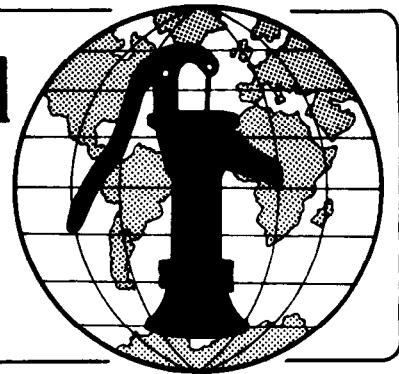


Water for the World



Means of Disease Transmission Technical Note No. DIS. 1.M.1

Water- and sanitation- related diseases are major causes of illness and death among people in both rural and urban areas in many developing countries. The health and well being of people cannot be improved without understanding these diseases and knowing how they are transmitted from one person to another.

This technical note describes what causes these diseases, how they are spread and the factors influencing their transmission. Methods for preventing the transmission of the water- and sanitation- related diseases can be found in the technical note, "Methods of Improving Environmental Health Conditions," DIS.1.M.2.

Useful Definitions

AQUIFER - A water-saturated geologic zone that will yield water to springs and wells.

BACTERIA - One-celled microorganisms which multiply by simple division and which can only be seen with a microscope.

FECES - The waste from the body moved out through the bowels.

LARVAE - Young forms that come from the eggs of insects and worm parasites.

PARASITES - Worms, insects or mites which live in or on animals or people.

There are about 30 diseases that are related to water and sanitation. Table 1 lists the 21 which are most important. Each of them affects from millions to hundreds of millions of people every year. All of these diseases are caused by living organisms that must spend much of their life in or on a human body. They include viruses so tiny that they can pass through the finest filter, bacteria and

protozoa that can be seen only with the aid of a microscope, tiny mites that are barely visible to the eye and worms that may be a meter long.

The transmission of all of these diseases is related in some way to water supply and sanitation, usually to inadequate disposal of human wastes and to contaminated water supplies. The diseases are transmitted through contact with or consumption of water, contact with infected soil, the bites of insects that breed in or near water and poor personal and family hygiene. Man is usually the source of the organisms that cause these diseases and human activity is an important factor in the transmission of them.

Following the order shown in Table 1, the transmission of the diseases will be discussed for each of the five categories.

Waterborne Diseases (Water Quality Related)

In the waterborne diseases, the microorganisms which cause the disease are swallowed with contaminated water. All but one, Guinea worm, are caused by organisms found in human excreta, the source of the contamination. The infective stage of Guinea worm is not from fecal contamination, but is from a tiny larva that develops in a water-flea after the larva is discharged into the water. The larva comes from a blister on the skin of a person infected with the meter-long adult worm.

Cholera and typhoid fever are the waterborne diseases which are most feared because, when untreated, they have high death rates. However, the diarrheas and dysenteries are more important because of the infant deaths and huge numbers of illnesses they cause. In the developing countries,

