**MODULE**

# *Infection Control in Health Care Facilities*

Diploma Program
For the Ethiopian Health Center Team


Ethiopia Public Health
Training Initiative

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# UNIT ONE

# INTRODUCTION

"A century ago hospitals were hazardous places. Postoperative infection was so common that suppuration was referred to as "laudable pus"; its presence was thought to indicate a useful reaction to injury. Delivery of babies often resulted in peuperal sepsis and death. Very little was known about the cause or spread of infectious disease; as a result hospital employees, physicians and nurses often developed contagious diseases after exposure to infected patients…neither personal nor environmental cleanliness was considered important. Flies and other insects were regarded as nuisances rather than as threats to health. Techniques to sterilization, disinfection and antisepsis were either unknown or unproven.

Infections in the health care facilities are major public health problems and often a source of great concern to clients, family, staff and community at large. The problem has global distribution but it is more palpable in the developing world, including our country, where hygiene and sanitation standards are low. They are commonly caused by bacteria (staphylococci, E. coli, etc) followed by viruses, protozoa, helminthes and fungi. They are transmitted from client to client, from client-to-staff or vice versa and from the health institution's environment, food, water etc. to clients and staff. These infections are important because:

1) They affect patients who are already sick due to other diseases and with little capacity to resist such additional infections and hence have poor outcomes.
2) They affect staff (health or auxiliary) who move from one room to another and remain in close contact with many other patients consequently infecting themselves and enhancing the chances of proliferation.

3) The manifestation of infection is obscured (overshadowed) by the initial illness which delays early detection and treatment.
4) They are in many cases resistant to the commonly used antibiotics and some, such as HIV, are not curable.
5) Once infection in health care facilities occurs, it requires a lot of effort to eradicate.

For these reasons focusing on the prevention and control of these infections is much better. It is more cost-effective than the treatment of individual cases or the control of epidemics.

This module has two major parts: the core and satellite modules. The core module is comprehensive, consisting of parts that should be known by all members of the team. The satellite modules are developed for specific categories of professionals within the health center team. Thus the core module will mainly focus on causative agents, their source, predisposing conditions, routes of transmission and distribution of the most common infections in health care facilities. It will also describe the standard precautions for their prevention and control and stress the formation of surveillance and infection control committees and their responsibilities. On the other hand, each satellite module will focus on the duties and responsibilities of a specific category of professionals (HO, PHN, EH and MLT) without much overlap of activities. Therefore the satellite module for HO deals with identification and management of infections in HCF. It highlights the HO's managerial role in organizing the surveillance and infection control committee. Similarly the satellite module for public health nurses discusses the important nursing procedures and techniques for the prevention and control of infections. Likewise the satellite module for environmental health technicians describes the role of these professionals in infection prevention and control, hygienic methods to be practiced and the proper collection and disposal of infectious (and non-infectious) waste in the health care facilities. Last but not least is the satellite module for MLT that deals with

techniques of specimen collection and handling, as well as the safety precautions necessary in the laboratory setting. It also deals with the identification of causative agents.

We hope this module will serve as a guide and readily available reference on infection prevention and control in the health facilities in Ethiopia by providing basic and-up-to-date information in this area. The writers would like to inform readers that this module is not a substitute for any book or written material developed on the subject. Finally it should be noted that the contents are periodically revised and are subject to changes to meet requirements of new scientific developments in the area.

## 1.1 Purpose and use of the module

Modules are educational materials prepared from scientific theories and current research. A careful synthesis of these materials by the module development team results in the comprehensive document or module.

This module mainly focuses on, and emphasizes, teamwork in solving health center problems viz. Health Officers, Public Health Nurses, Environmental Health, and Medical Laboratory Technicians all working together in various health center programs.
This module aims to:

- Alleviate the shortage of reading materials in the health center
- Be a source for basic training for the health center team
- Act as a refresher course on infection control
- Creat awareness and common responsibility among health center teams
- Develop control measures for frequently occurring severe infections

## 1.2 Directions for use of this module

In order to make the most effective use of this module the reader should adhere to the following directions:

- Read the introduction and purpose of the module first.
- Read the pre-test and attempt to answer the questions from the core module related to specific professions
- Read and study the contents of the core module
- Discuss the relevance of the contents with other team members
- Apply the knowledge and basic skills in day-to-day activities
- If additional information is needed, read the relevant topics and subject matter from the references given

# UNIT TWO

# CORE MODULE

## 2.1. Pre-and Post-test

## 2.1.1. Pre- and post-tests for the Health Center Team (From the Core Module)

***Directions:*** *Answer the following questions accordingly.*

1. The aim of health education in infection control in HCFs is:
    A. To increase the awareness of patients and attendants in HCFs.
    B. To involve patients, attendants, health professionals and auxiliary staff in the prevention and control of infection.
    C. To ensure the health professionals' involvement in the continuous monitoring of infection control activity in HCFs
    D. All of the above.
2. Which of the following infection transmission routes is (are) possible?
    A. Patient to patient or patient to attendant or vice versa
    B. Health professional to patient /attendant and vice versa
    C. Health professional/patient/attendant to HCF inanimate environment and vice versa
    D. All of the above.
3. Regarding wound infections the wrong statement is/are:
    A. They can be classified as accidental and surgical
    B. Accidental wounds are clean most of the time
    C. Accidental wounds are more common in health centers
    D. Pseudomonas aeroginosa can infect burn wounds
    E. Infection in dirty wounds is usually polymicrobial.

