

# Condensed Guidance on Disinfection Solutions

## Units of Measure

Concentrations of solutions can be expressed either as ppm, mg per litre or %.

$$1 \text{ parts per million (ppm)} = 1 \text{ milligram/liter (mg/L)} = 0.0001\%^1$$

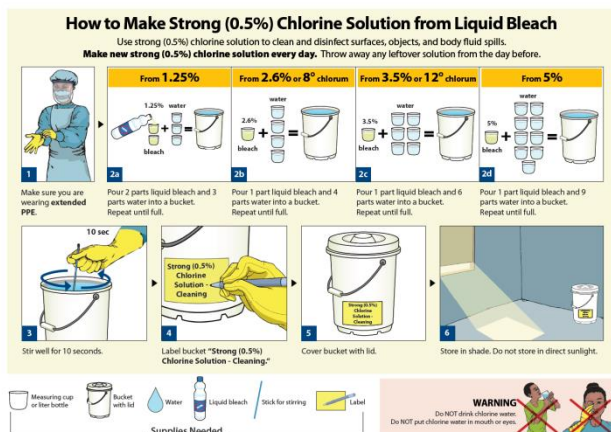
## Chlorine Concentrations

- Potable Drinking Water**  
0.5 mg/L – 2.0 mg/L (measured as “free residual chlorine” AFTER 30 minutes and assuming the turbidity is less than 5 NTUs when disinfection began).
- Hand Disinfectant** (aka “mild” solution) - 0.05%. WARNING- chlorine is a skin irritant and only to be used as a hand disinfectant as last resort!
- Surface Disinfectant** – 0.1 -0.5%. Strength will depend on application (see page 4).

## How to Make Chlorine Solutions from Liquid Bleach

Chlorine in liquid bleach comes in different concentrations. Any concentration can be used to make a dilute chlorine solution by applying the following formula:

$$\left( \frac{\% \text{ chlorine}^2 \text{ in bleach}}{\% \text{ chlorine desired}} \right) - 1 = \text{Total parts}^3 \text{ of water for each part bleach}$$



Source: CDC ([LINK](#))

- Example:** To make a 0.5% chlorine solution from 3.5% bleach:

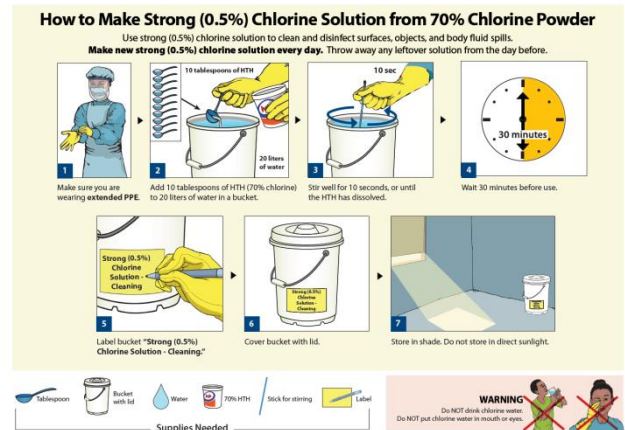
$$\left( \frac{3.5\%}{0.5\%} \right) - 1 = 7 - 1 = 6 \text{ parts water for 1 part bleach}$$

Therefore, you must add 1 part 3.5% bleach to 6 parts water to make a 0.5% chlorine solution.

## How to Make Chlorine Solutions from Chlorine Powders

If using chlorine powder<sup>4</sup>, calculate the amount of chlorine powder to be mixed with each litre of water by using the following formula:

$$\left( \frac{\% \text{ desired}}{\% \text{ chlorine in chlorine powder}} \right) \times 1000 = \text{grams of chlorine powder for each litre of water}$$



Source: CDC ([LINK](#))

- Example:** To make a 0.5% chlorine solution from calcium hypochlorite powder containing 70% active chlorine:

$$\left( \frac{0.5\%}{70\%} \right) \times 1000 = 7.1 \text{ grams of bleach powder for each litre of water}$$

Therefore, you must dissolve 7.1 grams of calcium hypochlorite (bleach) powder in each litre of water used to make a 0.5% chlorine solution.

<sup>1</sup> We are assuming the density of chlorine solution is same as water and pressure is atmospheric.

