Pool Chemical Injuries—United States, 2008–2017

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World Chlorine Council's
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Outline

- Background
- 2008–2017 U.S. pool chemical injury data
- Prevention recommendations
  - Model Aquatic Health Code (MAHC)

Pool Chemicals

- Chlorine/bromine
  - Add to aquatic venues to disinfect water
  - Most bacteria and viruses killed/inactivated within minutes
    - Can take days to kill *Cryptosporidium*
- Acid
  - Ideal pH range: 7.2–7.8
    - Maintain proper pH to ensure pathogens killed/inactivated and balance with preventing corrosion and swimmer comfort
    - ≥8.0 can decrease disinfection and cause irritation
    - <7.0 can cause corrosion and cause irritation

Chloramines

- Disinfection byproducts formed when free chlorine combines with organic matter (e.g., sweat, urine, feces) that swimmers bring into water
- Can remain in water or evaporate in air

Dataset

- U.S. Consumer Product Safety Commission (CPSC): National Electronic Injury Surveillance System (NEISS)
- Nationally representative sample of ~100 U.S. hospitals
- Data collected on emergency department (ED) visits for injuries involving consumer products
- Variables:
  - Product code (pool chemicals = 938)
  - Patient age, sex, race/ethnicity
  - Injury diagnosis
  - Affected body part
  - Patient disposition
  - Incident location
  - Narrative

