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Michele C.
Hlavsa, MPH, RN



CDR Joseph P.
Laco, MSEH,
REHS/RS



Vincent R. Hill,
PhD

Good Pool Chemistry Keeps Swimming Healthy and Safe

Editor's Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature this column on environmental health services from the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In these columns, authors from CDC's Water, Food, and Environmental Health Services Branch, as well as guest authors, will share insights and information about environmental health programs, trends, issues, and resources. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of CDC.

Michele Hlavsa is chief of the Healthy Swimming Program in CDC's National Center for Emerging Zoonotic and Infectious Diseases (NCEZID). CDR Joseph Laco serves as an environmental health officer at CDC's National Center for Environmental Health. Vincent Hill is chief of the Waterborne Disease Prevention Branch in CDC's NCEZID.

Many pool chemicals are used to protect the health and safety of swimmers and aquatics staff. For example, to help prevent outbreaks of infectious diseases, chlorine or bromine is added as a barrier to pathogen transmission. Muriatic (hydrochloric) acid is added to maintain pH at 7.2–7.8, taking into account disinfectant efficacy, swimmers, and equipment. Clarifiers are added to maximize water clarity, which enable lifeguards and others to identify distressed swimmers underwater and help prevent drownings.

Pool Chemical Injuries

While pool chemicals help pool owners and operators maintain healthy and safe water

conditions, chemical handling mistakes can lead to serious injuries. National Electronic Injury Surveillance System (NEISS) data tell us pool chemical injuries annually lead to an estimated 3,000–5,000 U.S. emergency department (ED) visits. Almost half of ED patients are less than 18 years. Poisoning due to inhalation or ingestion and dermatitis/conjunctivitis are the leading injury diagnoses (Centers for Disease Control and Prevention, 2009, 2011; Hlavsa, Robinson, Collier, & Beach, 2014).

As you would expect, the injuries typically occur during the summer swim season (Memorial Day weekend to Labor Day). NEISS injury reports indicate that injuries can be caused by an individual pool chemical or the mixing of

incompatible pool chemicals (e.g., in a bucket). Chlorine and acid are a powerful disinfection combination when each is diluted before they are mixed together; however, mixing concentrated chlorine and acid generates toxic chlorine gas. NEISS injury reports also indicate handling pool chemicals without using personal protective equipment, particularly when opening containers, and not securing pool chemicals away from children can lead to pool chemical injuries. The Agency for Toxic Substances and Disease Registry's Hazardous Substances Emergency Events Surveillance (now called the National Toxic Substance Incidents Program) data indicate human error is the leading factor that contributes to releases of pool chemicals (Anderson, Welles, Drew, & Orr, 2014).

NEISS records are on individual injured patients and the described pool chemical injuries typically lead to one individual visiting the ED, which isn't always the scenario with pool chemical injuries. One toxic chlorine gas event can affect scores of swimmers and aquatics staff (Hlavsa et al, 2018; Wilken et al, 2017). U.S. national outbreak data indicate toxic chlorine gas events can occur if there is no or low water flow in the recirculation system while the chemical feed system simultaneously continues to run. This combination of events allows concentrated chlorine and acid to mix and the generated toxic chlorine gas to build up in the recirculation system. The toxic chlorine gas is released through the inlets and into the pool when normal water flow is restored within the recirculation system.

Preventing Pool Chemical Injuries

Fortunately, pool chemical injuries are preventable through education, engineering,

FIGURE 1

Free Laminated Pool Chemical Safety Poster Available in English and Spanish

POOL CHEMICAL SAFETY: STORAGE
PROTECT YOURSELF AND SWIMMERS FROM THE THOUSANDS OF PREVENTABLE INJURIES THAT OCCUR EACH YEAR

BEFORE YOU STORE POOL CHEMICALS

- Get trained in pool chemical safety (for example, during operator training course)
- Ask for help if you are NOT trained for specific tasks
- Read entire product label or Material Safety Data Sheet (MSDS) before storing
- Learn your pool's Emergency Chemical Spill Response Plan and practice steps (for example, evacuation)

STORING POOL CHEMICALS SAFELY

- Follow product label directions for chemical storage:
 - Dress for safety by wearing appropriate safety equipment (for example, safety goggles, gloves, and mask)
 - Separate incompatible chemicals (for example, acid and chlorine)
 - Lock chemicals up to protect people and animals
 - Keep chemicals dry and do not mix different chemicals (for example, different types of chlorine products)
 - Keep chemicals cool in a well-ventilated area away from direct sunlight
 - Keep chemicals closed in original, labeled container
 - Store liquid chemicals low to prevent accidental contact (for example, by leaking) with chemicals or substances stored below them

DISPOSAL OF POOL CHEMICAL CONTAINERS

- Follow product label directions for safe disposal; never reuse containers
 - Contact local or state hazardous materials agency for proper disposal procedures for pool chemicals in unlabeled containers

Always respond to pool chemical spills immediately. Follow your pool's Emergency Chemical Spill Response Plan, and be sure to contact the proper authorities and management.

