DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES

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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.

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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).

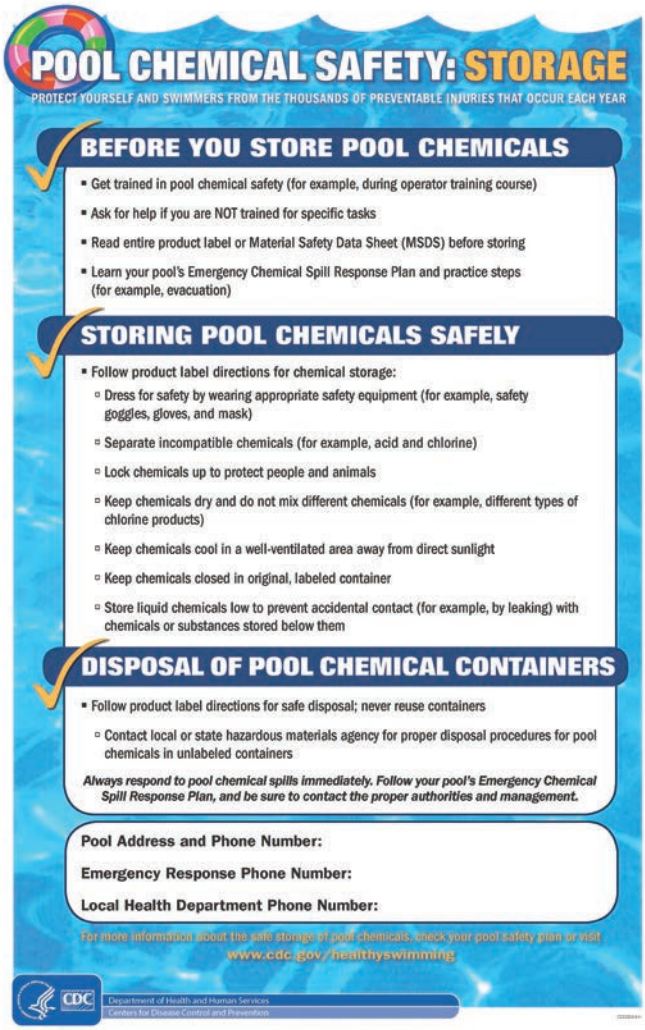
NEISS records are on individual injured patients and the described pool chemical injuries typically lead to one individual visiting the ED, which isn't always the scenario with pool chemical injuries. One toxic chlorine gas event can affect scores of swimmers and aquatics staff (Hlavsa et al, 2018; Wilken 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.

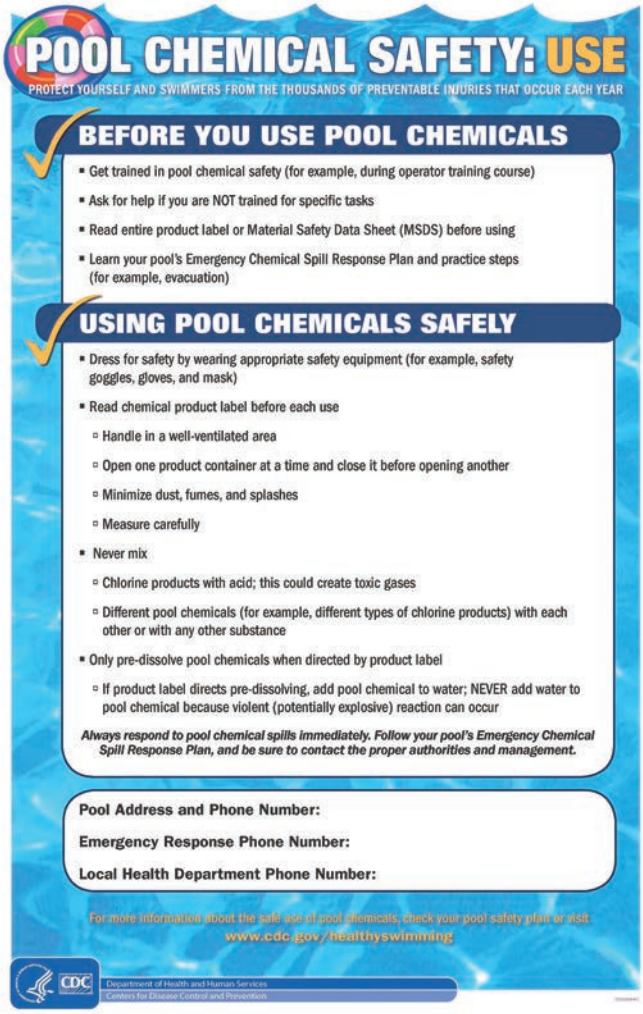
Preventing Pool Chemical Injuries

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

FIGURE **1**

Free Laminated Pool Chemical Safety Poster Available in English and Spanish





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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 deactivated 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/healthywater/swimming/aquatics-professionals/preventing-pool-chemical-events.html.

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