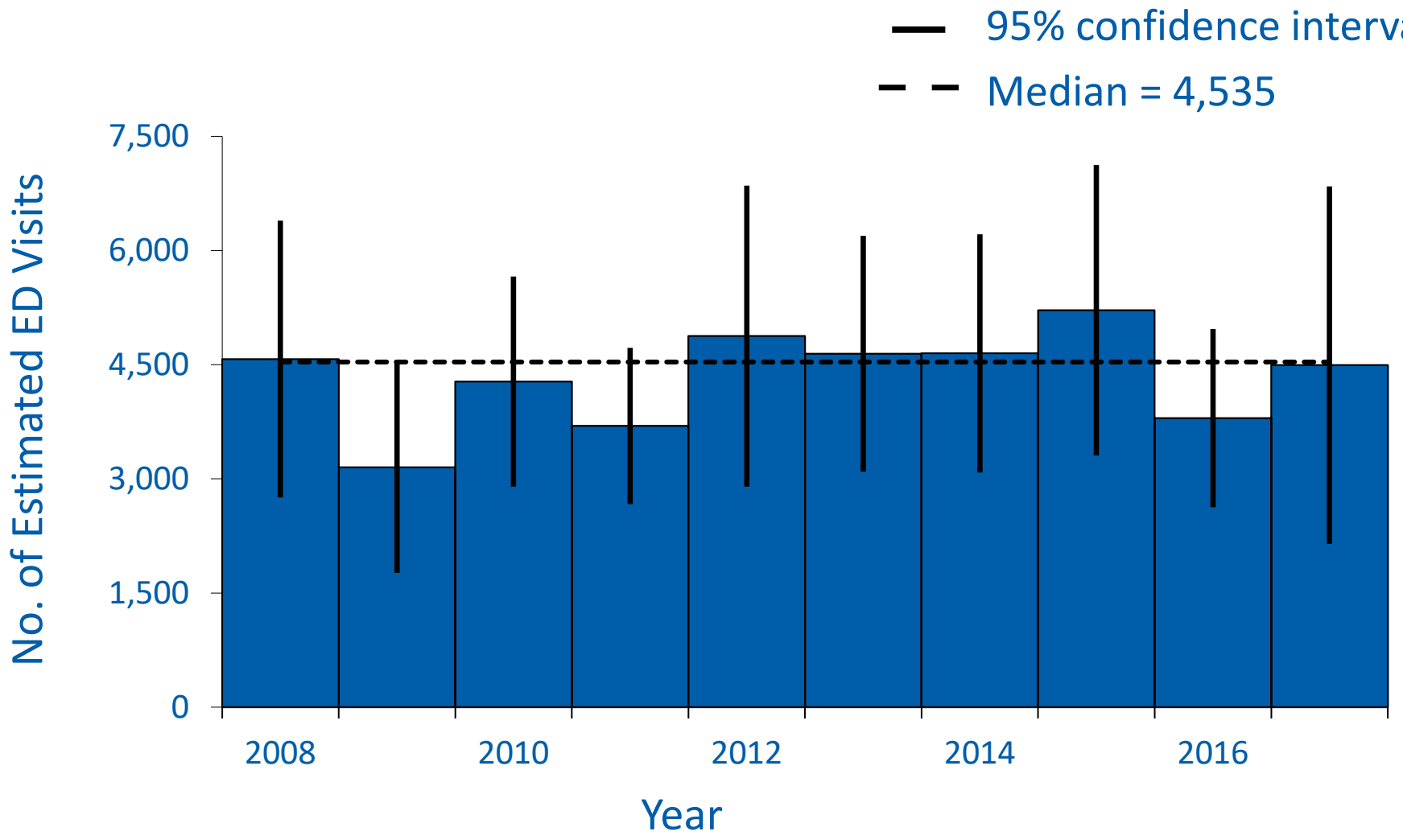
Methods

- Each case weighted based on probability of hospital being selected
- Weights summed to produce national estimates
- 95% confidence intervals calculated according to CPSC's direct variance method
  - Accounts for complex sampling design
- SAS version 9.4 used to analyze data

