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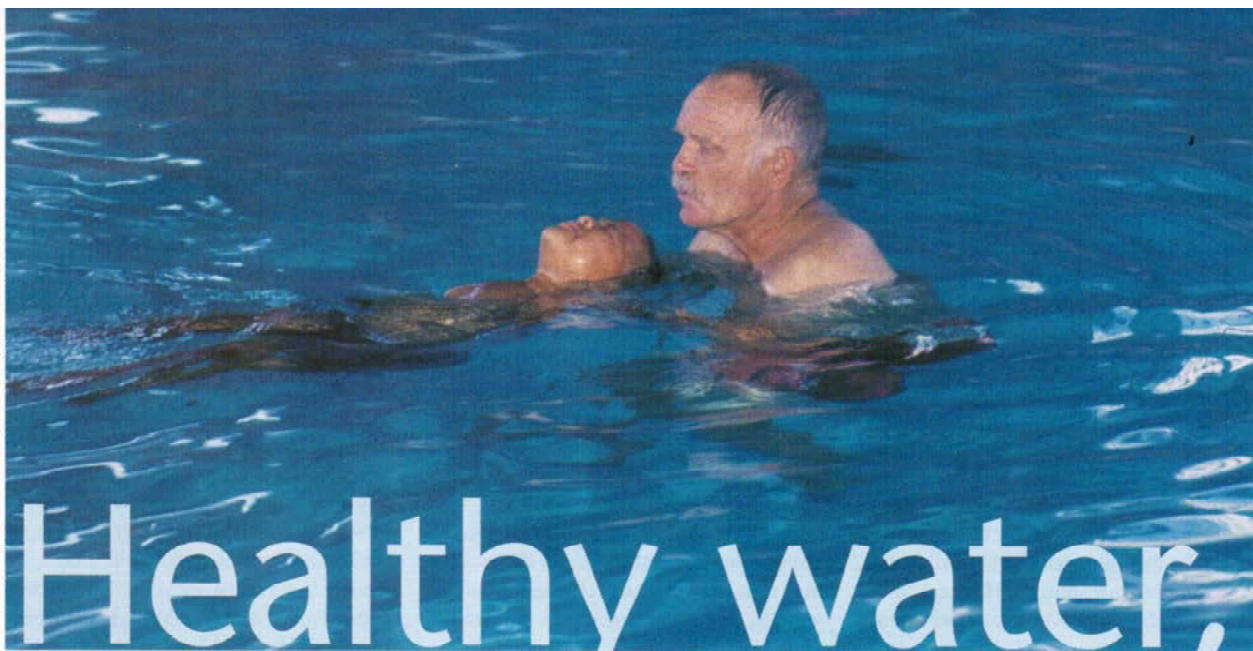
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Healthy water, healthy staff

*In our Sep/Oct issue,
aquatics expert
Dr. Alison Osinski
explained how to
ensure that the
air around indoor
therapy pools
remains healthy.
Here, the author
focuses on the proper
maintenance of
therapeutic
pool water.*

by Alison Osinski, Ph.D.

Pools used for therapy, health maintenance and wellness programs have unique features and equipment designed to aid the health and safety of patients. But when it comes to the long-term health and safety of the therapists, the equipment in the water is not the important factor. It's the water itself.

Because of the sheer number of hours spent in the water and the challenges of maintaining proper sanitization of warm-water therapy pools, aquatic therapists are highly susceptible to water-borne diseases. There are methods, however, that facility directors can use to lower the possibilities of disease transmission through the pool water. Properly sizing and maintaining pool equipment, knowing recommended water quality parameters and ensuring that therapists take special care of their skin, for example, will all work toward maintaining a healthy staff of aquatic therapists.

The rigors of warm water

Make no bones about it — maintaining proper water quality in a therapeutic pool can be a challenge. Elevated water temperatures and the high bather-load-to-water-volume ratio found in most therapy pools

make the chemical and physical qualities of the water more difficult to maintain than in regular swimming pools. Indeed, inadequate sanitation and oxidation of therapy pool water is a major cause of viral and bacterial infections suffered by aquatic therapists.

If any of the following symptoms are common among your therapists, you may have a water-quality problem:

- Chronic respiratory problems, sinus congestion, nosebleeds, asthma, sore throats
- Fatigue, irritability, headaches, inability to concentrate
- Persistent viral and bacterial infections
- Skin rashes, dry skin, other dermatological problems

So how do you solve — and prevent — the kind of poor water quality that can lead to these problems?