Table 1. Water and Sanitation-Related Diseases

Category	Disease Common name	Medical name	Type of Organism	Transmission		
Waterborne (Water quality related)	Cholera	Cholera	Vibrio	By consuming (drinking) fecally contaminated raw water containing an infective dose of the vibrio, bacterium, protozoan or virus; except Guinea worm where transmission is by swallowing water flea infected with worm larva that was shed from skin blister on infected human.		
	Typhoid fever	Typhoid	Bacteria			
Waterborne (Water quality related)	Paratyphoid fever	Paratyphoid	Bacteria	By consuming (drinking) fecally contaminated raw water containing an infective dose of the vibrio, bacterium, protozoan or virus; except Guinea worm where transmission is by swallowing water flea infected with worm larva that was shed from skin blister on infected human.		
	Bacillary dysentery	Shigellosis	Bacteria			
	Amebic dysentery	Amebiasis	Protozoan			
	Diarrhea	Salmonellosis	Bacteria			
	Diarrhea	Giardiasis	Protozoan			
	Jaundice	Hepatitis	Virus			
	Guinea worm	Dracunculiasis	Worm			
	Water-washed (Water quantity; and accessibility related)	Bacillary dysentery	Shigellosis		Bacteria	Anal-oral or skin-to-skin direct contact transmission resulting from poor personal cleanliness and hygiene caused from lack of water for sufficient washing, bathing and cleaning.
		Diarrhea	Salmonellosis		Bacteria	
		Viral diarrhea	Enteroviruses		Virus	
Trachoma		Trachoma	Intracellular bacteria			
Water-washed (Water quantity; and accessibility related)	Pink eye	Conjunctivitis	Bacteria	Anal-oral or skin-to-skin direct contact transmission resulting from poor personal cleanliness and hygiene caused from lack of water for sufficient washing, bathing and cleaning.		
	Itch	Scabies	Mite			
Water-contact (Body-of-water related)	Blood fluke disease	Schistosomiasis	Worm	Eggs in feces or urine hatch larvae in water, penetrate suitable snail, multiply greatly in snail, free-swimming larvae leave snail, penetrate skin when person has contact with infected water.		
Water-related insect vectors (carriers) (Water-site related)	Yellow fever	Yellow fever	Virus	Mosquitoes, tsetse flies and black-flies, which breed in or near water, pick up disease organisms when they bite infected person; organisms grow in vectors and are inoculated into another person when insect bites.		
	Malaria	Malaria	Protozoa			
	Filarial fever	Filiariasis	Worm			
	Sleeping sickness	Trypanosomiasis	Protozoa			
	River blindness	Onchocerciasis	Worm			
Sanitation-related (Fecal polluted soil related)	Hookworm	Ancylostomiasis	Worm	Eggs or larvae become infective when feces are deposited on soil; eggs are eaten from contaminated hands or vegetables, or larvae penetrate skin that comes in contact with infected soil.		
	Roundworm	Ascariasis	Worm			

the diarrheas and dysenteries cause hundreds of millions of illnesses and millions of infant deaths each year.

The basic transmission of waterborne disease is person to person. The microorganisms for infected people contaminate water which is consumed by other people. Figure 1 shows a common way that water becomes contaminated. The contamination of water supplies occurs:

1. Where latrines and privies are located uphill from or very close to a water source such as a spring, stream, pond or well. Liquids carrying the organisms seep from the latrines into the water supply.

2. Where privy pits, soakage pits, or sewage absorption systems penetrate the water table of an aquifer located near the surface and shallow wells and springs whose water comes from the aquifer are contaminated.

3. Where wells and springs are unprotected so that surface run-off enters these water sources. The run-off after rainfall carries disease-causing organisms into the water source.

4. Where sanitation is poor. If people defecate on the ground or in bodies of water rather than in safe latrines or privies, disease-causing organisms can get into water supplies.

5. Where Guinea worm occurs, water is contaminated when the skin of an infected person with a blister caused by the worm is immersed in water and great numbers of larvae are released into the water. Some of the larvae are eaten by tiny water fleas (Cyclops). The larvae in the water fleas grow, shed their skins, and become infective. When a water flea containing an infective larva is drunk with water from the contaminated source, the little worm is transmitted to a new person where it grows to maturity under the skin.