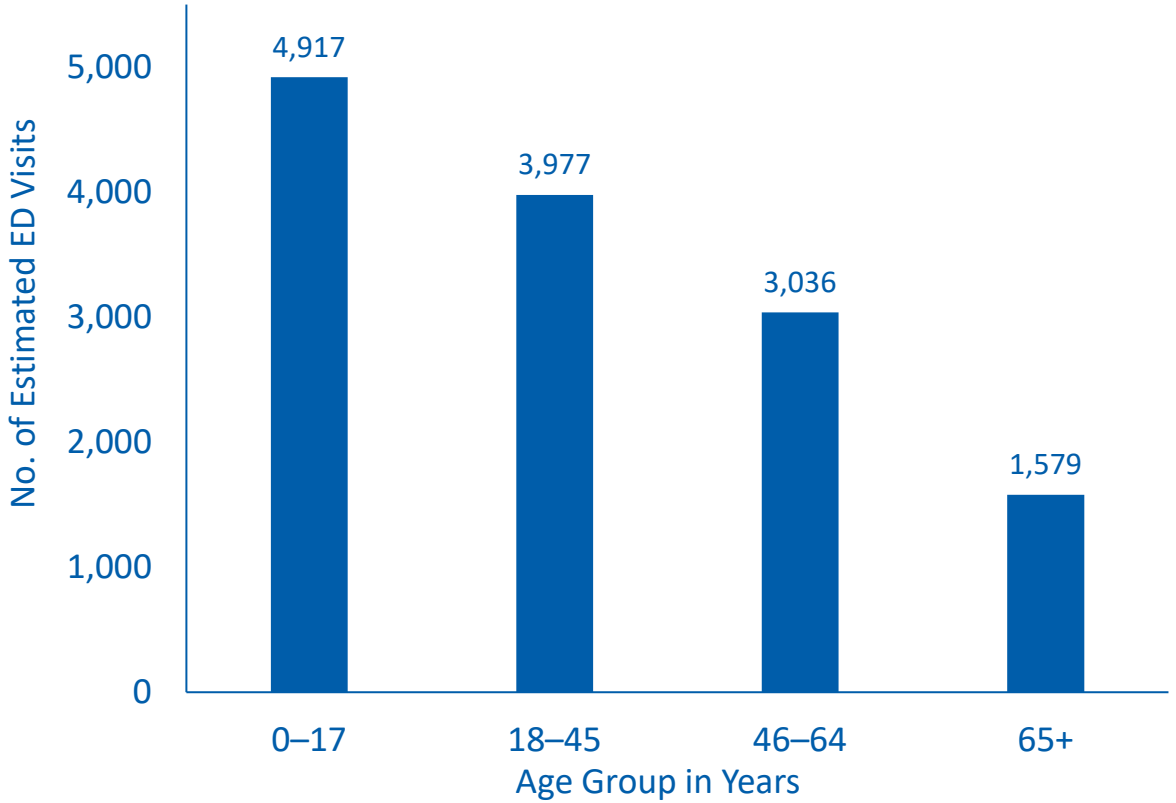
Results

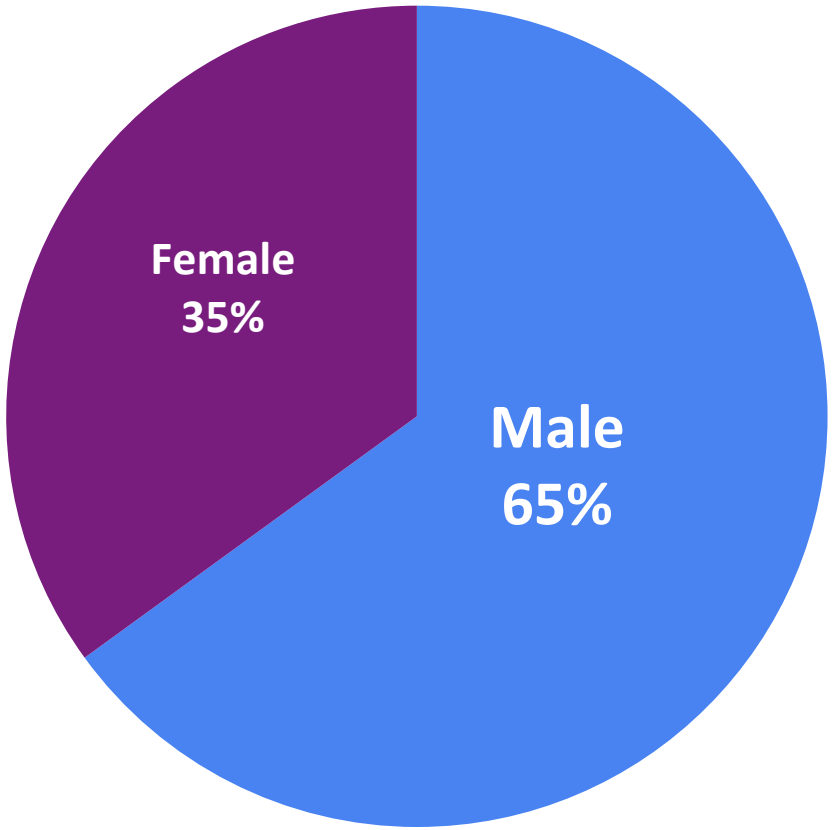
- During 2015–2017, an estimated 13,500 ED visits for pool chemical injuries
- Almost ⅔ of injuries occurred during the summer swim season (Memorial Day weekend through Labor Day)

Estimated Number of Emergency Department (ED) Visits for Pool Chemical Injuries — United States, 2008–2017



