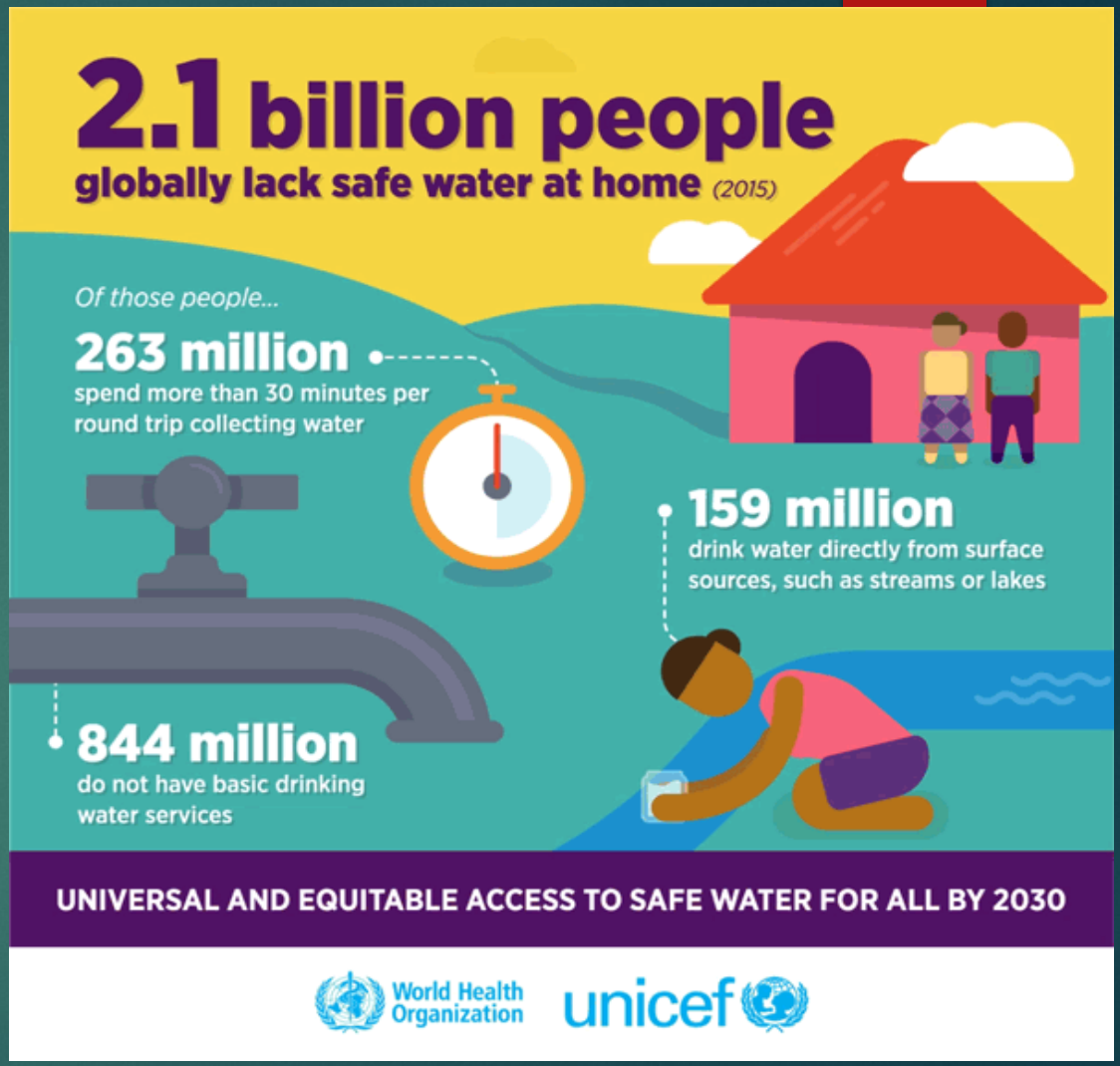
# WATER SANITATION

ASST. PROF. MARY ABIGAIL HERNANDEZ, RN, MPH

# OBJECTIVES

- Explain the different processes involved in the treatment of public water supply.
- Discuss the different water -related diseases caused by unsanitary water and its prevention
- Explain other methods of water treatments used in household.
- Recognize practices of collection, storing or handling water which are detrimental to health
- Recognize the importance of safe sanitation in maintaining health and well-being


