Chapter 10

SPECIAL AND EMERGENCY
DISINFECTION
Dug wells

Dug wells have been an important water source since ancient times and many towns continue to use them. The water in these wells comes from groundwater which, particularly in villages and towns, is almost always contaminated by seepage from nearby latrines. In addition, most of the wells are not properly protected and do not have mechanisms for drawing water that keep users from touching it. The well water may already be contaminated or handling may contaminate it when the water is drawn—the truth is that rarely is a public dug well free from the risk of transmitting waterborne diseases.

National and international institutions, public health agencies and health professionals have for decades been calling for disinfection campaigns for dug wells.

The first result of such efforts is that today a large number of different dosers can be found, almost all of which use chlorinated lime. These include containers with holes, plastic bags, concentric bottles and an entire range of porous ceramic pots. The second is that all of these empirical methods are bad and fail to accomplish their desired aim.

The fact is that a dug well is not used consistently: during the night, it is not used at all and during the day, water is drawn in varying amounts and at different rates. This means that the concentrations provided by constant feeding systems will, unfortunately, also vary widely at different times of the day or night. The end result is that users detest the chlorination of these wells because at times the chlorine content is so strong that the water is undrinkable and at other times those who drink it sicken because of the lack of sufficient chlorine.

This specific situation has brought on the current trend, favored by many public health institutions, of abandoning the inefficient disinfection of dug wells. Instead, people are recommended to collect water (dirty and contaminated) from the well, take it to their own homes and there filter and disinfect it. Sodium hypochlorite generated through electrolysis at either the community or household level can be used as a disinfectant, as can any other means available in the community (silver solutions, for example).

While this course of action requires good educational and monitoring plans, the results in the long term are far more positive than the controversial disinfection of open wells.

The classical dug well with all the conditions conducive to contamination
Disinfection of tanks, tankers and pipes

**New tanks**

All new tanks, reservoirs and cisterns (buried tanks) should be disinfected before they are put into service. Similarly, tanks that have been out of service for repair or cleaning should also be disinfected before they are put back into service. Prior to disinfection, the walls and bottoms of tanks should be cleaned by sweeping and scrubbing to remove all dirt and loose material.

One of the methods for disinfecting a new tank is to fill it to overflowing with clean water to which enough chlorine has been added to produce a concentration of 50 to 100 mg of chlorine per liter of water.

The chlorine solution is added to the water as early as possible during the filling operation to ensure thorough mixing and contact with all of the surfaces to be disinfected. Once the tank has been filled, the water should be allowed to stand, preferably for 24 hours, but never for less than six. It should then be drained out and the tank refilled for normal supply.

**Elevated tank**

A second method that is highly satisfactory and practical for rural use is the direct application of a strong solution (200 mg of chlorine/l) to the tank’s interior surfaces. The solution should be allowed to remain in contact with the surfaces for at least 30 minutes before refilling the tank with water.
Cisterns and tankers

A tank on wheels is just like a stationary tank, except for the obvious difference that it can be moved from one place to another. Therefore, the disinfection requirements and methodology to be used should be identical. There are, however, three subtle differences: 1) the accessibility to the interior 2) the material of which the tank is made and 3) the owner.

Accessibility is important, for it would be difficult to inspect or properly disinfect a tank unless the inside can be reached. Sometimes, there is no other choice but to scrub the walls and sweep the bottom. Unless there is reasonable access to the inside of a tank, its use as a container for drinking water should not be permitted.

In many rural areas where water is transported in tankers, conditions are poor and resources lacking. Often the tanks are no more than iron containers resting on four wheels. They may not even have an internal coating to protect the material of which the tank is made from the oxidating effect of the water and even less so from an agent as aggressive as chlorine.

This leads to another condition that must be fulfilled unconditionally: all tanks should be made of material that is suitable for holding water or should be duly given an internal coating that is approved for contact with drinking water.