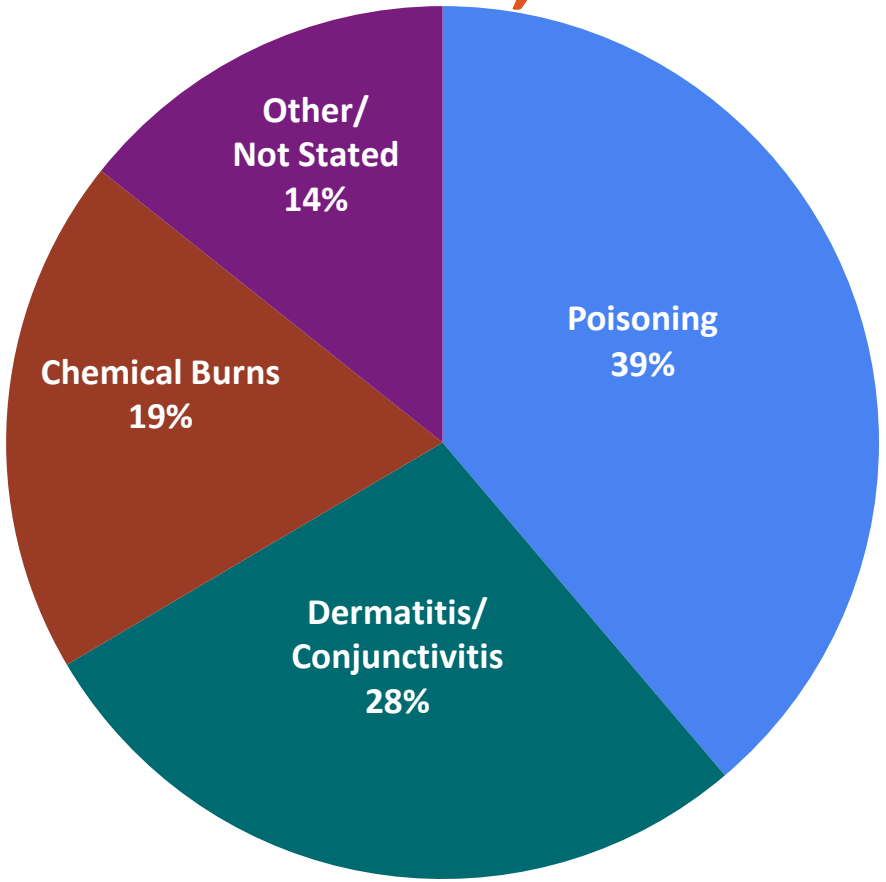
Demographics of Patients Visiting Emergency Department (ED) for Pool Chemical Injuries United States, 2015–2017





* Estimates might not sum to total because of rounding.

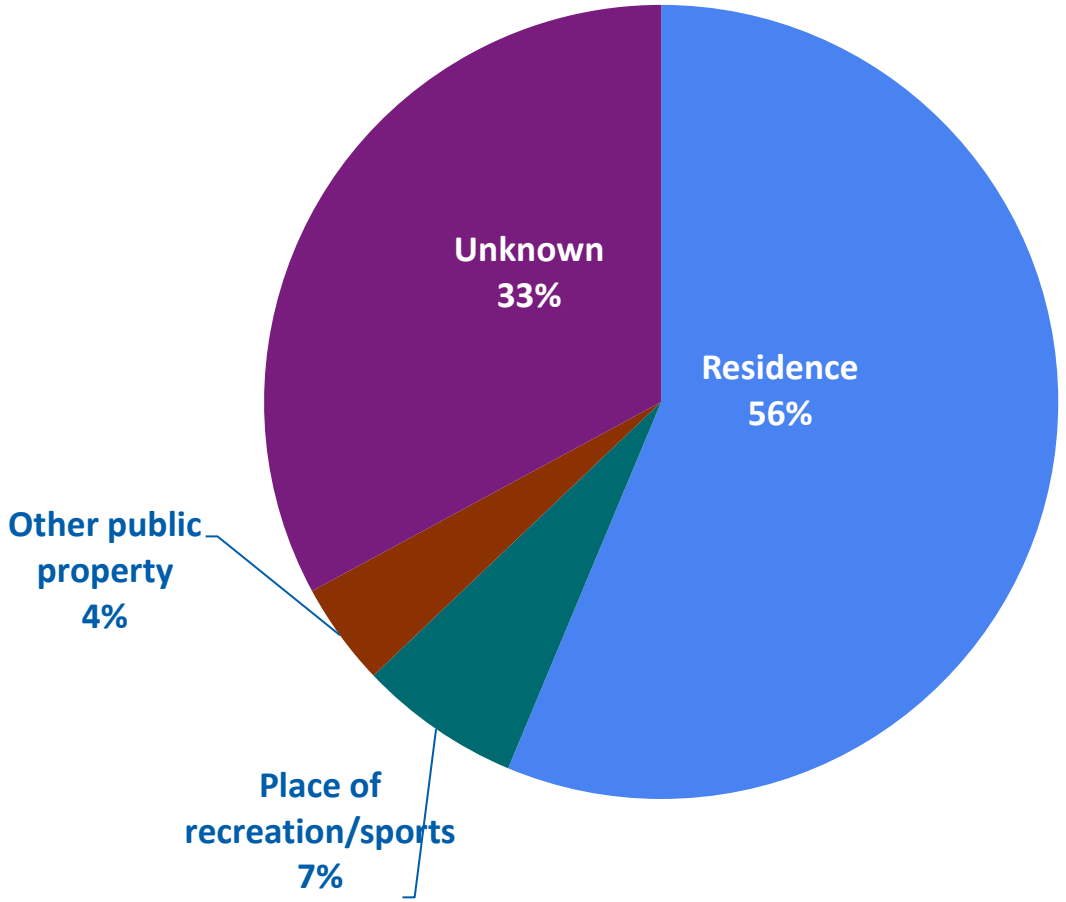
Injury Diagnosis for Patients Visiting Emergency Department for Pool Chemical Injuries United States, 2015–2017