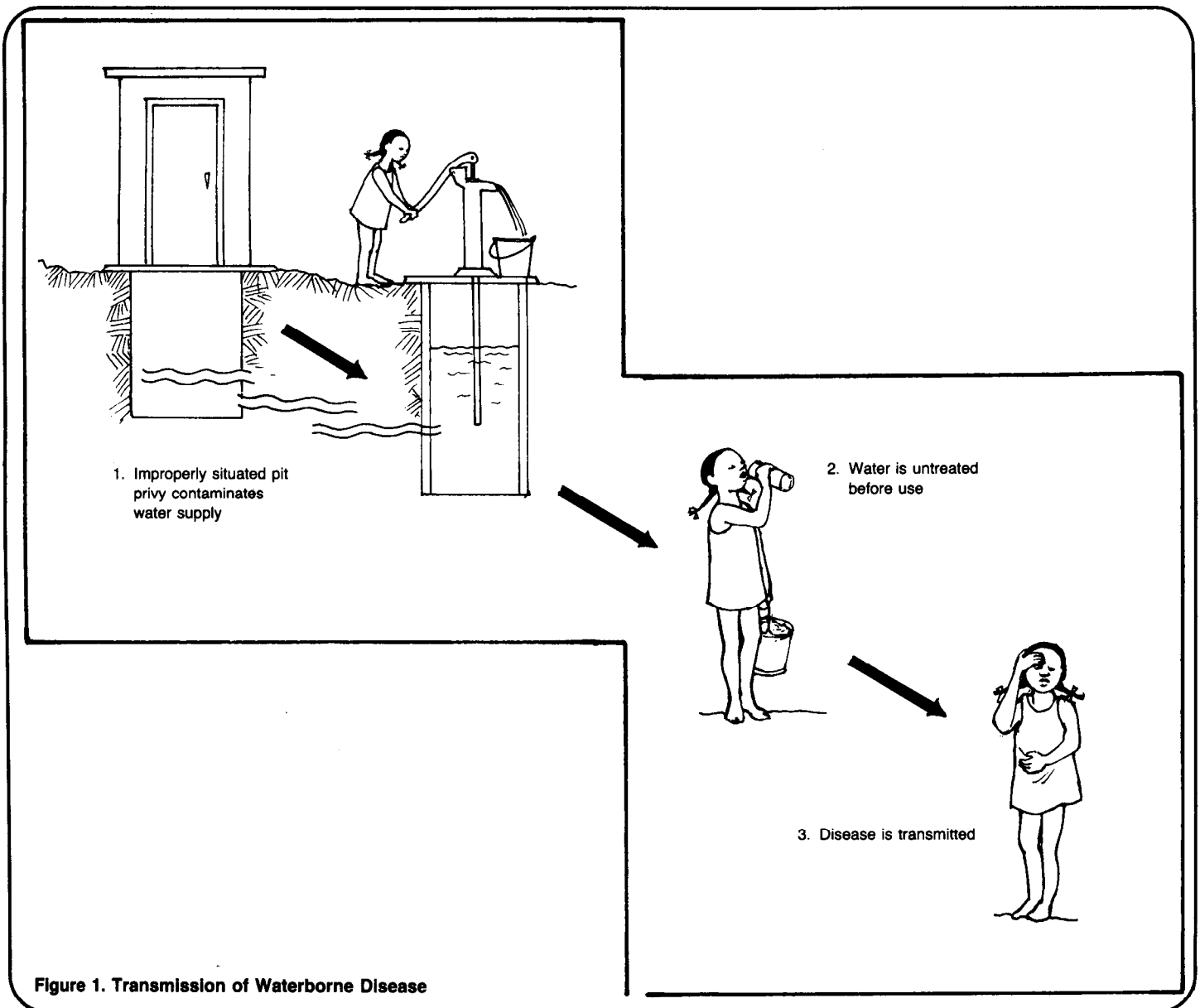


Figure 1. Transmission of Waterborne Disease

Water-Washed Diseases (Water Quantity and Accessibility Related)

Water-washed diseases are diseases whose transmission results from a lack of sufficient clean water for frequent bathing, hand washing before meals and after going to the toilet, and for washing clothes and household utensils. Several common diseases fall into this category. Shigellosis (bacillary dysentery), salmonellosis (food poisoning), trachoma, and scabies are all diseases that can be passed by direct contact between people or by the direct contamination of food by dirty hands or flies. Figure 2 shows one way water-washed diseases are spread. The diseases in this group are transmitted:

