# Emergency treatment of drinking water at point-of-use

## World Health Organization

This note is about simple treatment of drinking water at point-of-use for people in, or just after an emergency. The options suggested are quick short-term measures to provide a safe survival level supply of drinking water from unsafe polluted water sources. The options should be sustainable until a longer-term safe and cost-effective supply is available to the population.

The methods described are suitable for water taken from any source but, in general, will only remove physical and microbiological pollution. Pollution by chemicals such as after a spillage of industrial waste will not normally be removed by these processes and specialist advice should be taken.

In general terms, treatment of water at household level follows the processes shown in Figure1. However, depending on the quality of raw water, some processes may not be necessary.

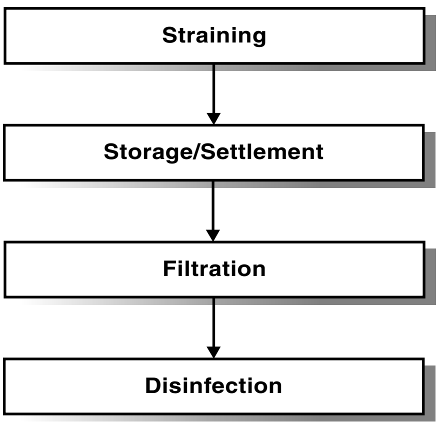



**Figure 1. General steps in the water treatment processes undertaken at household level**

## Straining

Pouring water through a clean piece of cotton cloth will remove a certain amount of the suspended silt and solids. It is important that the cloth used is clean, as dirty cloth may introduce additional pollutants. Specifically made monofilament filter cloths may be used in areas where guinea-worm disease is prevalent. Such cloths remove organisms known as *copepods*, which act as intermediate hosts for the guinea-worm larvae. The cloth must always be used with the same surface uppermost. The cloth may be cleaned using soap and clean water.

## Aeration

Aeration is a treatment process in which water is brought into close contact with air for the primary purpose of increasing the oxygen content of the water. With increased oxygen content:

- volatile substances such as hydrogen sulphide and methane which affect taste and odour are removed;
- carbon dioxide content of water is reduced; and
- dissolved minerals such as iron and manganese are oxidised so that they form precipitates, which can be removed by sedimentation and filtration.

The close contact between water and air required for aeration can be achieved in a number of ways. At a household level, rapidly shake a container part-full of

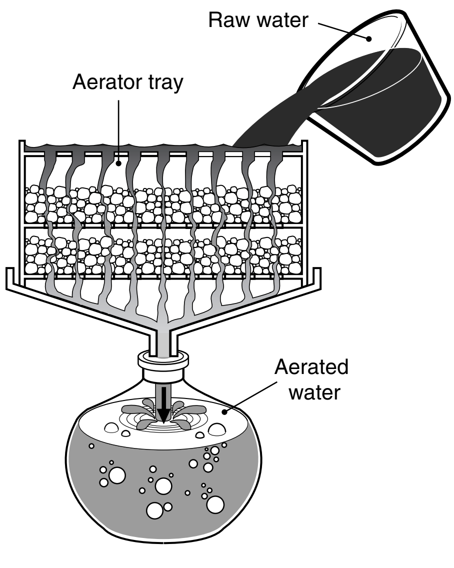
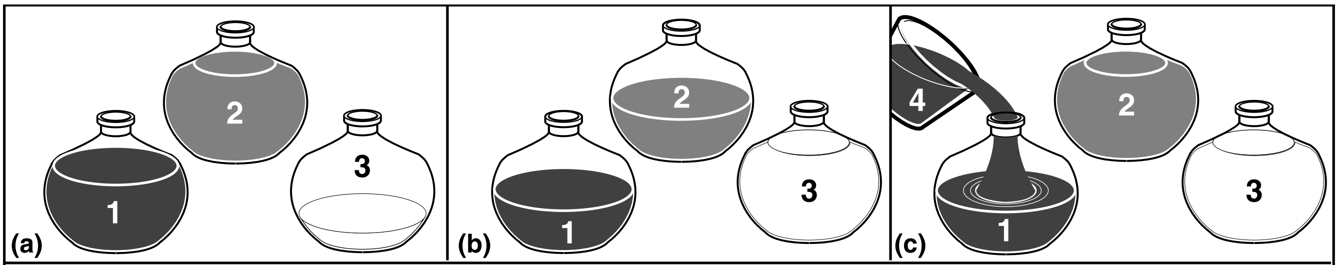



**Figure 2. Aerator trays**




**Drinking water:** Always take from pot 3. This water has been stored for at least two days, and the quality has improved. Periodically this pot will be washed out and may be sterilized by scalding with boiling water.