Pool chemical injuries most frequently resulted when

- Opening containers and breathing in vapor, fumes, or gases
- Adding pool chemicals right before swimmers entered the water
- Not keeping pool chemicals out of reach of children and teens

Incident Location of Pool Chemical Injuries Leading to Emergency Department Visits United States, 2015–2017



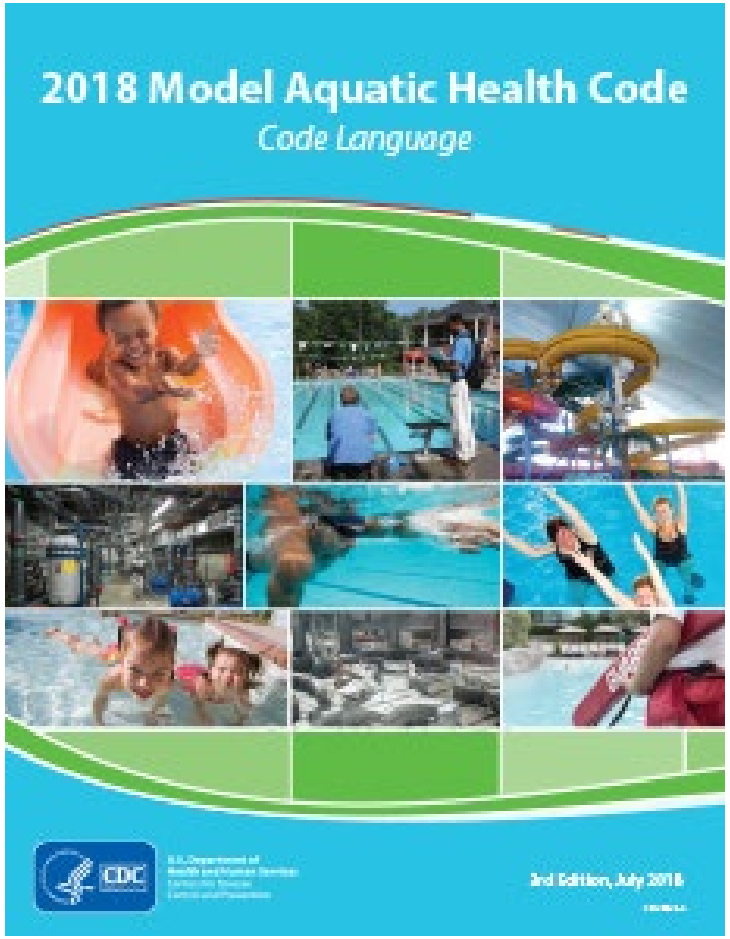
- Individual pool chemical events at public aquatic venues injure more people

