

Public Health and Recreational Water Today: A Legacy of 19th Century Standards

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The measurement of the sanitary conditions of pools and spas is dependent on the precision and reliability of the methods used. The use of inaccurate or inappropriate methods will result in either false positive or false negative results. Inaccurate readings may lull the operator, and the general public, into a false sense of security or, conversely, into a panic. It all comes down to the method employed. The method employed must not only be done correctly – it must be the correct method.

The recreational water industry is inundated with information on the testing and proper maintenance of water conditions. Recent conversations have revealed that water treatment professionals have a greater appreciation of the importance of water balance than why sanitizers are required for safe operations. Competing chemical sanitizer suppliers and device manufacturers do not test their systems with the same methods. Some chemical suppliers only imply, without ever actually stating, that they control bacteria. This sleight of hand relieves these suppliers from even attempting to prove that they protect public health. The matter is further complicated by out of date federal, state, and local regulations that do not address newer concerns such as Legionnaire's disease. The current lack of universally employed test methods makes it impossible for consumers to compare how competing systems stack up in protecting public health. This paper will discuss how the present confusion came about and how we might seek to improve the microbiological safety of recreational water today.

Reasons for Chemical Treatment of Pools and Spas

The treatment of recreational water has become a routine matter for most operators.

The numerous educational programs available have allowed for near universal proper implementation of water balance and sanitation maintenance. Most of these programs impart information on methods of applying water treatments but do not always address the consequences of deviating from accepted practices. This is particularly true for public health.

To establish a fundamental basis to examine public health, begin with the question "Why do we chemically treat recreational water at all?" Treatments can be divided into two broad categories: water balance and sanitation. Water balance treatments include maintenance of proper calcium hardness, alkalinity and pH. Proper water balance is important to prevent scaling on surfaces and corrosion of equipment. Water balance is thus important to preserve the integrity of the pool or spa components and protect the economic investment in the physical assets. Sanitation systems and treatments are intended to protect the health of the users from infectious diseases. Water balance and sanitizer treatments may interact in subtle ways. The role of pH in maintaining the proper ionization level of chlorine is just one example. Considering the number of infectious disease outbreaks in pools and spas over the past few years, safety is not a trivial issue.

Human pathogens are metabolically adapted to thrive under the same physiological conditions as the human body. It is not possible to shift the water balance of pools or spas such that humans will be comfortable and pathogens will be impeded. In fact, just the opposite is true. Pathogens are able to endure extended periods of sub-optimal pH and temperature that would be intolerable to bathers. Since it is not

possible to limit pathogen survival by physical means, chemical means must be utilized.

When dealing with safety in pools and spas, only a few diseases are of concern. Two of the most frightening diseases in history, HIV (AIDS) and the plague, and one of the most common serious infections, *Salmonella* poisoning, are not spread through recreational water. *Salmonella* food poisoning requires swallowing up to a million bacteria to result in symptoms. If a *Salmonella* infected person had a fecal accident in a pool, only the water immediately surrounding the feces would have a high enough concentration of bacteria to spread the infection. The circulation of water would quickly disperse the fecal contamination and reduce the concentration of *Salmonella* bacteria to a point where infection would not occur. The same holds true for HIV. Body fluids containing the virus are quickly diluted below the infective dose level. The plague bacterium is spread by bites of infected fleas or droplets coughed up by infected humans, not by water. As a general rule, if an organism does not naturally thrive in an aquatic environment, it won't be a major health threat in pools and spas.

A second group of diseases includes those that can occur in pools but are rare or poorly understood. These are referred to as "emerging diseases." Emerging diseases are either altogether new or are ones that we have only recently learned to reliably measure. Examples of this group are the parasites *Cryptosporidium* and *Giardia*, and rotavirus (Levy et al. 1998). Since these are new diseases, accurate information on prevalence and severity is lacking. Because of this, it is difficult to determine just how serious is the health threat posed by this group. Complicating matters further is the hardiness of these organisms. The effectiveness of current treatment systems for the control of these diseases has not been fully proven. Until further research is completed it will do little good to fixate on the health threat posed by this group. With incomplete information it is not possible to evaluate how well microbiological methods and treatment systems work in protecting public health from these diseases.

The best understood health threats in pools and spas are four species of bacteria: *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Legionella pneumophila*, and *E. coli* O157:H7. The first two cause skin infections. *Legionella pneumophila* causes Legionnaire's disease, which is a severe form of bacterial pneumonia that may be fatal if not quickly treated. *E. coli* O157:H7 is a recently emerged strain spread through food and water. Infection by the O157:H7 strain results in kidney failure in children under four years old. In children this young kidney failure may be fatal (Murray et al., eds. 1995). These diseases can serve as yardsticks to measure the effectiveness of current sanitation treatments.

