NebGuide

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Research-Based Information That You Can Use

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Drinking Water Treatment

Emergency Procedures

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When home drinking water supplies are interrupted, emergency or short-term treatment may be required. This NebGuide covers finding alternative sources of drinking water and treating contaminated water.

Emergency or short-term treatment may be required when the drinking water supply to your home is interrupted due to natural disasters, accidents, or other causes. This NebGuide discusses situations when emergency or short-term treatment will be necessary and describes methods that can be used to treat limited amounts of water intended for human consumption.

Causes of Interruptions to Water Supplies

Most water supply interruptions can be categorized into one of four types: loss of water pressure, known pathogen (disease-causing organism) contamination, short-term accidental contamination with known chemical or biological pollutant, and possible contamination with unknown chemical or biological pollutant.

Loss of water pressure can occur due to incidents such as damage to the water distribution system (e.g., water main break) or electrical failure. When this occurs, water is unavailable at the tap.

Known pathogen (disease-causing organism) contamination can occur after floods, earthquakes, or other natural disasters, or any time water is contaminated by human or animal waste.

Pathogen contamination may be present in surface water sources such as lakes, ponds, and streams. When using surface water directly from these sources, you should suspect human or animal impact and treat the water. Public water utilities occasionally issue "boil water advisories" when known pathogen contamination occurs. Emergency treatment should be continued until the boil advisory is lifted by the public water system. If bacterial contamination of a private well occurs, shock chlorination of the well and waterline is recommended (see the NebGuide G1761, *Drinking Water Treatment: Shock Chlorination*).

Short-term accidental contamination with known chemical pollutants can occur from chemical spills. Private water supplies also can be contaminated if back-siphoning occurs during tank filling or when any private well is contaminated from spills during chemical use.

Possible contamination with unknown chemical or biological pollutant may occur from intentional tampering with the water distribution system or source. In this situation, the contaminant and when it was introduced are unknown. It is important to seek professional guidance to determine what contaminants may be present in the water.

If you suspect intentional tampering with a public water system, contact your public water supply utility. If you are unable to contact the utility or if you suspect intentional tampering with a private water system, contact the Nebraska Department of Health and Human Services at 402–471–2541.

Alternative Water Sources for Different Emergency Situations

Because water is the most important nutrient for the human body, having adequate, drinkable water available is critical. The amount needed is different for each person and depends on factors such as age, health, activity, and climate. If your drinking water supply is interrupted, a safe, alternative drinking water supply must be obtained. Alternative water sources include the following. Additional information on each option is provided in the following section.

MOST DESIRABLE:

- For all emergency situations—Stored emergency water supply or bottled water.

LESS DESIRABLE:

- For loss of pressure—Hidden sources of water in the home with appropriate treatment if needed.
- For known pathogen or known chemical contamination—Contaminated water from the home with appropriate treatment.

LEAST DESIRABLE:

- For all emergency situations—Outside source of water with appropriate treatment.

A stored emergency drinking water supply is a good option for providing drinking water during an interruption to the water supply. For information on preparing and storing an emergency water supply, see the Nebraska Extension publication D*rinking Water: Storing an Emergency Supply* (G1536).

Bottled water can be a good option when drinking water supplies are interrupted. However, in certain situations, such as a large scale disaster, bottled water availability may be limited. To learn more about using bottled water as a short-term water supply, see the Nebraska Extension publication *Drinking Water: Bottled, Tap, and Vended* (G1448).

Hidden water sources in your home located in the hot water tank, water pipes, and toilet flush tanks can be used in emergency situations. In most situations, water from these sources should be treated by methods described later in this publication. If the interruption is due to power failure and only a short time has passed since interruption, water from the hot water tank or household pipes could be used without treatment. Water such as this in the plumbing is safe for only a few days and then must be treated before use. If there has been a major disaster, prevent contamination of the water in the house plumbing by shutting off the water valve that leads from the water main into the house.