6.1 SAFE DRINKING WATER FOR ALL
6.2 SANITATION FOR ALL
6.B MORE LOCAL PARTICIPATION
6 CLEAN WATER AND SANITATION
6.3 BETTER WATER QUALITY
6.A INTERNATIONAL COOPERATION
6.4 MORE EFFICIENT WATER USE
6.6 HEALTHIER ECOSYSTEMS
6.5 INTEGRATED WATER MANAGEMENT


2.1 billion people
globally lack safe water at home (2015)
Of those people...
263 million
spend more than 30 minutes per round trip collecting water
159 million
drink water directly from surface sources, such as streams or lakes
844 million
do not have basic drinking water services
UNIVERSAL AND EQUITABLE ACCESS TO SAFE WATER FOR ALL BY 2030
World Health Organization
unicef

# In the Philippines,

- Nearly 5 million people rely on unsafe and unsustainable water sources and 9 million lack access to improved sanitation

(water. Org)

# Water Usage in the Philippines

- Agricultural use accounts **for 83% to 85%** of this amount, the remainder being shared by the industrial, commercial, and domestic sectors.
  - Philippines water supply sector assessment

# Sources of Water

- **Surface water**
  - are those **found in rivers, lakes, ponds, streams** and other bodies of water above the ground
  - should **not be used** as a source of drinking-water **without sanitary protection or treatment.**
  - **Frequently polluted** by uncontrolled disposal od human excreta and other domestic, industrial or agricultural wastes

- **Ground water**
  - Considered the **largest source of water**
  - Accounts for the **water found under the soil** like wells, from deep and confined aquifers
  - **Normally safe to drink** since water is microbially safe and chemically stable

# Sources of Water

- **Rain water**
  - Basically free from impurities but contamination may occur at the collection and storage points.

***Philippine System of Integrated Economic and Environmental Accounts**

> This is to estimate the country's water resources because of the growing problem of the country's water supply

> made by National Statistical Coordination Board

# Levels of Water Facilities

- **Level 1:** stand-alone water points/ Point source ( hand pumps, shallow wells, rain water collectors
- **Level II** : piped water with a communal water point (bore wells spring systems
- **Level III:** piped water supply with a private water point. ( household service connection

# Levels of Water Facilities

- Level 1: Point Source

  - a protected well or a developed spring with an outlet but without a distribution system

- generally adaptable for rural areas where the houses are thinly scattered.
- normally serves around 15 to 25 households and its outreach must not be more than 250 meters from the farthest user.

# Levels of Water Facilities

- Level II: Communal Faucet System

  -A system composed of a source, a reservoir, a piped distribution network and communal faucets

  -The system is designed to deliver water to an average of 100 households with one faucet per 4 to 6 households

  -suitable for rural and urban areas where houses are clustered densely to justify a simple piped system.

# Levels of Water Facilities

- Level III: Waterworks System or Individual House Connections

  -it a system with source, a reservoir, piped distribution network and household taps

  - generally suited for densely populated urban areas

  - requires a minimum treatment of disinfection.

- **Drinking-water supply surveillance** is

  "the continuous and vigilant public health assessment and review of the safety and acceptability of drinking-water supplies" (WHO)

# CHARACTERISTICS OF WATER

- **Physical**
  - – refers to its turbidity, color, taste, and odor.

- **Chemical**
  - Refers to its alkalinity, hardness (soap consuming power), content of total solids, chloride and iron
  - Total solid content of a given water refers to the total mineral impurities contained in it.

- **Biological**
  - Refers to the presence of bacteria, viruses, parasites and other microscopic plant and animal like algae.
  - Presence of biological impurities serves as an index of the degree of pollution of the water

# Water Treatment Methods

- Chlorination/Disinfection
- Sedimentation
- Coagulation and Flocculation
- Filtration

# Water Treatment Methods

- **Chlorination/ chemical disinfection**
  - It is the most commonly used disinfection process.
    - Chlorine shall be used as the main water disinfectant
  - is employed primarily for microbial disinfection
  - can be achieved by using liquefied chlorine gas, sodium hypochlorite solution or calcium hypochlorite granules
  - Chlorine dissolves in water to form hypochlorous acid (HOCl) and hypochlorite ion ($OCl^-$).

# Water Treatment Methods

- Other disinfection methods include chloramination, and UV radiation

  - **Chloramines** are less effective than free chlorine but used as **secondary disinfectant** for the maintenance of stable distribution system residual

  - **UV radiation-** used to inactivate protozoa, bacteria, bacteriophage, yeast, viruses fungi and algae.