Regulations, Standards, and Guidelines for Public Health

The maze of regulations, standards, and guidelines is a confusing bundle of contradictory technical jargon to pool and spa owners, operators, vendors, sales people and even most professional scientists. Not all of the published documents on how to operate a pool or spa are pertinent. Confusion in determining when to follow which documents directly impacts operations and public safety. Regulations are issued by a government agency be it federal, state, or local. Regulations are legal requirements. Failure to comply with regulations may lead to closure of the facility. Standards may be issued by either government or non-government agencies. Standards issued by responsible trade organizations, such as the National Spa and Pool Institute, may become the body of regulations issued by government agencies. Until that adoption, standards by themselves are not legally binding. Guidelines are also issued by government and non-government agencies. Likewise they are not legally binding until codified as law by a regulatory agency.

The overall agency charged with ensuring public safety in recreational water is the U.S. Environmental Protection Agency. Congress has delegated national administrative control of pesticides to the EPA under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). From a legalese definition, bacteria and algae in pools are pests. All chemical systems sold for the express purpose of controlling pathogenic bacteria or algae in pools and spas must be registered by the EPA as pesticides under the guidelines specified in FIFRA and the Code of Federal Regulations. These regulations specify the degree of control that must be achieved and the type of toxicology data that must be established prior to the granting of a registration by the EPA. State and local agencies may also regulate pesticides. Where they occur, state and local regulations may be more, but not less, stringent than EPA regulations.

The history of the development of existing federal regulations dates to work begun in the 1940's and 1950's. Increased ability to propagate pathogenic organisms coupled with concern for public safety fueled extensive research on the spread of disease in water, particularly drinking water. The lack of accepted and standardized methods hampered researchers in comparing data on the effectiveness of treatment systems. In 1964 two researchers working for the Office of Pesticide Regulation Division of the USDA, the precursor of the present EPA, proposed a standardized laboratory method to test sanitizers for pools (Ortenzio and Stuart 1964). In the same year the American Public Health Association offered suggested regulations for verifying that sanitizers worked

under use conditions (APHA 1964). Those two documents have become the basis of DIS/TSS-12 (USEPA 1979). DIS/TSS-12 is used by the EPA to prove that sanitizers are effective. The same lab test is specified today, 35 years later. The same field test is specified today, 35 years later. Field performance data cover only the total number of bacteria, coliforms, and fecal streptococci. Both of the latter two are indicators that feces may have been introduced into the water. Devices were not on the market in 1964 so they are presently exempted from any federal oversight. Since 1964 an extensive data base on the numbers and types of health threats in recreational water has been developed. These are summarized and reported on periodically by the Centers for Disease Control and Prevention. Disease outbreak reports, bulletins on specific health threats, and overall summaries are available on-line (www.cdc.gov). The minimum performance for EPA registered sanitizers has not been updated to correspond to the data base on disease. The same advances in product safety that the public has demanded in their automobiles (advanced seat belts, improved airbags, child restraints, energy absorbing crumple zones) has not occurred in the recreational water industry.

The National Spa and Pool Institute (NSPI) and NSF International both publish recreational water operating standards. NSF International, formerly the National Sanitation Foundation, is an independent industry supported organization involved in the testing and certification of equipment. NSF International concentrates on equipment that has impact on public health. This includes food handling and storage equipment, drinking water, and equipment for use in pools and spas. NSF Standard 50 establishes voluntary specifications for equipment used in swimming pools and spas. Appendix H is the only published test method for the evaluation of sanitizer dispensing equipment (NSF 1996). This test method is intended to provide a reliable method for verifying that the dispensing device operates in a reliable and consistent manner. It is not intended to prove that the dis-

persing device maintains the spa in a hygienic state. It utilizes two species of bacteria as test subjects. This is the only published test method that specifies the use of *Pseudomonas aeruginosa*, the most common cause of rashes in spas. The National Spa and Pool Institute in collaboration with American National Standards Institute publishes standards covering the entire recreational water industry. A current list of these standards is shown in Table 1 below. Additional standards are in the review process.