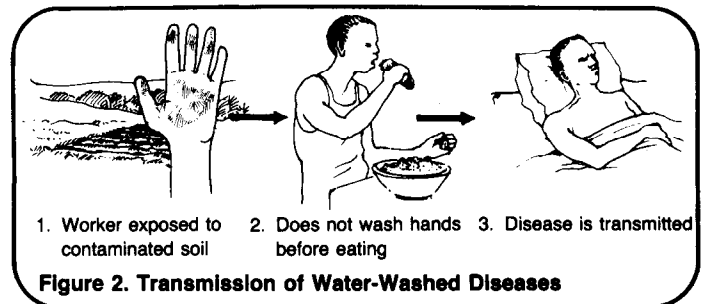


Figure 2. Transmission of Water-Washed Diseases

1. When a water supply produces insufficient quantities to meet peoples' needs or when the water supply is located at a distance from the users. The availability of only small amounts of water makes the practice of good personal and household hygiene difficult, or even impossible.

2. When feces are not disposed of in a sanitary way. Uncovered or unprotected latrines or stools passed on the ground are breeding places for flies and sources of bacteria. Bacteria and viruses are passed from feces to people by flies, contaminated fingers and food. Food contamination with salmonella quickly grows great numbers of the bacteria. When eaten, the food causes food-poisoning diarrhea with life-threatening consequences, especially for small children.

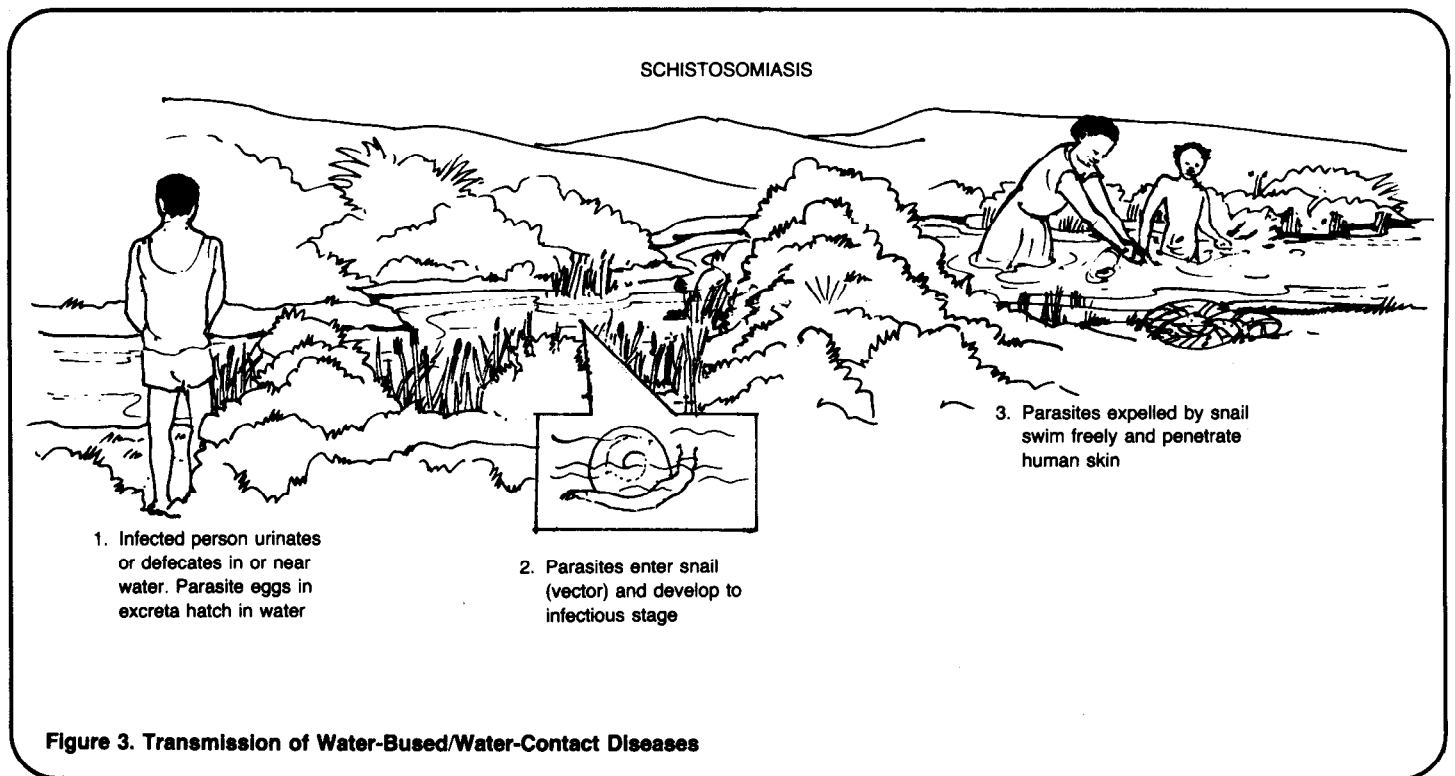
3. When people are ignorant of the need for personal hygiene and, for whatever set of reasons, either do not bathe frequently or use the same water and towels to wash more than one person, then trachoma and conjunctivitis are passed around within a family or other groups living together and scabies get passed from the skin of one person to the skin of another.