  -

# Water Treatment Methods

- **Coagulation/ Flocculation**
  - This chemical process usually comes first before sedimentation.
  - This involves the use of chemicals such as **alum or aluminum sulfate** to form flocculent precipitates of "flocs".
  - Alum, a chemical coagulant, is added to water to put the non-settling particles together into larger and heavier solids called flocs.
  - Usually accomplished in two stages: rapid mixing and slow mixing

    > Rapid mixing is done to disperse the coagulants evenly into the water and to ensure complete chemical reaction

    > Slow mixing or the flocculation.

# Water Treatment Methods

- **Sedimentation**
  - This process allows suspended particles that are denser than water to gradually settle to the bottom of the tank under still condition (plain sedimentation)
  - Long term storage reduces the amount of suspended sediment and bacteria
  - Shallow tanks with large surface area will be more effective for the process of sedimentation
    - SEDIMENTATION TANKS may be rectangular or circular in shape usually about 3 meters.( 10 ft deep)

# Water Treatment Methods

- **Filtration**
  - It is a physical process which removes the impurities from water by percolating it through layers of porous and granular material such as sand
  - Suspended particles are trapped within pore spaces of the filter media . This helps in removing harmful protozoa and natural color

# Household Water Treatment System

**Household water treatment and safe storage (HWTS)**

- is an important public health intervention to improve the quality of drinking-water and reduce diarrheal disease, particularly among those who rely on water from unimproved sources, and in some cases, unsafe or unreliable piped water supplies.

# Household Water Treatment System

- **Chlorination/ Disinfection**
  - Disinfection is an effective barrier to many pathogens and should be used for surface waters and for groundwater subject to faecal contamination.
  - The destruction of pathogenic microorganisms is essential and very commonly involves the use of reactive chemical agents such as **chlorine**
  - **Takes time to work, should be thoroughly mixed with an adequate dose of dissolved chemical and should be allowed to stand for at least 30 minutes before consumption**

# Chlorination

## Advantages:

- The benefits of chlorination are:
- Proven reduction of most bacteria and viruses in water
- Residual protection against recontamination
- Ease-of-use and acceptability
- Proven reduction of diarrheal disease incidence
- Scalability and low cost

## Disadvantages

- Relatively low protection against protozoa
- Lower disinfection effectiveness in turbid waters
- Potential taste and odor objections
- Must ensure quality control of solution
- Potential long-term effects of chlorination by-products

https://www.cdc.gov/safewater/chlorination.html#effectiveness

# Chlorination
# To use the chlorination method

- Add one full bottle cap of the sodium hypochlorite solution to clear water (or 2 caps to turbid water) in a standard sized container, agitate, and wait 30 minutes before drinking.

# Chlorination

- free chlorine (also known as chlorine residual, free chlorine residual, residual chlorine) in drinking water indicates that:
  - 1) a sufficient amount of chlorine was added initially to the water to inactivate the bacteria and some viruses that cause diarrheal disease; and,
  - 2) the water is protected from recontamination during storage. The presence of free chlorine in drinking water is correlated with the absence of most disease-causing organisms, and thus is a measure of the potability of water.

# Household Water Treatment System

- ***Therma: l (heat) technologies***
  - Primary mechanism for the destruction of microbes in water is heat produced by burning fuel.
  - These include boiling and heating to pasteurization temperatures
  - raise the temperature so that a rolling boil is achieved, (five minutes will be the minimum time suitable)
    removing the water from the heat and allowing it to cool naturally, and then protecting it from post-treatment contamination during storage.

# Household Water Treatment System

- ***Solar disinfection*** **(Solar water disinfection or SODIS system)**
  - uses clear plastic containers penetrated by UV radiation from sunlight and rely on the combined action of the UV radiation, oxidative activity associated with dissolved oxygen and heat.
  - plastic soda bottles are filled with 0.3-2.0 liters of low-turbidity water, shake them to oxygenate, and place the bottles on a roof or rack for 6 hours (if sunny) or 2 days (if cloudy). The combined effects of ultra-violet light (UV)-induced DNA damage, thermal inactivation, and photo-oxidative destruction inactivate disease-causing organisms.
  - SODIS has been proven to inactivate the viruses, bacteria, and protozoa that cause diarrheal diseases. Field data have also shown reductions of viruses, bacteria, and protozoa in water from developing countries treated with SODIS.