TO OBTAIN WATER FROM THE HOT WATER TANK, FOLLOW THESE INSTRUCTIONS:

- Turn off the gas or electric supply to the tank.
- Close the water intake valve into the tank by closing the shut-off valve at the top of the tank. This helps preserve the quality of the water in the tank. Open a hot water faucet in the building to allow air into the tank, which will allow water to drain.
- Open the water heater drain faucet briefly to rinse the interior surfaces and then catch water in a container. Never turn the gas or electricity back on until the water supply is restored and the tank is full of water.
- Use caution when draining water from the hot water heater tank. If the water heater was working prior to the disruption, the water will typically be 120°-140°F.

Note: it is a good idea to drain a few gallons of water every six months, allowing water to drain until it flows clean. This process will ensure that the tank and water remain free of mineral and rust deposits. To drain existing water in the pipes by gravity flow, follow these instructions:

- Locate and open the faucet with the highest elevation in your house. This allows air into the plumbing when water is drained out of a lower faucet. *Note:* To obtain water from both the cold and hot water pipes, turn on both taps or select the warm water mix on a single-lever faucet.
- Open a faucet with the lowest elevation in your house. Turn on both the hot and cold water taps or select the warm water mix on a single-lever faucet. Catch water in a clean container.

TO USE WATER FROM THE TOILET FLUSH TANK, FOLLOW THESE INSTRUCTIONS:

- Dip water out of the toilet flush tank (not bowl) with a clean ladle, cup, or pan.
- Follow the instructions for emergency treatment principles and processes for pathogenic contamination given later in this publication.

- Do not use flush tank water that has been treated with drop-in tablets or other chemicals.

Appliances such as ice makers in refrigerators may be another source of emergency drinking water. If the ice was made before contamination occurred, it is an acceptable source of drinking water. Ice made from contaminated water should be melted and treated using a method appropriate for the contaminant.

Outside sources of water can be obtained from ponds, streams, or precipitation. Prior to consumption, outside sources will need to be treated using one of the emergency treatment procedures described in the next section.

Try to avoid choosing water from an area where human or animal waste may have contaminated it. Also, try to obtain water from a clear water source. The nature of contaminants present in an outside water source is unknown, whereas contaminating pollutants in household waterlines are often known. Therefore, it is generally preferable to treat contaminated household water in a short-term situation and reserve treating outside sources as a last resort.

Emergency Treatment Principles and Processes for Pathogenic Contamination

Hidden water in the home, contaminated water in the home, and outside water sources can be treated for pathogenic microorganisms that may cause illness or disease. These might include bacteria such as *E. coli*, protozoan cysts such as giardia or cryptosporidium, and viruses such as Hepatitis A. Giardia or cryptosporidium are not likely to be present in Nebraska groundwater but may be found in contaminated surface water. Viruses should be suspected in any water that may be contaminated with human waste. Treatment options to manage pathogenic microorganisms include use of heat, chemical disinfection, ultraviolet light, filtration, or an appropriate combination of these methods. Each method has certain advantages and disadvantages that must be considered.

Microorganisms may be attached to or embedded in soil or other organic particles suspended in the water. The water to be treated should be allowed to stand so the suspended material settles to the bottom of the container. Coarse materials like sand will settle more quickly than finer materials suspended in the water.

During and after settling, care should be taken not to agitate the water. Water from the top of the container can be gently poured or drawn off into a second clean container. A second option for removing suspended particles is to strain the water through a clean cloth, layers of paper towels, or a paper coffee filter. Do not use a commercially available portable water filter for this step, as the suspended material may rapidly clog such filters.

Heat Treatment

Heat kills microorganisms and is the oldest effective means of disinfecting drinking water. Adequate heat treatment will kill virtually any disease-causing organism, including bacteria, cysts such as giardia and cryptosporidium, and viruses.

Heat the water to a vigorous boil for one minute, which includes an adequate safety factor at elevations found in Nebraska. Any longer could concentrate other chemical contaminants that may be present. Since water boils at a lower temperature as elevation increases, the Centers for Disease Control and Prevention (CDC) recommends boiling for three minutes at altitudes above 6,562 feet (2,000 meters).

Though boiling effectively disinfects water for drinking, it does not provide a residual (or long-term) disinfection; therefore, care must be taken not to recontaminate the water.

