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Guest Commentary

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Recreational water–borne infectious disease is an important problem both in the United States and elsewhere. For 1999 and 2000, the Centers for Disease Control and Prevention (CDC) reported 59 outbreaks of infectious disease associated with recreational water use in the United States, affecting almost 2,100 people and resulting in four deaths (CDC, 2002). A wide variety of microorganisms are responsible for recreational water–borne disease, including *Cryptosporidium*, *Shigella*, *E. coli* O157:H7, and norovirus (CDC, 2000, 2002) (noroviruses are named after the original strain, Norwalk virus, which caused an outbreak in a school in Norwalk, Ohio, in 1968).

The occurrence of outbreaks in ostensibly treated water suggests that current water treatment practices are not effective for pathogen control. Most of the reported outbreaks were associated with disinfection failures under routine conditions rather than nonroutine incidents such as accidental fecal releases (AFRs). The root causes of inadequate disinfection include human error, mechanical or electrical failure, unanticipated increases in bather load, unobserved incidents that introduce microorganisms, and improperly maintained filtration equipment.

Microbiological contamination of pools and spas is widespread. Sandel (1990) surveyed 15 residential spas and 126 pools in the United States. That study found free-halogen residuals of less than 1 milligram per liter (mg/L) in eight of the 15 spas, including in three with nondetectable levels of halogen. The average total plate count in pools was 20.1 colony-forming units per milliliter (CFUs/mL), with a range from 0 to "too numerous to count." Martins and co-authors (1995) surveyed 60 swimming pools and found similar low levels of chlorination (0–2.5 mg/L), high levels of microorganisms (heterotrophic bacteria in 70.4 percent of the samples), and a significant negative correlation between chlorine and total and fecal coliform bacteria, heterotrophic plate count, and fecal streptococci.

It should be a simple matter to maintain an efficacious free-available-chlorine residual of 3 mg/L throughout a pool; however, the data suggest that current treatment protocols are inadequate, as evidenced by the number and severity of outbreaks. What is needed is a new protocol that includes shock treatment to minimize both the opportunity for human error and the consequences of an accident. The term "shock treatment" as applied to recreational waters has a variety of meanings; however, it is often used synonymously with "superchlorination."

We investigated the regulatory perspective on shock treatment by contacting public health officials in 10 states that note shock information in state guidelines or laws. Public health officials from all 10 states stated that protection of public health was one of the most important reasons they would recommend shock treatment of pools or spas; however, three recommended shock treatment only in response to an AFR.

Many environmental health authorities recommend the use of shock treatment in response to AFRs. For example, the Maryland Department of Health and Mental Hygiene (MD-DHMH) (2001) has developed a comprehensive protocol for the use of shock treatment as an intervention following a pool accident that may have released pathogens. This protocol, based on CDC guidelines (CDC, 2001), provides detailed directions for responses to AFRs and other accidents.

Some agencies also recommend shock on a routine basis, including the New South Wales Department of Health (NSWDH) in Australia, CDC (1997), and some states. NSWDH has a "strong recommendation" for superchlorination in public pools and spas (NSWDH 1996, 1999) and advocates weekly or fortnightly superchlorination that maintains 10 mg/L of free-chlorine residual for a minimum of eight hours. CDC's guidelines for spas aboard cruise ships recommend maintenance of disinfection levels at 3 to 10 mg/L for chlorine or 4 to 10 mg/L for bromine and daily shock treatment. Texas and Georgia both recommend shock treatment daily for spas.

In addition to its application for AFRs, shock treatment may be used as a prophylactic for pathogen control. Moreover, a protocol that emphasizes the routine use of prophylactic shock may help in achieving fail-safe disinfection. Definitions that could be used in such a protocol for "shock treatment," "routine shock," and "intervention shock" are provided below:

- Shock treatment is defined as the addition of an immediately available oxidizing disinfectant, routinely or as an intervention. A shock chemical must be effective against a wide variety of pathogens and nuisance microorganisms with a reasonable CT factor. (The CT factor is the product of the residual disinfectant concentration [C] in mg/L and time [T] in minutes that the disinfectant is in contact with the water.) In addition, a shock chemical should be capable of destroying organic contaminants and nitrogen compounds with a reasonable reaction time.
- Routine shock involves raising free-chlorine levels to a minimum of 10 mg/L for one to four hours weekly for pools and daily for spas.

- Intervention shock, for a water quality problem (e.g., accidental fecal release, algae, clarity, eye irritation), involves raising the free-chlorine residual to 20 mg/L for an eight-hour period when bathers are not present.

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