This point has to do with the owner of the tanker. It so happens that it is usually difficult to convince or force these people to make necessary improvements in their vehicles. Education, information, and consciousness-raising must be used to persuade them. But it will also be necessary to call on health or even police authorities to force them to fulfill pertinent sanitary conditions. In some situations, tankers have been found to spread diseases, when it is their social task is to improve the quality of life of many people.

New mains and pipes

Distribution mains and pipelines are likely to be contaminated during their operation and laying, irrespective of the precautions taken. Therefore, they must be disinfected before they are put into use. Distribution systems need to be disinfected when contaminated in the event of main breaks or floods.

Every pipeline should be cleaned by swabbing with any of the modern instruments designed for that purpose and then flushed in order to remove all loose foreign matter.
Immediately before use, the packing and jointing material should be cleaned and disinfected, if possible. This should be followed by the internal disinfection of the pipeline.

A practical means of applying chlorine solution (with a concentration of 50 mg of chlorine/liter) for the disinfection of pipes is to flush each section to be disinfected. The intake valve is shut off and the section is allowed to drain dry through the discharge hydrant or valve. Then the discharge hydrant or valve is shut off and the section is isolated from the rest of the system. The disinfecting solution is fed through a funnel or hose into a hydrant or opening made especially for this purpose at the highest point on the pipeline. Since air valves are usually placed at the high points, removing an air valve is often a convenient way to provide a point of entry for the disinfecting solution. The solution should be left in the section for a period ranging from 12 to 24 hours and never less than six.

**Household tanks**

Most national water quality monitoring programs or public utility control programs focus specifically on water production and distribution until it enters the individual household connections. Furthermore, in many developing countries, for reasons of economy, drinking water projects are built to supply household tanks that serve as “lungs.” At times, the choice is made to distribute the storage capacity in a summatory of small tanks in each home supplied, instead of by building large tanks and cisterns.

Water of excellent quality that has been produced and distributed has been found time and again and in many countries, as well, to have spoiled precisely before being consumed. The reason for this is the poor condition of household tanks. One of the authors of this manual participated in a research project on the state of the water in the tanks of an important city in a developing country. It was found that in 75% of the cases the tanks contaminated the water that flowed into them.

Two quite different services

The same author found, at the conclusion of another tank disinfection program in a small rural town of another developing country, that the list of dead animals encountered in the household tanks that were cleaned and disinfected ranged from cockroaches to birds and from rats to ferrets, without counting an impressive series of such varied objects as small pieces of furniture, branches, cans, toys and even a bicycle.
The lack of legislation requiring home owners to take care of, clean and disinfect household water tanks and the absence of tank protection programs carried out by public health institutions is responsible for this situation, which is common in countries where water is stored in household tanks. It can also be attributed to a notorious lack of health education among users, for the apathy of those who are responsible for keeping the tanks clean (the home owners) is almost always due to their ignorance of the risks that can be avoided by keeping those tanks in excellent sanitary condition.

The cleaning and disinfection of household tanks should be popularized, either at the initiative of public health institutions, the local water company or the homeowner, through standards and rules that are simple and instructions that are easy to follow.

A household tank can be cleaned and disinfected in ways that are no different from those discussed in the section on new tanks and reservoirs. Even so, it is necessary to bear in mind two different details, for these elements are almost always smaller in household tanks than in the tanks or reservoirs of a water system or service. Household tanks can hold any volume, but the most common in single-family dwellings have a capacity of between 400 and 1,000 liters. These volumes sometimes make appropriate cleaning of the tank interior difficult. The second special characteristic is the cover. Many of the problems with household tanks can be traced to covers that fail to close tightly or the absence of such covers.