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Healthy water

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Oxidation reduction potential

The first factor to consider regarding proper water quality is the pool's sanitizer, whose job is to remove pathogenic organisms and waste products. Organic and chemical loading drastically reduce the effectiveness of your sanitizer to kill bacteria.

A standard method to determine whether your sanitizer is doing its job is to measure the oxidation reduction potential (ORP). Sometimes referred to as redox or high-resolution redox (HRR), ORP measures a sanitizer's ability to oxidize and sanitize pool water and, as such, is a true qualitative measure of water cleanliness.

ORP takes into consideration all water constituents, including pH, total dissolved solids (TDS), cyanurates and organic contaminants. ORP falls when pH, TDS, chloramine or cyanurate levels are high or when hypochlorous or hypobromous acid levels are low.

Pool chemicals should be introduced to the water in quantities necessary to maintain ORP levels at a minimum 750 millivolts in all commercial pools and spas, including therapy pools. The 750-millivolt figure comes from

the widely adopted German DIN Standard 19643, "Treatment and Disinfection of Swimming and Bathing Pool Water."

But maintaining proper sanitizer levels has less to do with the actual quantity of a chemical added to the water than it does with the chemical's *residual* — how much of the sanitizer remains in the water to achieve the necessary chemical reaction. To ensure the correct residuals, all facilities should have an ORP sensor installed as part of a pH/ORP controller. When connected to chemical feed pumps, ORP sensors provide constant monitoring and adjustment of sanitation levels.

Turnover time

Turnover time is the amount of time it takes to circulate, filter, heat and chemically treat a quantity of water equal to the pool's volume. In most states, the minimum turnover time required for code compliance for commercial swimming pools is six hours. It's important that the turnover time is calculated correctly to avoid turbidity and to maintain proper water quality, especially for a therapy pool with its warmer water and high bather-to-water-volume ratio.

According to the results of a study conducted by John Chadwick, the onset

of turbidity is directly related to the number of bathers, not just to turnover time (Chadwick 1996). Although some debris found in the water comes from the air, a far greater amount of debris is introduced to pool water by users. If debris is added to the pool water faster than the filter can remove it, turbidity will increase. This is why user-load ratios are so important.

Your circulation system should be sized to maintain the user-load-to-total-filtered-water ratio (in gallons per day) at 1 bather to 1,400 gallons or less — 1,400 gallons being the "constant" that Chadwick developed in his study. To determine the total amount of water filtered per day, multiply the flow rate in gallons per minute (gpm) by 60 (for gallons per hour) and then multiply that product by 24 (number of hours in a day). To then determine the maximum acceptable bather load at that flow rate without developing turbidity problems, divide your gallons per day by the constant 1,400.

As an example, consider a 24,000-gallon therapy pool with a six-hour turnover. Dividing 24,000 gallons by 360 minutes (six hours) gives you a flow rate of 66.67 gpm. Multiplying 66.67 gpm by 60 and then by 24 comes to 96,005 gallons per day. Dividing that by the constant 1,400 results

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in a maximum of approximately 69 bathers per day (this should include the therapists!).

When the actual bather load is greater than the maximum number of bathers recommended, turbidity and water-quality problems can arise. Either the patient load must be lowered or the circulation system should be redesigned to accommodate the heavier use.

Let's say that 250 patients and therapists actually enter the 24,000-gallon therapy pool used in the previous example. Working the formula backward, we find that the circulation system would need to be resized to allow a 99-minute turnover ($250 \text{ bathers} \times 1,400 = 350,000 \text{ gpd} \div 24 \div 60 = 243 \text{ gpm}$. $24,000 \div 243 = 99 \text{ minutes}$).

Because retrofitting a pool to greatly adjust the turnover time could be rather costly, therapy pool operators should carefully consider the number of patients and therapists that use their pool each day.

Monitor your staff

In addition to closely monitoring your pool's chemicals and equipment, you should closely monitor the health of your staff. Aquatic therapists who spend long hours in the pool are highly susceptible to dermatological problems, often caused

KNOW YOUR PATIENT

No matter how clean and clear your water, aquatic therapy can be harmful for certain individuals. Patients with the following conditions should avoid prolonged exposure to heated water:

- Pregnant women
- Young children
- Patients diagnosed with multiple sclerosis
- Patients suffering from heart disease, diabetes, high blood pressure or circulatory problems, or taking medication to control these problems
- Persons under the influence of drugs or alcohol, or taking prescription or nonprescription drugs that may cause drowsiness, such as tranquilizers or antihistamines

by moisture loss, halogen sensitivity and bacterial infection. Let's look at how these problems can be prevented.