<sup>2</sup> In countries where French products are available, the amount of active chlorine is usually expressed in degrees chlorum. One degree chlorum is equivalent to 0.3% active chlorine.

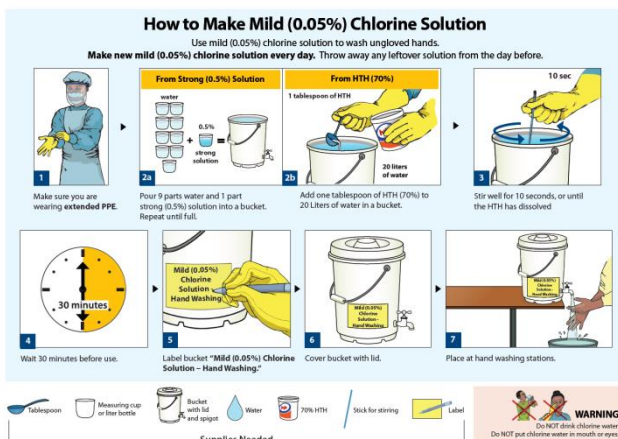
<sup>3</sup> “Parts” can be used for any unit of measure (e.g. ounce, litre or gallon) or any container used for measuring, such as a pitcher

<sup>4</sup> When chlorine powder is used, the resulting chlorine solution is likely to be cloudy (milky)

## Formula for Making a Dilute Solution from a Concentrated Solution

- Once a concentrated solution is made it is possible to make subsequent dilutions using this formula:

$$\left( \frac{\% \text{ chlorine in concentrate solution}}{\% \text{ chlorine desired (dilution)}} \right) - 1 = \begin{matrix} \text{Total parts of} \\ \text{water for each} \\ \text{part} \\ \text{concentrate} \end{matrix}$$



Source: CDC ([LINK](#))

- Example:** To make a 0.05% chlorine solution from 0.5% concentration solution.

$$\left( \frac{0.5\%}{0.05\%} \right) - 1 = 10 - 1 = 9 \text{ parts of water for each part concentrate}$$

Therefore to make a 0.05% solution from a 0.5% solution take 1 part concentrated solution and add to 9 parts boiled (filtered if necessary) water.

## Other Considerations

- Disinfection Effectiveness:** Chlorine and other disinfectants are less effective at deactivating pathogens in the presence of other organic or inorganic compounds. This is why for water treatment turbidity needs to be less than 5 NTUs. It is also why for health care settings it is recommended to clean with detergents and water prior to disinfecting surfaces. It is also why hand disinfection with mild chlorine solution should be used as a last resort as it is not as effective as soap and water.
- Combined Detergent Disinfectants:** Combined (one-step) detergent-disinfectant products can generally be used in place of a two-step (separate detergent and disinfectant product) process when disinfection is indicated for specific environmental cleaning procedures. See CDC guidance or manufacturers labels for further information.

- Safety:** It is important to label all containers (stocks solutions, as well as dilutions) that contain disinfectants regardless of their concentration. Labels should not only identify describe the type of disinfectant and concentration, but also the date the salutation was prepared as many disinfectants volatilize and therefore decrease concentration **in time**. **Safety PPE should always be worn when preparing disinfection solutions in particular eye protection.**

## Cleaning and Disinfection Frequency

- Regular cleaning and disinfection of contaminated surfaces and objects is an essential barrier to the spread of contamination both in health care facilities but also in public spaces within the community. Ensure that the healthcare facility has separate cleaning equipment (detergent, mops, buckets, sprayers, chlorine) for each section. Consider installing plastic sheeting to facilitate cleaning in temporary facilities. Suggested procedures:
  - Floors:** mop with hot water and detergent followed by 0.2% solution twice per day.
  - Beds:** wipe with 0.2% chlorine solution daily and between patients.
  - Commonly touched surfaces:** (tables, doorknobs, light switches, handles, desks, toilets, faucets, sinks, etc.) clean with soap and water and wipe with 0.2% chlorine solution as needed but at least 3 times per day.
  - Clothes and sheets:** soak in 0.2% chlorine solution for 10 minutes then rinse, wash as normal and dry on a line.
  - Cooking and eating utensils:** rinse in 0.05% chlorine solution then wash and dry on racks.
  - PPE:** wash with soap and chlorinated water or spray with 0.05% chlorine solution and leave to dry.
  - Spills of stools and vomit:** mop up and disinfect with 2% chlorine solution in the case of cholera outbreaks and 0.5% in the case of Viral Hemorrhagic Fevers (e.g. Ebola, Marburg) or Sars Outbreaks.
  - Dead bodies:** For cholera wash with 2% chlorine solution, and block orifices with cotton wool soaked in the same solution. Wash with 0.5% in the case of Viral Hemorrhagic Fevers (e.g. Ebola, Marburg) or Sars Outbreaks.