Each day when new water is brought to the house:
(a) Slowly pour water stored in Pot 2 into Pot 3, wash out Pot 2.
(b) Slowly pour water stored in Pot 1 into Pot 2, wash out Pot 1.
(c) Pour water collected from the source (Bucket 4) into Pot 1. You may wish to strain it through a clean cloth.

Using a flexible pipe to siphon water from one pot to another disturbs the sediment less than pouring.

**Figure 3. The three pot treatment system**

water, for about five minutes and then stand the water for a further 30 minutes to allow any suspended particles to settle to the bottom.

On a larger scale, aeration may be achieved by allowing water to trickle through one or more well-ventilated, perforated trays containing small stones, as shown in Figure 2. Again, the water must be collected in a container and allowed to stand for about 30 minutes to settle suspended particles.

## Storage and settlement

When water is stored for a day in safe conditions, more than 50% of most bacteria die. Furthermore, during storage, the suspended solids and some of the pathogens will settle to the bottom of the container. The container used for storage and settlement should have a lid to avoid recontamination, but should have a neck wide enough to facilitate periodic cleaning. For example a bucket with a lid could be used for this purpose.

Water should be drawn from the top of the container where it will be cleanest and contain less pathogens. Storage and settlement for at least 48 hours also eliminates organisms called the *cercariae*, which act as intermediate host in the life cycle of bilharziasis (*schistosomoasis)*, a water-based disease prevalent in some countries. Longer periods of storage will leader to better water quality.

A household can maximize the benefit of storage and settlement by using the three-pot system illustrated in Figure 3.

## Filtration

Filtration is the passage of polluted water through a porous medium (such as sand). The process uses the principle of natural cleansing of the soil.

### Simple up-flow sand filter

Simple household filters may be put together inside clay, metal or plastic containers. The vessels are filled with layers of sand and gravel and pipework arranged to force the water to flow either upwards or downwards through the filter. Figure 4 shows a modified simple upward rapid flow filter.

A filter such as this could be built from a 200 litre drum. It has a filter bed made up coarse sand (of about 0.3m depth) of grain size between 3 and 4mm diameter, and supported by gravel covered by a perforated metal tray. The effective filtration rate of such a filter could be as high as 230 litres per hour.

Such filters must be dismantled regularly to clean the sand and gravel and remove any settled silt. The frequency of cleaning is dependant on the level of turbidity of the raw water. Furthermore, such filters are not effective at removing the pathogens. Therefore the water must be disinfected or stored for 48 hours in order to make it safe.

### Charcoal filters

Charcoal can be quite effective at removing some tastes, odours, and colour. Ordinary charcoal available locally could be used, but activated carbon is more effective, though rather expensive. An example of such a filter is the UNICEF upflow sand filter, illustrated in Figure 5. However, if the charcoal is not regularly renewed or if the filter is left unused for some time, there is evidence that it can become the breeding ground for harmful bacteria.

### Ceramic filters

Water may be purified by allowing it to pass through a ceramic filter element. These are sometimes called candles. In this process, suspended particles are

