WATER DISINFECTION METHODS
Advantages and Disadvantages

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OBJECTIVES:

- Define and give examples of different methods of disinfection for drinking-water.
- Identify the difference between the physical and chemical disinfection techniques.
- Evaluate the safety, cost, effectiveness, and popularity of various disinfection techniques.
WHAT IS DISINFECTION?

**DISINFECTION is …**

- The removal, deactivation or killing of pathogenic organisms.
- A water treatment processes designed to destroy disease-causing microorganisms. The efficacy of disinfection is often assessed by measuring the coliform group of indicator organisms. (PNSDW2017)

**Purpose of DISINFECTION:**

- To ensure that water is safe to drink regardless on the method used.
TWO TYPES OF DISINFECTION

- Primary disinfection
- Secondary disinfection
COMMON MICROORGANISMS PRESENT IN WATER

- **BACTERIA** – Escherichia coli, leptospira species, salmonella, shigella and vibrio cholerae
- **PROTOZOA** – Balantidium coli, Cryptosporidium, Entamoeba histolytica, Giardia lamblia
- **VIRUSES** – Entero viruses, Hepa A and Rota virus
- **HELMINTHS** – Ascaris lumbricoides, T. solium, Trichuris trichuria
DISINFECTANTS USED IN WATER

◆ DISINFECTANTS USED FOR CHEMICAL disinfection

- Chlorine (Cl₂)
- Chlorine Dioxide (ClO₂)
- Hypo chlorite (OCl⁻)
- Ozone (O₃)
- Iodine (I)
- Potassium Permanganate (KMnO₄)
DISINFECTANTS USED IN WATER

◆ DISINFECTANTS USED FOR PHYSICAL disinfection
  ▪ Ultraviolet Light (UV)
  ▪ Sound (ultrasound)
  ▪ Heat (boiling)
CHLORINATION

What is CHLORINATION?

- Chlorination is the process of adding chlorine to drinking water to disinfect it and kill germs.
- Chlorination is a cheap, effective, relatively harmless (and therefore most popular) disinfection method.
- Chlorinated water can taste and smell different compared to raw water.
- Chlorine and its compounds are the common chemical disinfectants. They are quick in action. In the presence of moisture chlorine is highly corrosive.
Chlorine Gas

- Highly oxidizing, toxic, corrosive and hazardous yellow-green gas
- Can be lethal to human beings at 0.1% (volume) concentration
- Heavier than air and spreads slowly at ground level
- Effective against all types of microbes as both primary and secondary disinfectant
- Chlorine handling requires specialized equipment, care and skill
- A separate storage room should be provided. Chlorinator installed in the rooms with direct emergency access to outside air
- Self contained breathing apparatus and chlorine cylinder repair kit must be readily accessible (Masks, air tanks, chlorine detection devices etc.)
Sodium Hypochlorite Solution

- Clear, slightly yellowish solution with a characteristic odor
- If stores for a long time, it becomes inactive
- Same DBPs as chlorine gas plus bromate and chlorate formation
Calcium Hypochlorite

- White granular solid (or tablets compressed from the granules) with an odor of chlorine
- Toxic, irritating to the skin
- Non-combustible, but will accelerate the burning of combustible materials.
- May explode from heat or contamination
- Powerful oxidizing agent, particularly in the presence of water or as it decomposes when heated to release oxygen and chlorine gases
Chlorine Dioxide

- Denatures protein in bacteria and viruses even more effectively than chlorine
- Cannot be stored
- Must be produced on site
- Very soluble in water
- Does not react with NH-4
- Provides residual disinfection
- It may produce toxic chlorate and chlorite
- Installation of filtration system is necessary before point of use
OZONE

Ozone is a strong oxidant
- It is generated on-site at water treatment facilities by passing dry oxygen or air through a system of high voltage electrodes.
- Widely used in Europe
- More effective against microbes compared to chlorination
- No taste and odor problems
- No residual disinfectant
- Difficult to monitor and control

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ULTRAVIOLET RADIATION

- Damages DNA, inhibits replication
- No known toxic by-products
- Effective against bacteria and viruses
- No disinfectant residual
- Water must have low turbidity
- Lamps must be free of slimes and organic materials
- Difficulty in determining dosage
- No taste and odor

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FACTORS THAT AFFECT EFFICACY

- Dosage
- Contact time
- Turbidity
- Presence of reactive microorganisms
- pH
- Water temperature
- Relative strength of disinfectant
- Mixing
OTHER METHODS OF DISINFECTING WATER

- Boiling
  - effective method for small batches of water during water emergencies.
- Solar disinfection (SODIS)
- Bromine
- Iodine
- Chloramine
- Potassium Permanganate
- Ultrasound
After application of disinfection of choice, and that disinfection requirements have been met at the source, the distribution system (including the plumbing), is the final barrier to preventing water borne disease.
Intrusion of Pathogens can occur because of the ff.:

- Depressurization due to water main breaks or low water supply
- Contamination during maintenance, repairs or restoration
- Inadequate storage facility protection
- Cross connection/backflow
Summary

- Disinfection is the final process to which water is subjected prior to distribution. All other treatment processes such as sedimentation, flocculation, coagulation, filtration cannot give guarantee for safe water.
- Only the disinfection process can assure that the water is safe. In the absence of all other processes disinfection alone can be employed as a single effective treatment process.
- Effectiveness of the method also depends on the existing distribution system and the monitoring of our employees.
When your ship’s taking on water  
You don’t jump  
You don’t get a bucket  
(Seth Wright, Designated Survivor)  

You find the hole
THANKS TO …

- EPA.gov
- WHO.INT
- cdc.gov
- nesc.wvu.edu
- doh.wa.gov
- Canada.ca
- PNSDW 2017
- Friends from Dasma Water Districts
- Friends from other Water Districts
- J.ducoste
- GOWRI V PRABHU 2nd MSc EVS