Water-Contact Diseases (Body-of-Water Related)

Water-contact diseases are diseases which are transmitted when people have contact with infected water. The single most important water-contact disease is Schistosomiasis (blood fluke disease). It is very widespread in Asia, Africa and South America with

hundreds of millions of people at risk of getting the disease and millions suffering from it. Figure 3 shows how schistosomiasis is transmitted. Briefly, transmission is as follows: Schistosome eggs passed in urine or feces fall into water where a first stage larva hatches. The first stage larva, to survive, must find and penetrate a specific type of snail. In the snail, the first stage larva changes into a large number of sacs in which many thousands of forked-tailed second stage larva are produced over a period of months to years. Each day, several hundreds of these second stage larvae escape from the snail to swim about in the water seeking the warm skin of a human hand or food into which to penetrate. Once through the skin, the little worm enters the person's blood stream, grows to maturity (worms are about a centimeter long), works its way into the blood vessels of the intestine and urinary bladder, and lays its eggs in the wall of those organs. The eggs then cut their way through the tissues to the inside of the intestine or bladder and are passed with the feces or urine. So the transmission cycle continues.

Schistosomiasis is transmitted in areas:



1. Where poor sanitation is practiced so that feces or urine find their way into bodies of water that contain snails, or where rats or wild animals get the worms and keep the snails infected.

2. Where the appropriate type of snail is abundant and can become infected.

3. Where people enter infected water to bathe, wash clothes, dip up water, cultivate crops or swim.

4. Where irrigation projects or man-made lakes have extended the bodies of water in which snails can grow and have the chance to be infected from man or wild animals.

Water-Related/Insect Vector (Carrier) Diseases (Water Site Related)

Water-related insect vector diseases are those that are transmitted by insects which breed in or near water. Transmission occurs when the insect becomes infected with the disease organism from biting a person or animal, and then bites another person. The parasites are injected into the skin or bloodstream by the insect bite. The insects breed in water that is used as water supplies (streams and rivers) and, in the case of mosquitoes, in water storage jars, and water tanks, or in shaded high humidity areas near streams or lakes.