• **Moisture loss.** Moisture loss can cause dry skin; eczema; and red, itchy, chapped or blistering skin. Moisture-loss problems usually get worse during the winter months because the air is drier and people tend to spend more time indoors.

A sure-fire way to prevent moisture loss is to limit the amount of time therapists

spend in the water. Of course, this is easier said than done when considering budget and staff constraints. Far easier is to have your therapists, before getting in the pool, apply a product that helps prevent chafing or a lanolin-based antiseptic to help prevent moisture loss and skin irritation.

When your therapists get out of the pool, have them shower off using a mild soap or a soap designed specifically for swimmers that does not further dry or irritate the skin. Therapists should towel dry after showering by gently patting their skin rather than vigorously rubbing. When dry, they should apply an over-the-counter cream that replaces lipids or one that contains alpha hydroxy or the drug Doxepin.

• **Halogen sensitivity.** Halogen compounds used in pool water treatment include chlorine, bromine and iodine in the form of potassium iodide. Problems can develop as a result of short-term exposure to high halogen levels or long-term exposure to low halogen levels. It is estimated that 5 to 17 percent of regular pool users will develop contact dermatitis and halogen hypersensitivities.

If your therapists are developing halogen sensitivities, you may need to consider alter-

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Healthy water

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nate forms of sanitization such as the use of polymeric biguanide or an ozone generator.

Polymeric biguanide, also known as polyhexametamethylene biguanide or PHMB, is a blue, chlorine-free liquid similar to antimicrobial scrubs used in hospitals. It is the only EPA-approved nonhalogen sanitizer (except in California) and its benefits are that it does not alter the pH of pool water and does not cause corrosion, calcification or bleaching. It is also non-

odorous and doesn't cause eye irritation.

Ozone generators are another method of eliminating or reducing the levels of halogens in a pool. There are two methods of ozone generation: ultraviolet (UV) light/hydrogen peroxide and corona discharge.

In a UV light system, pool water passes through a chamber containing mercury vapor lamps. The lamps radiate sufficient energy to sterilize water in the chamber. Because UV radiation does not oxidize, hydrogen peroxide is used as the oxidizing agent. Hydrogen peroxide, however, dissipates rapidly from pool water, cannot be used in chlorinated pools and

RECOMMENDED THERAPUTIC POOL WATER CHEMISTRY PARAMETERS

Oxidation reduction potential (ORP)	750 - 900 millivolts (mV) (commercial) 650 mV (residential) 865 mV (Cryptosporidium, Giardia and viral inactivation)
Free available chlorine	3.0 - 5.0 ppm or as needed to maintain a 750 mV ORP
Combined available chlorine	< 0.3 ppm
Total available chlorine	No more than 0.2 ppm higher than free available chlorine
Total bromine	4.5 - 6.5 ppm or as needed to maintain a 750 mV ORP
Polymeric biguanide (PHMB)	30 - 50 ppm
Hydrogen peroxide	30 - 100 ppm
Salinity (electrolytic cells)	2,500 - 6,000 ppm (4,000 ppm ideal)
Sulfates	< 200 ppm
pH	7.2 - 7.8
Acid or base demand	Neither
Total alkalinity	80 - 120 ppm
Calcium hardness	200 - 400 ppm
Total dissolved solids (TDS)	< 1,500 ppm above start-up count
Nitrate	< 10 mg/L (Uncontrollable algae growth at 25 mg/L)
Phosphates	0.2 - 0.5 maximum
Clarity	Crystal clear 0.25 Nephelometric Turbidity Units (NTU) 0.2 Jackson Turbidity Units (JTU)
Turnover time	Six hours (Multiple-use and competitive swimming pools) Two to four hours (Therapy pools, swim school pools, warm-water pools or pools with heavy bather-load-to-water-volume ratios) One hour (Wading pools, activity pools, flume splash pools) < 30 minutes (Spas)
Water temperature	104° F (maximum spas) 86° - 94° F (therapy pools) 83° - 86° F (multiple-use pools) 78° - 82° F (competitive pools)
Total coliforms	Membrane filtration technique: < 1 colony per 100 milliliters Multiple tube fermentation method: Zero to fewer than 15 percent of samples in the series Presence/absence test: Absent Standard agar plate count: < 200 bacteria per millimeter
Standard (heterotrophic) plate count	Colony forming units < 200 colonies per milliliter
Pseudomonas aeruginosa	Membrane filter technique: < NTCC (too numerous to count) Presence/absence test: Absent

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dissolves diatomaceous earth (i.e., it can't be used in pools with D.E. filters). On the plus side, hydrogen peroxide usually reduces or eliminates user discomfort, skin irritation, and odor and corrosion problems.