In all currently published NSPI standards, chemicals and acceptable biological limits are specified in Appendix A. Appendix A is not part of the standard and is not subject to ANSI review. Appendix A suggested operating guidelines for sanitizer chemicals are not in agreement with EPA registrations. Furthermore, they are not all inclusive in that they fail to include at least two chemical sanitizers that have been registered by the EPA after having been proven safe, effective and reliable under federal statutes recognized by all 50 states. Under biological limits in Appendix A the reader is referred to local codes, which may or may not be the same as the federal codes specified by the EPA. Both organizations regularly solicit industry input and update these standards. In spite of that periodic review, these standards lag behind technological developments and the increasing information on health threats.

Guidelines are suggested operating procedures that are not legally binding. In recent years the CDC has issued two guidelines of particular merit to spa operators. As the popularity of spas increased in the early 1980's the CDC sponsored numerous studies on the transmission of disease in spas. The 1985 "Suggested Health and Safety Guidelines for Public Spas and Hot Tubs" came out of that effort (CDC 1985). After a 1994 outbreak of Legionnaire's disease on a cruise ship that killed one and sickened 50 passengers, four of whom required mechanical life support, the CDC issued its "Recommendations to Minimize Transmission of Legionnaires' Disease from Whirlpool Spas on Cruise Ships" (NCEH and NCID 1997).

Standard number	Topic
ANSI/NSPI - 1	Public pools
ANSI/NSPI - 2	Public spas
ANSI/NSPI - 3	Residential spas
ANSI/NSPI - 4	Above ground / on ground pools
ANSI/NSPI - 5	Residential in ground pools
ANSI/NSPI - 6	Residential portable spas
ANSI/NSPI - 8	Barrier code

Table 1 - National Spa and Pool Institute Standards

Both documents emphasized the absolute need for adequate sanitizer treatments and proper physical maintenance at all times. The latter document concluded that previous CDC and current NSPI guidelines require only minor adjustment to enhance public health. The chlorine levels recommended by both documents are higher than those allowed by label directions approved by the EPA. The increase in sanitizer level is presumably intended to provide additional buffering for times of greater chlorine demand. What levels of chlorine should the vigilant operator follow: the legal EPA concentration or the higher level recommended by the non-binding CDC guidelines? To complicate matters further, the 1994 document also concluded that inadequate data is available to compare the effectiveness of the assorted treatment systems in a side by side evaluation. If the CDC, one of the most prestigious health organizations in the world, has difficulty reconciling public safety with current operating systems, EPA labels, and inadequate information about diseases, how is the conscientious pool operator supposed to stop disease outbreaks?

The development of new treatment systems and the better recognition of known and emerging organisms has resulted in a mismatch between disease and regulations. The addition of new standards and guidelines has not addressed these diseases (see Table 2). The treatment systems developed by the recreational water industry have grown faster than the regulations and the supplemental documents.

Questions the Professional and Consumer Should Ask

What are the practical implications of the mismatch of disease and regulations? An assessment of public safety can be made using the known bacterial diseases. The most suitable test method recognized today is that specified by the EPA in DIS/TSS-12 for the evaluation of chemical sanitizers. The types of questions posed by DIS/TSS-12 can be used to evaluate both chemicals and devices. An initial evaluation

of public safety should start with the following questions:

- *How was the chemical/device tested?* How was accuracy and scientific integrity of the study verified? Are the performance claims valid? The EPA requires audits before granting registration. The NSF International will conduct studies on devices and certify that they are in compliance with appropriate standards. Internal company studies may not have been audited for accuracy. When comparing how well two systems work in preventing disease outbreaks, both should be tested using the same method and with non-biased data. Other comparisons are not valid and public health safety cannot be assumed. All suppliers should be able to prove their systems protect public health in studies at least as thorough and reliable as that required for EPA registration. If the evidence that the chemical or device actually works is questionable, would you be willing to let your children swim in the pool or spa?
- *What regulations, standards and guidelines were used in the testing process?* Has the system been proven to be effective? Chemicals that are expressly sold for the control of bacteria in pools and spas must have an EPA registration number. They are required to demonstrate reliable control of *E. coli* and fecal streptococci bacteria under real life conditions. If a chemical can control these two bacteria it should also be able to control *Pseudomonas aeruginosa* and *Legionella pneumophila*. Some companies sell chemicals and imply they control bacteria but do not actually make a legal claim for control. These chemicals are skirting the law. Some of these compounds are being sold as sanitizers when they do not work. If the company is implying that the chemical provides a sanitizing effect, the supplier should be able to prove that it works. Before the EPA will register a sanitizer, the toxicology of the chemical is thoroughly studied. If a chemical is