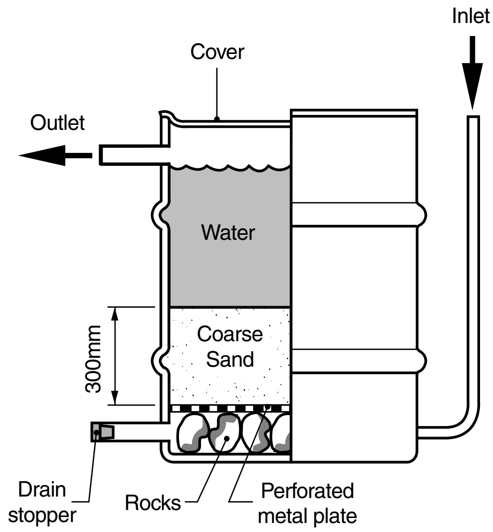



**Figure 4. A simple upflow rapid sand filter**

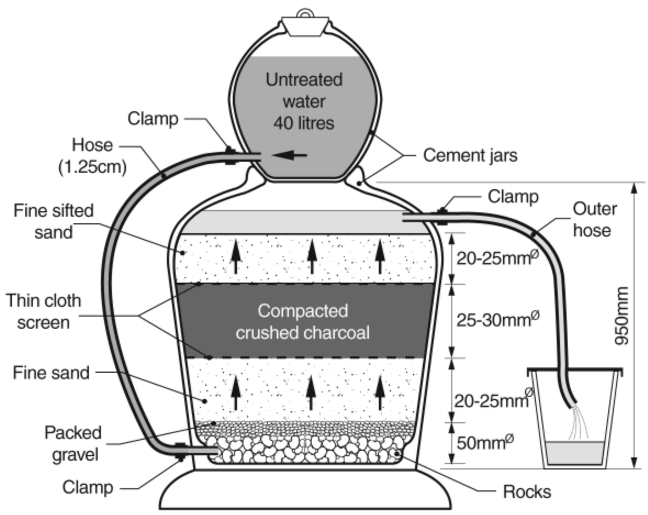
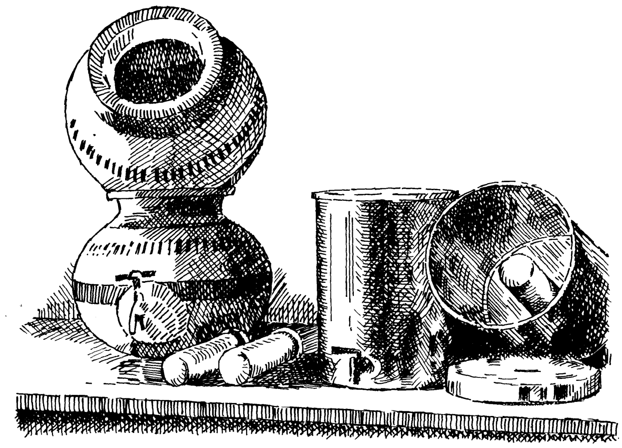



**Figure 5. The Unicef upflow charcoal filter**

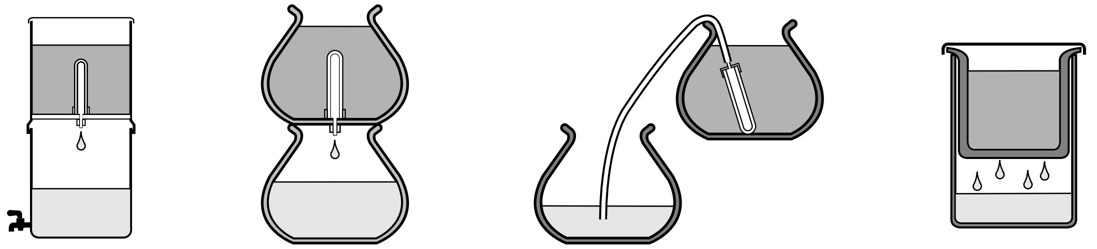
mechanically filtered from the water. The filtered water must be boiled or otherwise disinfected. Some filters are impregnated with silver which acts as a disinfectant and kills bacteria, removing the need for boiling the water after filtration. Ceramic filters can be manufactured locally, but are also mass-produced. They can be costly but have a long storage life and so can be purchased and stored in preparation for future emergencies. The impurities held back by the candle surface need to be brushed off under running water, at regular intervals. In order to reduce frequent clogging, the inlet water should have a low turbidity. Figure 6 shows a variety of ceramic candles.