Pool Address and Phone Number:
Emergency Response Phone Number:
Local Health Department Phone Number:

For more information about the safe storage of pool chemicals, check your pool safety plan or visit www.cdc.gov/healthyswimming

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POOL CHEMICAL SAFETY: USE
PROTECT YOURSELF AND SWIMMERS FROM THE THOUSANDS OF PREVENTABLE INJURIES THAT OCCUR EACH YEAR

BEFORE YOU USE POOL CHEMICALS

- Get trained in pool chemical safety (for example, during operator training course)
- Ask for help if you are NOT trained for specific tasks
- Read entire product label or Material Safety Data Sheet (MSDS) before using
- Learn your pool's Emergency Chemical Spill Response Plan and practice steps (for example, evacuation)

USING POOL CHEMICALS SAFELY

- Dress for safety by wearing appropriate safety equipment (for example, safety goggles, gloves, and mask)
- Read chemical product label before each use
 - Handle in a well-ventilated area
 - Open one product container at a time and close it before opening another
 - Minimize dust, fumes, and splashes
 - Measure carefully
- Never mix
 - Chlorine products with acid; this could create toxic gases
 - Different pool chemicals (for example, different types of chlorine products) with each other or with any other substance
- Only pre-dissolve pool chemicals when directed by product label
 - If product label directs pre-dissolving, add pool chemical to water; NEVER add water to pool chemical because violent (potentially explosive) reaction can occur

Always respond to pool chemical spills immediately. Follow your pool's Emergency Chemical Spill Response Plan, and be sure to contact the proper authorities and management.

Pool Address and Phone Number:
Emergency Response Phone Number:
Local Health Department Phone Number:

For more information about the safe use of pool chemicals, check your pool safety plan or visit www.cdc.gov/healthyswimming

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and enforcement. To minimize the risk of these injuries, pool chemical safety training (Figure 1) should be included in operator training and provided to any aquatics staff involved in storing or handling pool chemicals. Additionally, preventing unauthorized access to chemical storage spaces, exhausting air from these spaces at rates that help protect occupant health and safety, and providing eyewash stations in these spaces can minimize the risk of pool chemical injuries or at least their severity. To specifically minimize risk of toxic chlorine gas events, the chemical (chlorine and acid) feed should be deac-

tivated if there is no or low water flow in the recirculation system.

These examples of preventive education and engineering measures are recommended in the Model Aquatic Health Code (MAHC, www.cdc.gov/mahc). The MAHC's overarching objective is to prevent illness and injuries associated with public treated recreational water venues (i.e., pools, hot tubs/spas, and water playgrounds), which it does through providing recommendations based on the latest science or best practices. State and local jurisdictions, depending on their individual needs, can voluntarily adopt all or part of the

MAHC. Because the MAHC provides prevention recommendations in its chapters on design and construction, operation and maintenance, and policy and management, recommendations to prevent a specific illness or injury can appear in multiple MAHC chapters.

State and local environmental health colleagues have reported that it can be difficult to find all the relevant MAHC code and supporting annex rationale language. In response, the Centers for Disease Control and Prevention is developing Mini-MAHCs. Mini-MAHCs are concise documents that aggregate MAHC code and annex language

on a specific public health issue. One Mini-MAHC addresses general pool chemical safety (Preventing Pool Chemical Injuries), while another specifically addresses toxic chlorine gas events (Preventing Toxic Chlorine Gas Events, www.cdc.gov/mahc/editions/current.html). All Mini-MAHCs reference content from the 2018 MAHC, 3rd Edition.

Maximizing the positive public health impact of pool chemicals calls for minimizing the risk of pool chemical injuries. State and local environmental health practitioners are on the frontline of prevention through educating pool operators about pool chemical safety, inspecting on pool code elements that minimize the risk of pool chemical injuries, investigating pool chemical injuries to identify their root cause(s), and informing the development of optimized measures to prevent future events. Without state and local environmental health practitioners, we cannot have healthy and safe swimming.

For more information on preventing pool chemical injuries, visit www.cdc.gov/healthy

water/swimming/aquatics-professionals/preventing-pool-chemical-events.html. 🐼

Corresponding Author: Michele Hlavsa, Epidemiologist, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30329-4027.
E-mail: acz3@cdc.gov.

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