or calf.
- By exposure to human feces through sexual contact.

What are the symptoms of cryptosporidiosis?

The most common symptom of cryptosporidiosis is watery diarrhea. Other symptoms include:

- Stomach cramps or pain
- Dehydration
- Nausea
- Vomiting
- Fever
- Weight loss

Some people with Crypto will have no symptoms at all. While the small intestine is the site most commonly affected, Crypto infections could possibly affect other areas of the digestive tract or the

respiratory tract.

How long after infection do symptoms appear?

Symptoms of cryptosporidiosis generally begin 2 to 10 days (average 7 days) after becoming infected with the parasite.

How long will symptoms last?

In persons with healthy immune systems, symptoms usually last about 1 to 2 weeks. The symptoms may go in cycles in which you may seem to get better for a few days, then feel worse again before the illness ends.

Who is most at risk for cryptosporidiosis?

People who are most likely to become infected with *Cryptosporidium* include:

- Children who attend day care centers, including diaper-aged children
- Child care workers
- Parents of infected children
- People who take care of other people with cryptosporidiosis
- International travelers
- Backpackers, hikers, and campers who drink unfiltered, untreated water
- People who drink from untreated shallow, unprotected wells.
- People, including swimmers, who swallow water from contaminated sources
- People who handle infected cattle
- People exposed to human feces through sexual contact

Contaminated water may include water that has not been boiled or filtered, as well as contaminated recreational water sources (e.g., swimming pools, lakes, rivers, ponds, and streams). Several community-wide outbreaks of cryptosporidiosis have been linked to drinking municipal water or recreational water contaminated with *Cryptosporidium*.

Who is most at risk for getting seriously ill with cryptosporidiosis?

Although Crypto can infect all people, some groups are more likely to develop more serious illness.

- Young children and pregnant women may be more susceptible to the dehydration resulting from diarrhea and should drink plenty of fluids while ill.
- If you have a severely weakened immune system, you are at risk for more serious disease. Your symptoms may be more severe and could lead to serious or life-threatening illness. Examples of persons with weakened immune systems include those with HIV/AIDS; cancer and transplant patients who are taking certain immunosuppressive drugs; and those with inherited diseases that affect the immune system.

If you have a severely weakened immune system, talk to your health care provider for additional guidance. You can also call CDC-INFO toll-free at 1-800-232-4636. Also see CDC's Fact Sheets for Immunocompromised Persons on Infection at http://www.cdc.gov/crypto/factsheets/infect_ic.html and Prevention at http://www.cdc.gov/crypto/factsheets/prevent_ic.html.

What should I do if I think I may have cryptosporidiosis?

If you suspect that you have cryptosporidiosis, see your health care provider.

How is a cryptosporidiosis diagnosed?

Your health care provider will ask you to submit stool samples to see if you are infected. Because testing for Crypto can be difficult, you may be asked to submit several stool specimens over several days. Tests for Crypto are not routinely done in most laboratories. Therefore, your health care provider should specifically request testing for the parasite.

What is the treatment for cryptosporidiosis?

Nitazoxanide has been FDA-approved for treatment of diarrhea caused by *Cryptosporidium* in people with healthy immune systems and is available by prescription. Consult with your health care provider for more information. Most people who have healthy immune systems will recover without treatment. Diarrhea can be managed by drinking plenty of fluids to prevent dehydration. Young children and pregnant women may be more susceptible to dehydration. Rapid loss of fluids from diarrhea may be especially life threatening to babies. Therefore, parents should talk to their health care provider about fluid replacement therapy options for infants. Anti-diarrheal medicine may help slow down diarrhea, but a health care provider should be consulted before such medicine is taken.

People who are in poor health or who have weakened immune systems are at higher risk for more severe and more prolonged illness. The effectiveness of nitazoxanide in immunosuppressed individuals is unclear. HIV-positive individuals who suspect they have Crypto should contact their health care provider. For persons with AIDS, anti-retroviral therapy that improves immune status will also decrease or eliminate symptoms of Crypto. However, even if symptoms disappear, cryptosporidiosis is often not curable and the symptoms may return if the immune status worsens.

I have been diagnosed with *Cryptosporidium*, should I worry about spreading the infection to others?