Limitations

- Don’t capture pool chemical injuries that don’t lead to ED visit
- Minimal/missing data on pool chemical injuries in NEISS
- Only most severe diagnosis recorded—some injuries might be missed
- Injury-causing chemical could be misidentified (e.g., eye irritation could be caused by chloramines, not chlorine itself)
- Water chemistry changes quickly—hard to determine etiology of injuries

Model Aquatic Health Code (MAHC)

- Recommendations
  - Aim to prevent and illness, injury, disability, and death at public aquatic venues
    - Design, construction, operation, and management
- U.S. jurisdictions can voluntarily adopt the MAHC



CDC Pool Chemical Safety Recommendations

- Design of pool chemical storage area/pump room
- Chemical storage
- Chemical handling
- Maintenance and repair
- Pool chemical training
- Emergency response plan
- Chemical packaging and labeling (for manufacturers)

*For reference purposes, MAHC elements discussed in following slides will be followed by specific section number that covers that element

Design of Pool Chemical Storage Area/Pump Room

Construction

- Include spill containment features to prevent chemical leaks or spills (MAHC 4.9.2.4.3)
- Easily accessible safety showers, eyewash stations (MAHC 4.9.2.1.4)
- Fire suppression equipment (MAHC 4.9.2.7.1.2)
- Adequate lighting (MAHC 4.9.1.2.2, 5.9.1.9)

Air handling: indoor venues

- Separate air handling systems for chemical storage area, pump room, and venue area from rest of building (MAHC 4.9.2.5.1, 4.9.2.5.2, 4.9.2.6.1, 4.9.2.6.2)
- Well ventilated (MAHC 4.9.2.1.1, 4.9.2.5.2.3.1)

Design of Pool Chemical Storage Area/Pump Room

Engineering

- Device automatically deactivates chlorine/pH feed pumps when there is no or low flow in recirculation system (MAHC 4.7.3.2.1.3, 5.7.3.5.1.2)
- Alarm to alert aquatics staff if automatic shutoff triggered (MAHC 4.7.3.2.1.3.2, 5.7.3.5.1.2.1)

Security

- Limit access to chemical storage (MAHC 4.9.2.3.2, 4.9.2.3.3)
- Provide door that automatically closes and locks (MAHC 4.9.2.4.5.2, 4.9.2.4.5.6)

Personal protective equipment (PPE) and safety data sheets (SDS)

- Ensure availability of PPE (MAHC 5.9.1.10, 6.0.1.10) and up to date SDS in multiple locations (MAHC 4.9.2.4.1)

Chemical Storage

Store chemicals in compliance with local building and fire codes (MAHC 5.9.1.1) and manufacturer's SDS and labels (MAHC 5.9.1.3)

