Methods to Make Chlorine Solution in Ebola Emergencies

Chlorine solution is widely used for disinfection in emergency response activities. In Ebola response, 0.5% chlorine solution is recommended for cleaning non-living things and surfaces and 0.05% chlorine solution is recommended for cleaning living things. The conversion factor between percent and ppm or mg/L of chlorine solutions is: 1.0% = 10,000 ppm = 10,000 mg/L. The recommended chlorine solutions concentrations in Ebola response are thus 5000 ppm (or mg/L) (0.5%) and 500 ppm (or mg/L) (0.05%). Chlorine solutions in these concentrations can be purchased or manufactured on site. The methods for on-site manufacturing include: 1) dilution of HTH or NaDCC powder in water; 2) dilution of concentrated liquid solution in water; and, 3) generating sodium hypochlorite using salt, water, and electricity. Each of these methods is described below. Please note this fact sheet is not intended for large Ebola Treatment Units (which generally have automatic chlorination through piped networks), but for smaller units or others mixing their own chlorine solutions.

Method 1: Purchasing Hypochlorite Solutions Directly

There are suppliers currently manufacturing and selling quality-controlled hypochlorite solutions at the recommended concentrations, at concentrations that can be used for dilution, or at recommended concentrations for using sodium hypochlorite for household water treatment in Ebola-affected countries. At the time of writing, these suppliers are:

Liberia	PSI	Amy Latrielle, Reid Moorsmith (alatrielle@psi.org, reid@psi.org)
Liberia	Operation Blessing	Bill Horan (bhoran9@gmail.com)
Guinea	PSI	Amy Latrielle, Reid Moorsmith (alatrielle@psi.org, reid@psi.org)
Guinea	Tinkisso	UNICEF, Antenna Carole DeBazignan (cdebazignan@antenna.ch)

It is not recommended to purchase commercial bleach off the shelf and use it for emergency response, as testing has shown extensive variation in concentration (see attached file Lantagne-AJPH). If commercial bleach is used, its concentration should be tested to establish the correct dilution factor.

Method 2: Manufacturing Hypochlorite Solutions

No matter the method used to manufacture hypochlorite solutions, it is critical that: 1) clean water (without metals or organic materials) is used in the dilution process; and, 2) all materials – such as tanks, mixers, taps, etc. – used in manufacturing are plastic (no metal can be exposed to the solutions). This is to ensure the solutions do not rapidly degrade.

Method 2.1: Dilution of HTH or NaDCC powder

If HTH or NaDCC is used, the amount to add can be calculated using the following equation:

$$\text{mg HTH/NaDCC} = \frac{\text{Liters}_{\text{water}} \times \text{ desired concentration in } \frac{\text{mg}}{\text{L}}}{\frac{\text{Percent Chlorine of HTH/NaDCC}}{100}}$$

For example, if 65% strength HTH is used and 100 Liter of 0.05% (5,000 mg/L) water is desired, the resulting mg of HTH to add to obtain this amount is: 100 * 5,000/(65/100) = 769,230 mg = 769 grams. A scale will be needed to initially accurately measure the amount to add, which once known can be converted into a volume to add (such as teaspoons or measuring device). While there is much debate and varying evidence as to the relative benefits of HTH and NaDCC, the important thing to remember is both have their drawbacks and benefits, both are effective, and both can be used in Ebola emergencies, provided the pH of the manufactured solution is not >8.

Method 2.2: Dilution of concentrated liquid solution in water

If concentrated liquid is used, the amount to add can be calculated using the following equation:

$$\text{mL Chlorine to add} = \frac{\text{Desired } \frac{\text{mg}}{\text{L}} \times \text{Liters}_{\text{water}}}{\text{\% Chlorine} \times 10{,}000 \frac{\text{mg/L}}{\%} \times \frac{1 \text{ Liter}}{1{,}000 \text{ mL}}}$$

Which can be simplified to:

$$\text{mL Chlorine} = \frac{\text{Desired } \frac{\text{mg}}{\text{L}} \times \text{Liters}_{\text{water}}}{\text{\% Chlorine} \times 10}$$

For examples, if 5.0% sodium hypochlorite solution is used to make 100 Liters of 500 mg/L solution, the resulting amount to add is 500 * 100 / (5*10) = 1,000 mL = 1 Liter of solution. If the quality of the concentrated sodium hypochlorite solution is not known, its concentration should first be tested to ensure the % chlorine number used above is correct. Note if the concentrated solution is pH stabilized, after dilution the pH will move to the pH of the dilution water (generally 6-8) and then the chlorine will be available for disinfection.

Method 2.3: Generation of sodium hypochlorite using salt, water, and electricity

Sodium hypochlorite concentrations up to about 1% (10,000 mg/L) can be manufactured using an electrolytic generator, salt, water, and electricity. When using this method: 1) manufacturer instructions should be followed as to the amount of salt and water and time to use; 2) the solution should be regularly tested to ensure accuracy; 3) the generator probes should be regularly cleaned with acid solution to ensure their lifespan; and, 4) only high quality salt and water should be used as raw materials. Electrolytic generators vary in size and cost between 100-2,000 USD and 1 Liter-200 Liters of manufacturing capacity. High-quality 200 Liter capacity generators can be purchased at a cost of about 2,000 USD from AquaChlor in Florida (Jotoma1@earthlink.net) as well as other manufacturers; it takes about 6-8 hours of time to generate 0.7% (7,000 mg/L) solution using this generator.

Expiry and Stabilization

Sodium chlorine solutions degrade quickly when exposed to heat and UV light. At 1%, a solution will lose half its concentration in 4-6 weeks if not stabilized. The expiry time can be extended by empirically determining the amount of sodium hydroxide (lye) to add to the solution to raise the pH of the solution to greater than 11.9. Simple pH test strips can be used to test the pH of the chlorine solution; ColorpHast brands are recommended because the color does not degrade as quickly in the presence of chlorine. However, chlorine efficacy is highest at lowest pH, so while it is recommended to stabilize concentrated solutions for transport and storage, it is not recommended to stabilize the 500 mg/L and 5,000 mg/L solutions used for cleaning in Ebola emergencies. In Ebola emergencies, it is recommended that chlorine solutions be made fresh (and tested) daily to ensure effective disinfection.

If you have any questions on the information in this fact sheet, or comments for edits, please email Daniele Lantagne at daniele.lantagne@tufts.edu.

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