## Low and Intermediate Disinfectants and their Advantages and Disadvantages

	DISINFECTANT	SPECTRUM	ADVANTAGES	DISADVANTAGES
<b>LOW LEVEL DISINFECTANTS</b>	<input type="checkbox"/> <u>Quaternary ammonium compounds</u> e.g., alkyl dimethyl benzyl ammonium chloride, alkyl dimethyl ethylbenzyl ammonium chloride.	<input type="checkbox"/> Bactericidal <input type="checkbox"/> Virucidal (only enveloped viruses) <input type="checkbox"/> Fungicidal	<input type="checkbox"/> Toxicity: May be used on food contact surfaces. <input type="checkbox"/> Wide material compatibility o Noncorrosive <input type="checkbox"/> Detergent properties, with good cleaning ability <input type="checkbox"/> Low cost	<input type="checkbox"/> Toxicity: Skin irritant, can also cause respiratory irritation <input type="checkbox"/> Narrow microbiocidal spectrum <ul style="list-style-type: none"> <li>• Not mycobactericidal or sporicidal, only limited activity against non-enveloped viruses.</li> <li>• Diluted solutions can support growth of microorganisms, particularly gram negative organisms.</li> </ul> <input type="checkbox"/> Affected by environmental factors: <ul style="list-style-type: none"> <li>• Activity reduced by various materials (e.g., cotton, water hardness, microfiber cloths, organic material).</li> <li>• Could induce cross resistance with antibiotics.</li> </ul> <input type="checkbox"/> Persists in the environment and waterways.
<b>INTERMEDIATE LEVEL DISINFECTANTS</b>	<input type="checkbox"/> <u>Alcohols</u> (60-80%) e.g., isopropyl alcohol, ethyl alcohol, and methylated spirits	<input type="checkbox"/> Bactericidal <input type="checkbox"/> Virucidal <input type="checkbox"/> Fungicidal <input type="checkbox"/> Mycobactericidal	<input type="checkbox"/> Broad spectrum (but not sporicidal) <input type="checkbox"/> Rapid action <input type="checkbox"/> Nontoxic <input type="checkbox"/> Non-staining, no residue <input type="checkbox"/> Noncorrosive <input type="checkbox"/> Low cost <input type="checkbox"/> Good for disinfecting small equipment or devices that can be immersed (e.g., stethoscopes, thermometers).	<input type="checkbox"/> Slow acting against non-enveloped viruses <input type="checkbox"/> Does not remain wet. Rapid evaporation makes contact time compliance difficult (on large environmental surfaces). <input type="checkbox"/> Affected by environmental factors: o Inactivated by organic material. <input type="checkbox"/> Material compatibility. Can damage materials (plastic tubing, silicone, rubber, deteriorate glues). <input type="checkbox"/> Flammable
	<input type="checkbox"/> <u>Chlorine releasing agents</u> e.g., bleach /sodium or calcium hypochlorite, sodium dichloroisocyanurate (NaDCC)	<input type="checkbox"/> Bactericidal <input type="checkbox"/> Virucidal <input type="checkbox"/> Fungicidal <input type="checkbox"/> Mycobactericidal <input type="checkbox"/> Sporicidal (hypochlorites only at 5000ppm or 0.5%)	<input type="checkbox"/> Hypochlorites are broad spectrum (sporicidal) <input type="checkbox"/> Rapid action <input type="checkbox"/> Nonflammable <input type="checkbox"/> Low cost <input type="checkbox"/> Widely available <input type="checkbox"/> Can reduce biofilms	<input type="checkbox"/> Inactivated by organic material. <input type="checkbox"/> High toxicity: <ul style="list-style-type: none"> <li>• Can release toxic chlorine if mixed with acids or ammonia.</li> <li>• Skin and mucous membrane irritant.</li> </ul> <input type="checkbox"/> Material compatibility: <ul style="list-style-type: none"> <li>• Damages fabrics, carpets.</li> <li>• Corrosive</li> </ul> <input type="checkbox"/> Leaves residue, requires rinsing or neutralization. <input type="checkbox"/> Offensive odors <input type="checkbox"/> Poor stability: <input type="checkbox"/> Subject to deterioration if exposed to heat and UV.
	<input type="checkbox"/> <u>Improved hydrogen peroxide</u> e.g., 0.5% enhanced action formulation hydrogen peroxide, 3% hydrogen peroxide	<input type="checkbox"/> Bactericidal <input type="checkbox"/> Virucidal <input type="checkbox"/> Fungicidal <input type="checkbox"/> Mycobactericidal <input type="checkbox"/> Sporicidal (only at 4-5%)	<input type="checkbox"/> Rapid action <input type="checkbox"/> Nontoxic <input type="checkbox"/> Detergent properties, with good cleaning ability <input type="checkbox"/> Not affected by environmental factors. Active in the presence of organic material <input type="checkbox"/> Safe for environment	<input type="checkbox"/> Material compatibility. Contraindicated for use on copper, brass, zinc, aluminium. <input type="checkbox"/> High cost