Below are a series of simple and precise instructions to be given to the people, together with explanations about the need to keep household tanks clean and disinfected:

1. Prepare a reasonable supply of water in closed and covered containers because no water will be available during the cleaning and disinfection process.
2. Start by removing the tank cover and shut off the floatation valve so that water stops flowing from the main. At that point, the water in the home can no longer be used until the process has been completed.
3. Open the tank’s drain valve (“discharge or drain”) and drain the water until only 10 cm remain on the bottom.
4. Using that water and a hard bristled brush, scrub the inside walls of the tank until they are as clean as possible. A hand brush, together with clean cloths can also be used to help. A flashlight can be useful in this case.
5. Drain out all dirty water through the tank’s drain valve (not through the household installations and water taps).
6. Repeat the operation as often as necessary until the inside walls are clean.
7. Open the floatation valve and let water run into the main and fill the tank ¼ full. Add enough sodium or calcium hypochlorite to produce a final concentration (when the tank is full) of 100mg of chlorine per liter of water. (In countries where a single product is available, i.e. sodium hypochlorite with a fixed concentration throughout the country -for example, 8%-, the authorities who prepare the instructions could
calculate the amount to be added. In that case, the instructions should merely state: “add such and such a volume of bleach for every one thousand liters of tank capacity.” In areas where various chlorine compounds are sold freely, the necessary amount should be calculated using the following formulas).

<table>
<thead>
<tr>
<th>On the basis of:</th>
<th>Sodium hypochlorite</th>
<th>Calcium hypochlorite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>This compound is sold as a liquid under several different names (bleach, etc.), with varying chlorine contents, the most commonly found being from 7% to 10%.</td>
<td>This compound is marketed in solid state with varying chlorine contents, the most common being from 60% to 70%.</td>
</tr>
</tbody>
</table>
| Formula to be used | \[
V = \frac{V_t \times 10}{\%}
\]
Where:
- \( V \) = Volume in milliliters of sodium hypochlorite to be added to the water tank
- \( V_t \) = Tank volume = Volume of water to be added to the tank to prepare the disinfecting solution
- 10 = Multiplier to be used to state the result in milliliters of the product
- % = Chlorine concentration in the product, as specified by the manufacturer (place only the number in the formula, for example “7” when the chlorine concentration in the product is 7%)
| | \[
W = \frac{V_t \times 10}{\%}
\]
Where:
- \( W \) = Product (calcium hypochlorite) weight in grams to be dissolved in the tank
- \( V_t \) = Tank volume = Volume of water to be added to the tank to prepare the disinfecting solution
- 10 = Multiplier to be used to state the result in grams of the product
- % = Chlorine concentration in the product, as specified by the manufacturer (place only the number in the formula, for example “65” when the chlorine concentration in the product is 65%)
| Example | For a 500-liter tank using sodium hypochlorite with an 8% concentration, the amount of the product to be added to the tank will be:
\[
V = \frac{500 \times 10}{8} = 625 \text{ ml}
\] | For an 800-liter tank using calcium hypochlorite with a 70% concentration, the amount of the product to be dissolved in the tank will be:
\[
W = \frac{800 \times 10}{70} = 114 \text{ g}
\] |

8. Once the disinfectant has been added, fill the tank to the top level.
9. When the tank is full of the disinfecting solution, open each of the household water taps and let the water run until a strong chlorine smell is noticeable. Then turn off the water. This operation is important for disinfecting not only the tank, but also all of the household pipes and taps. **This water must not be drunk or used for any other purpose whatsoever.**
10. Leave the household water system untouched for 12 hours so that the chlorine can act (the period can be shortened, but to no less than six hours). If possible, leave it undisturbed overnight.
11. Following the disinfection, drain off all of the water in the tank and open all of the household taps to eliminate all of the chlorine still remaining in the pipes.
12. Let fresh water from the distribution system enter the tank. It can now be used for drinking and other purposes, because the installations have been disinfected.

13. Make sure that the tank is well covered and that no animals or birds can get inside. The ideal situation would be to padlock the tank cover.

14. Repeat the tank cleaning and disinfection process every six months and never let more than a year pass between operations.

**Disinfection of the water supply in emergency situations**

Long-term measures for the provision of a safe water supply aided by personal hygiene and health education will greatly help to protect and promote public health. However, natural disasters like cyclones, earthquakes, and floods do occur and sometimes result in complete disruption of the water supply. While efforts should be made to put the systems back into operation, top priority should also be given to providing the affected population with safe drinking water.