**Candle filters**

## Disinfection

It is essential that drinking water be free of harmful organisms. Storage, sedimentation and filtration of water reduce the contents of harmful bacteria but none of them can guarantee the complete removal of germs. Disinfection is a treatment process that ensures drinking water is free from harmful organisms or pathogens. It is recommended that this be the final treatment stage, as many of the disinfection processes will be hampered by suspended solids and organic matter in the water. There are various methods of achieving disinfection at household level:



(a) Manufactured unit (b) Candle with jars (c) Using candle with siphon (d) Porous jar

**Figure 6. Ceramic filters**

# Emergency treatment of drinking water

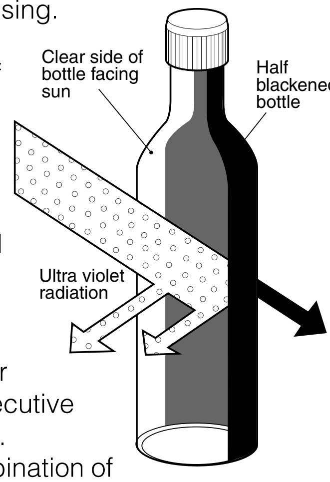
## Disinfection by boiling

Boiling is a very effective though energy consuming method to destroy various pathogens such as viruses, spores, cysts and worm eggs. The water should be brought to a rolling boil for at least five minutes and preferably up to a period of twenty minutes. Apart from the high energy costs involved in boiling, the other disadvantage is the change in taste of water due to the release of air from the water. The taste can be improved by vigorously stirring the water, or shaking the water in a sealed container after it has cooled. A better water quality can be obtained by storing the boiled water, as described earlier.

## Disinfection using chlorine

Chlorine is a chemical most widely used for the disinfection of drinking water because of its ease of use, ability to measure its effectiveness, availability and relatively lower cost. When used correctly, chlorine will kill all viruses and bacteria, but some species of protozoa and helmithes are resistant. There are several different sources of chlorine for home use; in liquid, powder and tablet form. Chlorine is commonly available to households as liquid bleach (sodium hypo chlorite), usually with a chlorine concentration of 1%. Liquid bleach is sold in bottles or sachets, available on a commercial basis.

Chlorine must be added in sufficient quantities to destroy all the germs but not so much as to affect the taste adversely. The chemicals should also have sufficient contact time with the pathogens (at least 30 minutes for chlorine). Deciding on the right quantity can be difficult, as substances in the water will react with the disinfectant at different rates. Furthermore, the strength of the disinfectant may decline with time depending on how it is stored. It is therefore recommended that in emergency situations, chlorine solutions be centrally dispensed to the users by qualified personnel. Displaced people should receive standard containers for collecting/storing water, as well as simple dropper tubes or syringes. Technical staff should provide the instructions for mixing the chlorine solution, at the point of dispensing. See Note 1 *Cleaning and disinfecting wells* for details of preparing chlorine solutions.




## Solar disinfection

Ultra-violent rays from the sun are used to inactivate and destroy pathogens present in water. Fill transparent plastic containers with water and expose them to full sunlight for about five hours (or two consecutive days under 100% cloudy sky). Disinfection occurs by a combination of radiation and thermal treatment. If a water temperature of least 50°C is achieved, an exposure period of one hour is sufficient. Solar disinfection requires clear water to be effective.

An enhanced example is the SODIS system, whereby half-blackened bottles are used to increase the heat gain, with the clear side of the bottle facing the sun, as shown above.

## Other water treatment chemicals

A number of commercially produced chemicals have been developed to holistically treat water at household level in emergency situations. Studies have shown that some of these powders significantly remove pathogenic bacteria, viruses and parasites from water. They also enable the particles to flocculate together, so they then to sink to the bottom of the container. Commercially available sachets typically treat 10 litres of water. The water should be allowed to stand for at least 5 minutes before it is strained. It should be allowed to stand for a further 30 minutes before it is used for human consumption.

## Further information


Shaw, Rod (ed.) (1999) *Running Water: More technical briefs on health, water and sanitation,* ITDG, UK.



## World Health Organization

WHO Headquarters
Avenue Appia 20
1211 Geneva 27
Switzerland

Telephone: (+ 41 22) 791 21 11
Facsimile: (+ 41 22) 791 31 11
Telex: 415 416
Telegraph: UNISANTE GENEVA



**This information has been prepared by WEDC**
**Author:** Sam Kayaga **Series Editor:** Bob Reed **Design:** Glenda McMahon **Illustrations:** Rod Shaw **Graphics:** Ken Chatterton
Water, Engineering and Development Centre, Loughborough University, Leicestershire, UK.
Phone: +44 1509 222885 Fax: +44 1509 211079 E-mail: WEDC@lboro.ac.uk Website: www.lboro.ac.uk/wedc