SOURCE: Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings CDC 2016 ([LINK](#))

## Common Disinfection Solutions in Healthcare Facilities and Their Uses

	<b>2% Chlorine</b> (Use for disinfection of corpses, stools and vomit in case of a cholera outbreak)	<b>1% Chlorine</b> (Used as a mother solution for drinking water disinfection)	<b>0.5% Chlorine</b> (Disinfection of corpses, stools, vomit, urine, body spills, gloved hands in case of Viral Hemorrhagic Fevers (e.g. Ebola, Marburg) or Sars Outbreaks.	<b>0.2% Chlorine</b> (Disinfection of floors, walls, surfaces, beds, objects, latrines in case of cholera outbreak)	<b>0.1% Chlorine</b> (Disinfection and cleaning of showers, washing facilities, dustbins, reusable sharps containers)	<b>0.05% Chlorine</b> (Disinfection of hands, skin, clothing, bedding, gloves, aprons, goggles, clothing, lorries and carts (used for waste transportation)
<b>Calcium hypochlorite (HTH)</b> at 70% active chlorine	<b>30g per litre</b> (2 level dessert spoons per litre)	<b>15g per litre</b> (1 level dessert spoons per litre)	<b>7.5g per litre</b> (1 level dessert spoon per 2 litres)	<b>3g per litre</b> (2 level dessert spoons per 10 litres)	<b>1.5g per litre</b> (1 level dessert spoons per 10 litres)	<b>0.7g per litre</b> (1 level dessert spoon per 20 litres)
<b>Chlorinated lime</b> at 35% active chlorine	<b>60g per litre</b> (4 level dessert spoons per litre)	<b>30g per litre</b> (2 level dessert spoons per litre)	<b>7.5g per litre</b> (1 level dessert spoon per litre)	<b>6g per litre</b> (4 level dessert spoons per 10 litres)	<b>3g per litre</b> (2 level dessert spoons per 10 litres)	<b>1.5g per litre</b> (1 level dessert spoon per 10 litres)
<b>NaDCC Tablets</b> at 1g active chlorine per tablet	<b>20 tablets per litre</b>	<b>10 tablets per litre</b>	<b>5 tablets per litre</b>	<b>2 tablets per litre</b>	<b>1 tablet per litre</b>	<b>0.5 tablet per litre</b>
<b>Sodium hypochlorite concentrate</b> at 15% active chlorine	<b>168ml per litre</b>	<b>84ml per litre</b>	<b>42ml per litre</b>	<b>168ml per 10 litres</b>	<b>84ml per 10 litres</b>	<b>42ml per 10 litres</b>
<b>Sodium hypochlorite (bleach)</b> at 5% active chlorine	<b>500ml per litre</b>	<b>250ml per litre</b>	<b>125ml per litre</b>	<b>50ml per litre</b>	<b>25ml per litre</b>	<b>12ml per litre</b>

SOURCE: Public Health Engineering in Precarious Situations MSF 2010 ([LINK](#))