While no single universal measure is applicable to all situations, the following may be useful to ensure a safe water supply, depending upon local conditions and available resources. Simultaneous action to tide over the situation should include a thorough search for all possible water sources within a reasonable distance of the affected area. Water from private water supply systems and other sources may be transported by tankers to the points of consumption.

In an emergency situation, if quantity is important, quality is mandatory. To achieve bacteriological safety, proper disinfection should be ensured. Failure to do so could result in the outbreak and spread of the dreaded pandemics that sicken people already in a state of psychological shock over the disaster itself, not only physically, but also spiritually.

There are two important moments following a disaster. One is “absolutely immediate” and the other, “relatively immediate,” on the second or third day after the event. In the former case, with the impact of the disaster (whether an earthquake, a cyclone, or other event) still too fresh in their minds, disorder reigns and means of all kinds are in short supply. In those cases, the boiling of water is all that can be recommended. Vigorous boiling for a minute kills off any microorganism that may be present in the contaminated water.

During the second moment -two or three days after the occurrence of the disaster- a peculiar situation arises that health officers in particular must cope with. It is not the lack of disinfectants but, rather, their excess supply that creates the problem. After disaster strikes an area, it is flooded with a wide variety of donated disinfectants. These are normally chlorine-based compounds, but of different compositions and concentrations. It is useful to know how to handle them properly.

Two suggestions are to be made in this situation:

- First, it is important for the population never to prepare or handle stock solutions with a high hypochlorite concentration. People should be given a disinfecting solution ready for use in a batch system (for disinfection of a household tank or container).

- Second, an ideal stock for use in emergency situations is one that has a concentration of 5,000 mg of chlorine/liter.
Health officials should prepare stock solutions from any chlorine-based product using the following formula.

\[
\frac{V \text{ water} \times C \text{ stock}}{C \text{ product} \times 10} = W \text{ product}
\]

Where:
- \(V \text{ water}\) = Volume of stock solution that will be prepared, in liters
- \(C \text{ stock}\) = Concentration of stock solution (if, as suggested, a 5,000 mg of chlorine/L of water is intended, the value for \(C \text{ stock}\) should be = 5,000)
- \(C \text{ product}\) = Chlorine concentration in the product, as specified by the manufacturer (place only the number in the formula, for example 65 when the chlorine concentration in the product is 65%)
- \(10\) = Multiplier to be used to state the result in grams of the product
- \(W \text{ product}\) = Grams of the product to be dissolved in \(V \text{ water}\)

While there is no hard and fast standard, the following is considered to be a good dose:

**The disinfection dose that will be suggested to the population is 5 mg/l during extreme emergencies and then 2 mg/l under less stressful conditions.**

It should be recommended at all time that the chlorine be “allowed to work” at least 30 minutes.

The following table presents the appropriate dilutions that people should prepare from the stock solution they are given.

<table>
<thead>
<tr>
<th>Volume of water to be disinfected (liters)</th>
<th>Volume of stock solution (of 5,000 mg/l) to be added to obtain a final concentration of 5 mg/l</th>
<th>Volume of stock solution (of 5,000 mg/l) to be added to obtain a final concentration of 2 mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 drops = 1 ml</td>
<td>8 drops</td>
</tr>
<tr>
<td>5</td>
<td>100 drops = 5 ml</td>
<td>40 drops = 2 ml</td>
</tr>
<tr>
<td>10</td>
<td>10 ml</td>
<td>4 ml</td>
</tr>
<tr>
<td>20</td>
<td>20 ml</td>
<td>8 ml</td>
</tr>
<tr>
<td>100</td>
<td>100 ml</td>
<td>40 ml</td>
</tr>
<tr>
<td>200</td>
<td>200 ml</td>
<td>80 ml</td>
</tr>
<tr>
<td>1,000</td>
<td>1 liter</td>
<td>400 ml</td>
</tr>
</tbody>
</table>

If iodine tincture (which is a solution with a 2% concentration) is available, the recommendation is to add five drops per liter of water and allow it to act for a 30-minute period.