# Solar Disinfection

## Advantages

- Proven reduction of viruses, bacteria, and protozoa in water
- Proven reduction of diarrheal disease incidence
- Simplicity of use and acceptability
- No cost if using recycled plastic bottles
- Minimal change in taste of the water
- Recontamination is low because water is served and stored in the small narrow necked bottles

## Disadvantages

- Need to pretreat water of higher turbidity with flocculation and/or filtration
- Limited volume of water that can be treated all at once
- Length of time required to treat water
- Large supply of intact, clean, suitable plastic bottles required

# Types of Water Examinations Required for Drinking Water

- **Initial examination -** The physical, chemical and bacteriological examinations of water from newly constructed systems or sources are required before they are operated and opened for public use.

- **Periodic examination -** Water from existing sources is subject to bacteriological examination as often as possible but the interval shall not be longer than six months, while general systematic chemical examination shall be conducted every 12 months or oftener.

Code on Sanitation of the Philippines

# Standards for water sampling

- Initial examination shall be conducted for new and newly constructed water sources while periodic examination shall be done for existing water sources.
- Water samples for initial and periodic examination from all water sources shall cover microbiological, physical, chemical and radiological parameters
- The collection of water samples shall comply with the standard sampling requirements
- Only certified sampling personnel shall collect water samples for regulatory purposes
- Drinking water from refilling stations, vending machines, mobile tanks and bulk water supply shall be subject for initial and periodic examination.

# Critical parameters of quality drinking water

- Feacal coliforms
- Turbidity- this is describes the cloudiness of water
  - Chlorine and other disinfectants may not work properly if the water is too turbid
- Chlorine residual- the amount of chlorine in the water.
  - This is an effective disinfectant and kills microorganism. Amount of chlorine should be controlled to ensure that adequate chlorine is In the water to disinfect properly
- pH-a measure of acidity of water which affect the ability of chlorine to kill microorganism

# Water- related diseases

- Some of the pathogens that are known to be transmitted through contaminated drinking-water lead to severe and sometimes life-threatening disease.
- Examples include
  - typhoid, cholera,
  - infectious hepatitis (caused by hepatitis A virus or hepatitis E virus) and
  - disease caused by *Shigella* spp. and *E. coli* O157.
  - Others are typically associated with less severe outcomes, such as self-limiting diarrheal disease (e.g. noroviruses, *Cryptosporidium*).

-WHO

# Water- related diseases

- Bacteria are generally the group of pathogens that is most sensitive to inactivation by disinfection.

- Protozoa are the group of pathogens that is least sensitive to inactivation by chemical disinfection. UV light irradiation is effective against *Cryptosporidium*, but *Cryptosporidium* is highly resistant to oxidizing disinfectants such as chlorine.

# 4 categories of Water- related diseases

- a. Water-borne – infections spread through contaminated drinking water (e.g. diarrheal diseases, typhoid fever)
- b. Water washed – diseases due to the lack of proper sanitation and hygiene (e.g. Ascariasis, Ancylostomiasis)
- c. Water-based – infections transmitted through an aquatic invertebrae organism (e.g. Schistosomiasis)
- d. Water related insect vector borne- disease transmitted by insects that depend on water for their propagation (e.g. Malaria, Lymphatic Filariasis, Japanese encephalitis)

# REASONS FOR HIGH PREVALENCE OF WATER RELATED DISEASES

- Insufficient water supplies and sanitation,
- Inadequate housing and lack of hygienic conditions
- Lack of good health care

# Ways to protect drinking water from contamination

- Washing clothes or bathing within a radius of 25 meters from any well or other source of drinking water is prohibited.
- No artesians, deep or shallow well shall be constructed within 25 meters from any source of pollution
- No radioactive sources or materials shall be stored within a radius of 25 meters from any well or source is adequately and safely enclosed by proper shielding
- A warning sign, "NOT FOR DRINKING" shall be permanently posted on tap hydrant or faucet with unsafe water

# Ways to protect drinking water from contamination

- Water from a well
  - As a standard rule, construction of  a well should be situated at least 25 meters away from the latrine or rubbish heap to prevent contamination by seepage from the latrine/ rubbish heap to the well.
  - Where the area is sloping, the well should be located above these sources of pollution.`

- Safe and readily available water is important for public health, whether it is used for drinking, domestic use, food production or recreational purposes. Improved water supply and sanitation, and better management of water resources, can boost countries' economic growth and can contribute greatly to poverty reduction.