	EPA regulations	ANSI/NSPI standards	NSF standards	CDC guidelines
<i>Pseudomonas aeruginosa</i>	not covered	not covered	covered	not covered
<i>Staphylococcus aureus</i>	not covered	not covered	not covered	not covered
<i>Legionella pneumophila</i>	not covered	not covered	not covered	indirectly covered
<i>E. coli</i>	covered	not covered	not covered	not covered
Parasites	not covered	not covered	not covered	not covered
Viruses	not covered	not covered	not covered	not covered

Table 2 – The maze of regulations, standards and guidelines and how they address disease threats in recreational water.

being sold for the control of bacteria without an EPA registration, where is proof that it is not toxic to swimmers? Devices are presently exempt from FIFRA oversight, but can be tested for effectiveness under the field test phase of DIS/TSS-12. Devices can also be examined for chemical safety using the same type of toxicology reviews as sanitizers. Chemicals that have been registered by the EPA as sanitizers have been proven to provide good bacterial control, when used according to label directions. If a chemical or device does not have an EPA registration number on the label, the buyer or the operator should beware.

• *What happens when the chemical/device fails?* If the chemical or device is not essential for the maintenance of hygiene, failure may have no impact on user health. On a hot day when the pool is at maximum loading and a pump drops off line for 15 minutes it maybe worrisome but not critical. In the same 15 minute period if the sanitizer drops below the minimal effective level, the pool is poised for an outbreak should a fecal release occur. On every container of sanitizer sold in the US there is a warning that it is a violation of federal law to use the product in any manner other than that stated on its label. The law applies to every application of sanitizers, not just when the sanitizer is used in public facilities as some individuals have tried to claim. Yet, some devices are being marketing that specify a lower concentration of chlorine or bromine than is listed on the EPA approved label. Devices are exempt from EPA regulation under FIFRA but the instructions for the device cannot supersede the instructions on the chlorine or bromine label. The label concentrations are established as a matter of federal law by the EPA. If one of these devices is being used with chlorine at less than EPA mandated levels and an outbreak occurs, who is at fault?

As we raise the bar of expectations for safety in our everyday lives we need to address not only the bacterial threats but also emerging diseases. How are we going to assure ourselves that the water treatment systems employed in pools and spas meet those increased expectations? What minimum level of health effects do we consider acceptable? Following the existing EPA guidelines for testing sanitizers, and then operating in accordance with the label directions as approved by the EPA, should prevent nearly all bacterial outbreaks. Preventing more deaths caused by uncontrolled bacteria will require better education concerning toddlers, fecal accidents, and the absolute necessity of maintaining sanitizer levels in pools and spas at all times. This would immediately im-

prove user safety and reduce consumer health concerns without the addition of new regulations or expense. With minor changes in federal oversight, all treatment systems that make public health claims could be subject to review under the existing performance standards of DIS/TSS-12. This would mean the devices expressly sold as sanitizers and chemicals that imply control would have to prove that they are both safe and effective. There is no reason that companies selling these systems today could not hire the NSF International to independently prove that their products work. In the longer term, all existing and new sanitizers should be evaluated for their ability to control *Pseudomonas aeruginosa* and *Legionella pneumophila*. Any treatment not capable of providing adequate control should be banned from use. This standard of performance should be incorporated in federal law in an updated DIS/TSS-12. Data on the severity of threats posed by emerging diseases needs to be developed. Much of this information can be gathered by better cooperation with public health agencies and the CDC. After that has been accomplished the recreational water industry needs to re-evaluate how efficient existing physical and chemical systems are at preventing these diseases. It is likely that retrofitting existing facilities and changing chemical operating guidelines will be required. New microbiology test methods may need to be developed to ensure that all sanitizer systems protect the public from these more hardy diseases. The data gathering on actual disease threats, design retrofits to improve physical removal, and the testing of treatment systems to kill the pathogens before they attack the human users must be accomplished in an open arena of scientific exchange.

With approximately eight million pools and spas regularly used by tens of millions of Americans, the number of serious disease outbreaks is very small. The overwhelming majority of the pools and spas use chemical sanitizers that been proven safe and effective by federally mandated testing. Most disease outbreaks have occurred when EPA approved label directions have not been followed. The number of pools and spas on non-EPA regulated sanitation systems is small but constantly increasing. How safe is the public from disease outbreaks in these systems? It is time that microbiological testing requirements be modified so that they address the major and emerging disease threats and that testing becomes mandatory for not only the existing EPA registered products, but also cover devices and chemicals that only imply that they are sanitizers.

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