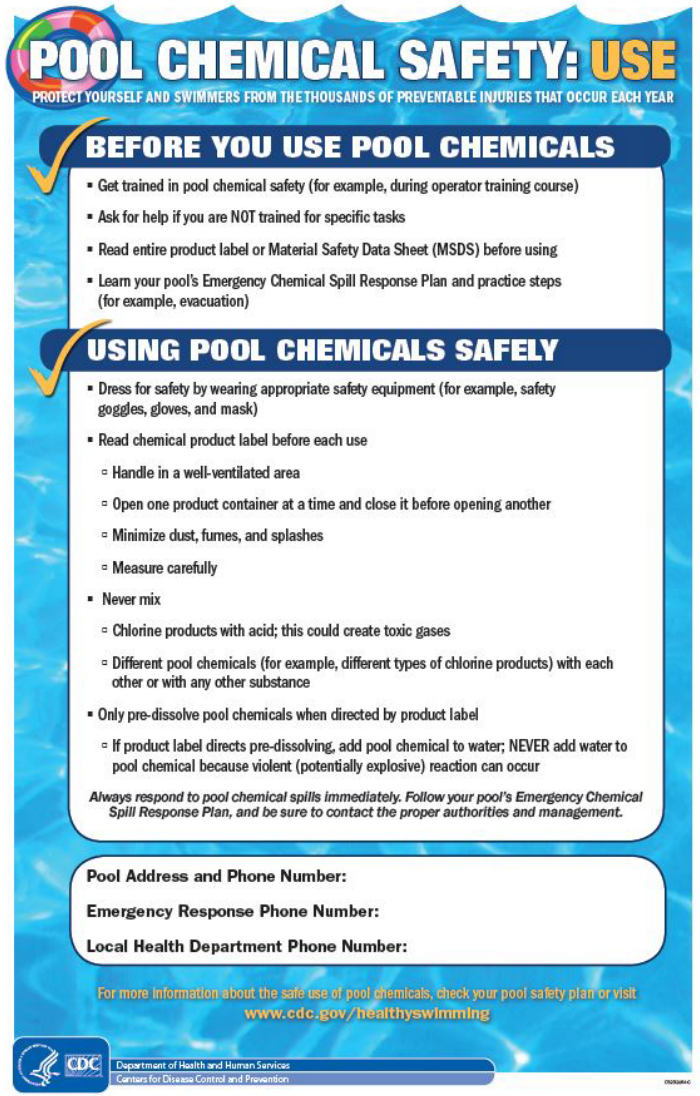
Examples:

- Store pool chemicals below 95°F and in conditions recommended by manufacturer
- Prevent chemicals from getting wet
- Store incompatible chemicals away from each other
- Store chemicals in original labeled containers
- Protect chemicals from heat sources
- Store and consume food away from chemicals

Chemical Handling

Handle chemicals in compliance with OSHA and EPA regulations (MAHC 5.9.1.2)

- Allow only individuals trained in pool chemical safety practices to handle pool chemicals
- Post instructions on pool chemical safety practices in chemical storage room and pump room
- Respond to chemical spills immediately by following emergency response plan



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Maintenance and Repair

- Close venue to swimmers if recirculation system not running or before servicing chlorine/pH control feed or recirculation system (MAHC 5.7.3.5.1.2.1)
- Turn off feed and recirculation system before servicing
- Ensure adequate ventilation and use PPE during maintenance and repair
- Ensure only properly trained people service systems
- Communicate and document maintenance and repairs
- Set up preventive maintenance program (MAHC 5.4.2)

Pool Chemical Training

- Train all staff in pool chemical safety basics, including at least these topics (MAHC 6.0.1):
  - Safe chemical storage and handling procedures (MAHC 6.0.1.1)
  - Personal protective equipment procedures (MAHC 6.0.1.2)
  - Spill procedures (MAHC 6.0.1.3)
  - OSHA requirements (MAHC 6.0.1.4)
  - Chemical and SDS lists (MAHC 6.0.1.5)
- Training plan in place (MAHC 6.0.1.6)

Emergency Response Plan

- Develop an emergency response plan that includes accidental chemical release procedures (MAHC 6.3.4.5.6.1), including:
  - How to determine when HAZMAT response needed
  - Response and cleanup
  - Training staff in these procedures
  - List of equipment and supplies for cleanup
- Availability of supplies for remediation should be verified weekly (MAHC 6.3.4.5.6.2)

Chemical Packaging and Labeling (for Manufacturers)

- Package and label each pool chemical so that they can be easily identified
- Keep packaging and labeling consistent to avoid chemical mixing
  - Notify customers of any changes in packaging or labelling
- Consider identifying chemicals on container lids
- Use labels resistant to corrosion and deterioration

Acknowledgments

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