In a corona-discharge system, high concentrations of ozone are produced by a continual supply of high-voltage electricity. The corona-discharge equipment is stored in a special chamber where it reacts with dehumidified air.

• **Bacterial infection.** Many dermatological problems experienced by aquatic staff are caused by bacterial infection. To combat these infections, try performing weekly or monthly microbiological tests to determine whether the bacteriological quality of the therapy pool water is consistently acceptable. The tests can be performed either in-house or by an independent laboratory, depending on local code requirements.

If any of your staff members suffer from frequent or prolonged illness, try testing your water for standard plate count (total coliforms), nitrate levels, staphylococcus bacteria (staph) and *Pseudomonas aeruginosa*. If microbiological analysis reveals positive results for any of these contaminants, have everyone stay out of the water. Eradication may be time consuming and work intensive, but it must be done quickly or the problem will get worse. And don't just stop at working to eradicate the problem; find the cause of the outbreak, or the problem will quickly reappear.

Keeping everyone healthy

You've worked hard to get the best available equipment and therapists for your facility. But to run a successful facility, the water in your pools must be in top condition.

Excessive pool-related illnesses can lead to legal implications, decreased productivity, higher absentee rates, under-used facilities and bad public relations. Encourage your aquatic therapists to be proactive in protecting their own health. They should notify you if they're suffering from any symptoms that appear to be persistent, and seek their advice and opinions regarding the design, maintenance, management and operation of the facility.

After all, you can't help your patients get healthy if you can't keep your staff healthy. ●

Reference

Chadwick, John (1996). "Turnover rates and the health code." *Aquatic Facilities Management*, 1 (1), Fall.

Alison Osinski, Ph.D., is principal of Aquatic Consulting Services, San Diego, Calif.



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letters to the editor

What's the fuss?

Regarding "What's the fuss about TDS?" (In my view, Jan/Feb 1998): When I swim in a pool that tastes salty (urine?) or soapy, I assume that it is not clean and I try not to return. That's what the fuss is about.

James Fitzgerald

Scuba Instructor
State University of New York
Fredonia, NY

Healthy water

Editor's note: We received a number of comments regarding the discussion of ozone generation in Dr. Alison Osinski's article, "Healthy water, healthy staff," published in the Jan/Feb 1998 issue of AI. Due to an editing error, information was presented incorrectly. Dr. Osinski supplied the following information to clear up any confusion readers may have:

Installation of a slip-stream corona-discharge (CD) ozone system can help reduce, but not eliminate, the levels of halogens needed to treat therapy-pool water and lessen halogen-sensitivity problems. Ultraviolet (UV) ozone-generation systems (entirely different from UV-light systems) are less costly, but aren't capable of generating enough ozone to be effective in heavily used therapy pools. Full-stream ozonation would be ideal, but is cost prohibitive for most small therapy pools.

UV ozone systems use mercury vapor UV lamps made of quartz glass to bombard oxygen (O_2) molecules with UV rays, break the oxygen into oxygen atoms (O_1) and recombine as the unstable, very effective oxidizer ozone (O_3). Corona-discharge ozone systems pass dried air past di-electric or high-voltage electrodes that split the oxygen into individual oxygen atoms, which recombine as ozone. Regardless of the method of ozone generation, the air is treated in all ozonated pools, and the result-

ing ozone is injected into the water.

If a pool operator is interested in operating a halogen-free pool, I recommend either poly-hexametamethylene biguanide (PHMB) treatment or a UV-light/hydrogen peroxide system. In a UV-light/hydrogen peroxide system, water, rather than air, is treated. Colorless liquid hydrogen peroxide is used as the oxidizing agent, and a hydrogen peroxide residual is usually maintained in the pool.

Ultraviolet light is used to sanitize the water in the UV-light/hydrogen peroxide system. Water flows through clear, quartz glass or Teflon tubes past low-pressure, 254-nanometer mercury vapor lamps capable of producing a minimum 30,000 microwatt second per square centimeter ultraviolet light dosage. The tubes are housed in a chamber installed downstream of the filters.

UV light kills pathogens by destroying nucleic acid in microorganism cells. Turbid water will absorb UV light and make UV less effective as a disinfectant, so it's important that water be turned over rapidly and filtered adequately. Flocculants or clarifiers should be used to reduce the level of colloidal particles present in the therapy-pool water.

Alison Osinski, Ph.D.

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