Yes, *Cryptosporidium* can be very contagious. Infected individuals should follow these guidelines to avoid spreading the disease to others:

1. Wash your hands frequently with soap and water, especially after using the toilet, after changing diapers, and before eating or preparing food.
2. Do not swim in recreational water (pools, hot tubs, lakes, rivers, oceans, etc.) if you have cryptosporidiosis and for at least 2 weeks after the diarrhea stops. You can pass Crypto in your stool and contaminate water for several weeks after your symptoms have ended. You do not even need to have a fecal accident in the water. Immersion in the water may be enough for contamination to occur. Water contaminated in this manner has resulted in outbreaks of cryptosporidiosis among recreational water users. **Note:** You may not be protected in a chlorinated recreational water venue (e.g., swimming pool, water park, splash pad, spray park) because *Cryptosporidium* is chlorine-resistant and can live for days in chlorine-treated water.
3. Avoid sexual practices that might result in oral exposure to stool (e.g., oral-anal contact).
4. Avoid close contact with anyone who has a weakened immune system.
5. Children with diarrhea should be excluded from child care settings until the diarrhea has stopped.

This fact sheet is for information only and is not meant to be used for self-diagnosis or as a substitute for consultation with a health care provider. If you have any questions about the disease described above or think that you may have a parasitic infection, consult a health care provider.

From http://www.cdc.gov/crypto/factsheets/infect.html

Hyperchlorination to kill *Cryptosporidium*[*]

Cryptosporidium **(or "Crypto") is a chlorine resistant parasite, so even well-maintained pools, water parks, and interactive fountains can spread Crypto among swimmers. If an outbreak of Crypto infections occurs in your community, the health department might ask you to hyperchlorinate. Additionally, to help keep Crypto levels in the water low, you might choose to hyperchlorinate regularly (for example, weekly). If necessary, consult an aquatics professional to determine and identify the feasibility, practical methods, and safety considerations before attempting to hyperchlorinate.**

Step 1: Close the pool to swimmers. If you have multiple pools that use the same filtration system — all pools will have to be closed to swimmers and hyperchlorinated. Do not allow anyone to enter the pool(s) until hyperchlorination is completed.

Step 2: Raise the free chlorine concentration (see Table) and maintain pH 7.5 or less and the temperature at 77°F (25°C) or higher.

Step 3: Achieve a contact time (CT) inactivation value of 15,300 to kill Crypto. The CT inactivation value refers to the concentration of free chlorine in parts per million (ppm) multiplied by time in minutes at a specific pH and temperature.

Use the formula below to calculate contact time (CT)				
Parts per million (ppm) free chlorine	**x**	**Minutes**	**=**	**CT**
20[†]	**x**	**765**	**=**	**15,300**[¶,§]
10	**x**	**1,530**	**=**	**15,300**

Step 4: Confirm that the filtration system is operating while the water reaches and is maintained at the proper chlorine level for disinfection.

Step 5: Backwash the filter thoroughly after reaching the CT inactivation value. Be sure the effluent is discharged directly to waste and in accordance with state or local regulations. Do not return the backwash through the filter. Where appropriate, replace the filter media.

Step 6:** Allow swimmers back into the water only after the required CT inactivation value has been achieved and the free chlorine and pH levels have been returned to the normal operating range allowed by the state or local regulatory authority.

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* Check for existing guidelines from your local or state regulatory agency before use. CDC recommendations do not replace existing state or local regulations or guidelines.

† Many conventional test kits cannot measure free chlorine levels this high. Use chlorine test strips that can measure free chlorine in a range that includes 20–40 ppm or mg/L (such as those used in the food industry) or make dilutions for use in a standard DPD test kit using chlorine-free water.

¶ Shields JM, Hill VR, Arrowood MJ, Beach MJ. Inactivation of *Cryptosporidium parvum* under chlorinated recreational water conditions. J Water Health 2008;6(3):513–20.

§Crypto CT inactivation values are based on killing 99.9% of Crypto. This level of Crypto inactivation cannot be reached in the presence of 50 ppm chlorine stabilizer, even after 24 hours at 40 ppm free chlorine, pH 6.5, and a temperature of 77°F (25°C). Extrapolation of these data suggest it would take approximately 30 hours to kill 99.9% of Crypto in the presence of 50 ppm or less cyanuric acid, 40 ppm free chlorine, pH 6.5, and a temperature of 77°F (25°C) or higher. Shields JM, Arrowood MJ, Hill VR, Beach MJ. The effect of cyanuric acid on the chlorine inactivation of *Cryptosporidium parvum*. J Water Health 2008; in press.

** CDC does not recommend testing the water for Crypto after hyperchlorination is completed. Although hyperchlorination destroys Crypto's infectivity, it does not necessarily destroy the structure of the parasite.