Boiled water may taste flat. The taste can be improved by pouring it back and forth between two clean containers to reoxygenate it or by adding a pinch of salt to each quart after it has cooled.

Chemical Treatment

Liquid chlorine bleach is the most commonly used chemical for emergency disinfection of water. Other options include iodine and chlorine dioxide, which are often marketed to outdoor adventure enthusiasts such as backpackers, or individuals traveling to countries where there is less confidence in the microbial content of the water supply.

The killing effectiveness of the chemical depends on the concentration of the chemical in the water, the amount of time the available chemical is in contact with the water prior to use (contact time), the water temperature, and the characteristics of the water supply.

A decreased concentration of the disinfectant or a lower temperature will require a longer contact time for adequate disinfection. If the water temperature is less than 41°F (or 5°C), it should be allowed to warm prior to disinfection or the chemical dose should be doubled. If the water is cloudy, strain it through a clean cloth, layers of paper towels, or a coffee filter before treatment.

A common objection to chemical disinfection is the flavor it gives to the treated water. If flavorings of any kind are added to the water to improve taste, it should be done after the recommended contact time for disinfection. Flavorings added before adequate contact time has been achieved will "tie up" some of the chemical available for disinfection. Adding about 50 mg of vitamin C (ascorbic acid) per liter or quart of water after the contact time can improve the taste. Vitamin C is often available in 250 and 500 mg tablets where vitamin supplements are sold. Tablets should be pulverized and divided before adding to the water. In addition, freshness preservatives containing vitamin C are often available where canning supplies are sold.

Bacteria are very sensitive to chemical disinfectants while inactivation of viruses requires high dosages of disinfectant or longer contact times. Heat treatment, ultraviolet light, or filtration is recommended if cryptosporidium or giardia are suspected in the water.

LIQUID CHLORINE BLEACH

Regular household chlorine bleach that contains 4–6 percent sodium hypochlorite as the only active ingredient can be used to inactivate bacteria and most viruses. Bleaches with labels such as "Fresh Wildflowers," "Rain Clean," "Advantage," or labeled as scented may contain fragrances, soaps, surfactants, or other additives and should be avoided for drinking water disinfection.

For clear water, add six drops per gallon with a medicine dropper. For cloudy water, strain water through a clean cloth, layers of paper towels, or a coffee filter prior to treatment and add a larger disinfectant dose of 16 drops per gallon. Stir the water and let it stand covered for 30 minutes. For adequate disinfection, the water should have a slight chlorine odor to it after the 30-minute waiting period. If this odor is not present after the 30 minutes, repeat the dose and let it stand covered for another 15 minutes. If this odor is not present, the bleach may have lost its effectiveness due to age or exposure to light or heat.

Use the freshest chlorine bleach available. If the chlorine taste is too strong in the treated water, taste can be improved by pouring the water from one clean container to another several times.

Halazoner® tablets are another form of chlorine for drinking water disinfection. The tablets are convenient and inexpensive but may require high doses and longer contact times. Follow directions provided by the manufacturer for use.

Chemical treatment with chlorine provides some protection against recontamination since some available chemical remains in the water.

Heat treatment, ultraviolet light, or filtration is recommended if cryptosporidium or giardia are suspected.

CHLORINE DIOXIDE

Available in tablet form or in a kit requiring users to mix together drops of two chemicals, chlorine dioxide is marketed for use by campers, hikers, international travelers, or others needing to consume water with possible pathogenic contamination. When used as directed by the manufacturer, chlorine dioxide can be effective for bacteria and most viruses. Heat treatment, ultraviolet light, or filtration is recommended if cryptosporidium or giardia are suspected. When using a chlorine dioxide product, follow directions provided by the manufacturer.

IODINE

Two forms of iodine commonly sold for chemical disinfection of drinking water are tincture of iodine (2 percent) and tetraglycine hydroperiodide. Iodine was once widely used, but is no longer recommended because health research has shown that as many as 8 percent of people have hidden or chronic thyroid, liver, or kidney disease that iodine can make worse. Iodine should not be ingested by children younger than age 14. Do not use iodine-containing products unless you have discussed the risks with your physician.