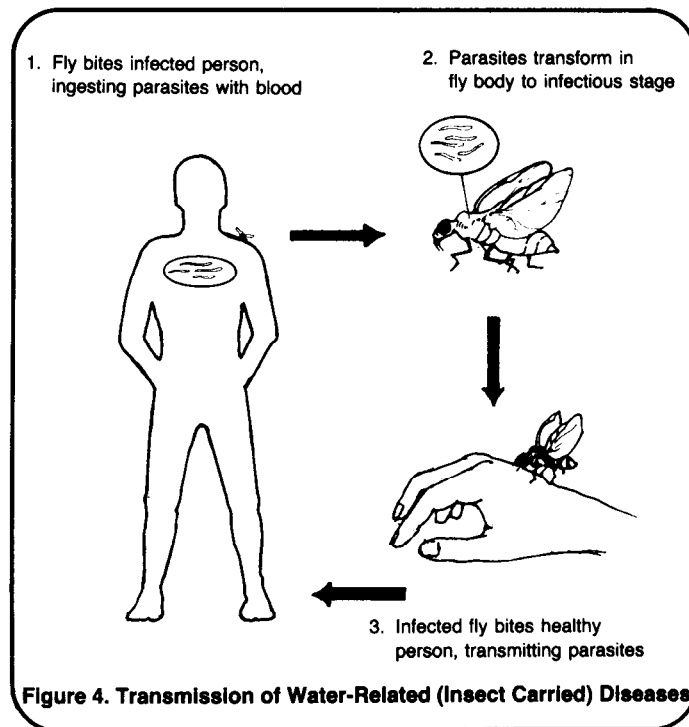
The most common diseases in this category are:

- African trypanosomiasis (sleeping sickness) which is transmitted by the tsetse fly which thrives on high humidity and breeds in river areas under lush vegetation growing at water sites.

- Onchocerciasis (river blindness) which is transmitted by blackflies which breed while attached to rocks and vegetation in fast-flowing rivers and streams. Figure 4 shows how onchocerciasis is transmitted.

- Malaria which is transmitted by female anopheline mosquitoes which breed in a wide variety of water collections.

- Arboviruses (yellow fever) which is also transmitted by mosquitoes. The



type of mosquitoes that carries this disease is different from that which carries malaria. Mosquitoes that carry yellow fever breed in highly polluted stagnant water and usually rest in areas far from their breeding places.

- Filariasis which is a worm infection spread by mosquitoes. The mosquitoes that carry the parasite breed in any stagnant pond or pool or in water in cans, coconut husks, dishes, gutters or wherever water is standing.

The transmission of water-related insect vector diseases occurs in many types of situations in which the insect vectors are able to breed in large numbers, can bite persons infected with the protozoan or worm that causes the disease, and later, after the parasites have developed in them, have the opportunity to bite other people. In many situations, the water supply site where people come to get their water, is the place where the insects get their opportunity to bite both infected and other people. The household environment is also a place where some of these diseases are transmitted.

Sanitation-Related Diseases (Fecal Polluted Soil Related)

Sanitation-related diseases are specifically those that are transmitted by people lacking both sanitary facilities

for waste disposal and knowledge of the need to dispose of wastes in a sanitary manner. The infective stage of the worm which causes those diseases develops in fecally contaminated soil. The most common diseases in this category are hookworm and roundworm.

Hookworm larvae develop and live in damp soil that has been contaminated with feces containing hookworm eggs. They penetrate the bare feet of people walking or standing on the infected soil. See Figure 5. Entrance can also occur through the hands or other skin areas.

Roundworm or ascariasis is transmitted by swallowing eggs which have become infective by developing on polluted soil. The eggs are eaten by children who play on the infected soil, drop food on the soil and then eat it, or eat from dirty hands or eat contaminated raw vegetables.

Both diseases occur:

1. Where there are not latrines and the soil is polluted, where latrines are not sanitary or where they are not used.

2. Where fresh untreated feces are used as fertilizer.

3. Where people are not educated to wash their hands before eating.

Summary

This technical note has discussed several diseases which are common in many countries. They are all directly related to local environmental conditions and are all passed from person to person. The cycle, or chain of transmission, involves both direct transmission of the disease or else depends on an agent, or vector, for the transmission.

Once the chain of transmission is understood, means to break the chain should be adopted. Generally, relatively simple environmental measures need to be developed to stop the spread. The methods of doing this are discussed in "Methods of Improving Environmental Health Conditions," DIS.1.M.2.