ULTRAVIOLET LIGHT

Portable, handheld ultraviolet light water treatment devices are marketed to outdoor adventurers and international travelers. The devices provide ultraviolet light at an appropriate wavelength for an adequate time and intensity to effectively inactivate pathogens. For effective treatment, the ultraviolet light must penetrate the entire water supply. Therefore, the water to be treated must be free of suspended particles and color. When using a portable ultraviolet light water treatment device, follow directions provided by the manufacturer.

FILTRATION

Commercially available portable filters provide widely varying degrees of protection against disease-causing contaminants. The better filters provide adequate protection but less sophisticated filters (often less expensive) may not provide protection.

The more sophisticated filters marketed to outdoor recreationists typically operate by a hand pump that draws water into the filter through an intake hose or by slow gravity flow through a filter or series of filters. The filtration process works by physically removing the contaminants from the water and retaining them within the filter medium. The size of the contaminants retained depends on the pore size or the space between media fibers or granules. Most filters list an average pore size and are rated by the manufacturer according to the smallest particle they can trap.

For example, a one micron (one thousandth of a millimeter) filter traps contaminants one micron in diameter or larger. In general, a 0.1 to 10 micron filter will remove cryptosporidium and giardia cyss and bacteria, while a 0.005 to 0.1 micron filter is needed to remove viruses. Many portable filters sold for field use may be acceptable for removal of cysts and bacteria but do not have small enough pore sizes to reliably remove viruses. Heat or chemical treatment is recommended if viruses are suspected.

The removal percentage of contaminants is affected by the amount of time the water is in contact with the filter media. Shorter contact time generally results in less contaminant removal. Some filters have a chemical treatment component such as activated carbon or iodine-impregnated resins that are effective against bacteria and some viruses. The contact time with the iodine in the filter may be too short to kill protozoan cysts, however.

Portable filters do provide immediate access to drinking water without adding unpleasant tastes or odors. However, as with boiling, the water can become recontaminated after filtration. While the filters may be reliable in remote areas where human waste contamination is unlikely, in populated areas filtration should be followed by either chemical disinfection with chlorine or boiling as described previously.

Proper selection, operation, care, and maintenance of portable water filters is essential for producing safe drinking water in emergency or short-term situations. When considering the purchase of a filter, be aware of the filter's rating for pore size, output, pump strokes per liter, and pump force (how much effort is required to operate the pump). If size and speed are not critical factors, a gravity-fed drip filter that lets water slowly drip from a reservoir down through the filter may be a good option. Be aware that membranes in some filters can be damaged by chlorine in the water. Also, cloudy or turbid water can quickly clog a filter and shorten the life of the unit. When using a portable water filter, always follow the manufacturer's instructions for use, care, and replacement.

Emergency Treatment Principles and Processes for Known or Unknown Chemical or Biological Contaminants

If short-term contamination of the water supply with a known chemical pollutant occurs, treatment may be possible. Treatment options will be different from those listed above for pathogenic contamination. An example is when it is known that atrazine contamination has occurred. Activated carbon filtration could be used to treat the drinking water. To learn more about appropriate treatment options for chemical pollutants, see the Nebraska Extension Circular *Drinking Water Treatment: An Overview* (EC703).

If contamination with an unknown chemical or biological pollutant occurs, treatment of the water should not be attempted at the household level. Effective treatment options can only be identified if the contaminant to be managed is known. An unaffected water source should be used in this situation.

Summary

Emergency or short-term treatment of drinking water may be necessary due to natural disasters, accidents, or other situations caused by humans. Alternative drinking water sources for emergency situations and short-term use may include a stored emergency water supply that has been prepared ahead of time, bottled water, hidden sources of water within the home, and outside water sources. When a stored water supply or bottled water supply are unavailable, alternative water sources may be made safe from pathogenic microorganisms by use of heat, chemical disinfection, ultraviolet light, filtration, or an appropriate combination of these methods. Each method has advantages and disadvantages, which should be considered for individual situations. Treatment options other than those used for pathogenic contamination might effectively treat water for other known pollutants.

If local public health department (or water utility) information differs from the recommendations in this publication, the local information should be followed. Local officials will be familiar with site- and event-specific conditions.

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