4. Infection control and prevention in HCFs requires knowledge that:
    A. Microbial resistance patterns are important
    B. Hand washing is an important preventive procedure for HCF infection
    C. Viruses and helminthes are the commonest causes
    D. Most of the HCF infections are preventable
    E. All of the above.
5. Which one of the following is the commonest HCF infection?
    A. UTI
    B. Pneumonia
    C. Malaria
    D. Sepsis
    E. None of the above.
6. Which one of the following is not the source of infection in HCFs?
    A. Infected infusants
    B. Antiseptic solutions
    C. Health personnel
    D. Medical equipment
    E. All of the above.
7. Infections in HCFs are different from infections in the general community in that infections in HCFs are:
    A. Resistant to commonly used antibiotics because most of them are caused by viruses like HIV
    B. More costly to treat
    C. Associated with high mortality and morbidity
    D. Difficult to diagnose
    E. All of the above except A.
8. Who do you think should take health education or refresher training in infection control in HCFs? Why?

_____

_____

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9. Who are the members of waste management committee in infection control in HCFs?

_____

_____

10. What are the responsibilities of the Head of the Health Center in infection control management committees?

a) _____

b) _____

c) _____

d) _____

e) _____

11. What are the types of surveillance in HCFs?

a) _____

b) _____

12. Describe the common infection syndromes in HCFs.

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13. List the steps in out break investigations in HCFs.

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14. Write the responsibilities of department heads in infection control in HCFs.

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## 2.1.2. Pre and post tests for specific categories of the Health Center Team (from the Satellite Module)

### 2.1.2.1. Health Officers

***Directions:*** *Answer the following questions accordingly.*

1. Regarding wound infections which one of the following is true?
    A. Prophylactic antibiotics with tetanus antitoxin are the best in wound infection control and prevention
    B. Proper wound management includes thorough cleaning and debridement of the wound
    C. Presence of foreign bodies (e.g. catheter, suture) increases the risk of wound infection
    D. All accidental wounds should be primarily sutured
    E. B and C.
2. For pneumonia in a HCF:
    A. The commonest cause is S. pneumonia
    B. A patient with mental change is at high risk
    C. It can be treated effectively using commonly used antibiotics
    D. It can be easily diagnosed
    E. All of the above.
3. Which one of the following is wrong regarding IV related bacteremia?
    A. Coagulase negative staphylococcus species are the commonest cause
    B. Primarily caused by contaminated IV fluids
    C. History and physical examination are not important for diagnosis
    D. Treatment doesn't involve the removal of the IV line
    E. It is not a life threatening infection.

4. To reduce the risks of UTI in HCFs which of the following is correct?
    A. Avoid unnecessary catheterization
    B. Irrigate with antiseptic solutions
    C. Aseptic techniques should be followed during insertion
    D. Use of a condom catheter in a male when prolonged catheterization is indicated
    E. None of the above.
5. A 40 year old male patient came to the HC with complaints of trauma to his left foot secondary to a traffic accident two hours ago. The patient sustained extensive soft tissue injury with obvious injury to the muscle tissues with visible bone, blood vessels and nerves. There was gross contamination of the wound with soil with visible gravel and pieces of wood. There was however no sign of fracture or neurovascular damage.

    The management of this patient includes:
    A. Cleansing, debridment, systemic antibiotics and tetanus antitoxin
    B. Primary closure of the wound
    C. Urgent referral to the hospital
    D. Learving wound open/undressed
    E. All of the above.
6. Which one of the following microbial classes is a major cause of infection in the HCF?
    A. Bacterial
    B. Viral
    C. Fungal
    D. Helminthic.

7. Which one of the following risk factors contributes to the development of UTI in HCFs?

    A. Catheterization
    B. Instrumentation
    C. Urinary tract anomalies
    D. All of the above.

8. Which of the following bacteria is a major cause of UTI?

    A. Proteus mirabilis
    B. Enteroccocus
    C. Escherichia coli
    D. Pseudomonas aeroginosa

**2.1.2.2. Public Health Nurses**

***Directions: Answer the following questions accordingly***

1. Which of the following types of decontamination ensure the destruction of pathogens from clients/objects?

    A. Cleaning
    B. Disinfection
    C. Sterilization
    D. All of the above.

2. What is the normal level of temperature and duration of boiling at sea level for disinfection?

    A. $90^0$C for 20 minutes
    B. $100^0$C for 20 minutes
    C. $121^0$C for 10 minutes
    D. None of the above.

3. Which of the following types of barrier methods stop the spread of micro-organisms from clients to staff?
    A. Gloves
    B. Masks
    C. Eye glasses
    D. Aprons and gowns
    E. All of the above.
4. Which types of sterilization is/are ultimate alternatives for non-reusable materials in Health care facilities?
    A. Flaming
    B. Steaming under pressure
    C. Autoclaving
    D. Incinerating.
5. Which of the following dressing techniques is not part of the guidelines for keeping wound sites clean?
    A. No need to determine the type of wound for dressing
    B. Keep all articles sterile in contact with the wound
    C. Keep the wound clear
    D. Protect skin from irritations.
6. The following are true for parental procedures except:
    A. Clean the site with antiseptic solutions
    B. Allow time to dry antiseptics
    C. Start a circular motion from outside to inside during cleaning
    D. None of the above.
7. Which of the following techniques is acceptable preparation for entering into a solution room?
    A. Obtain needed equipment
    B. Enter to wear gown and mask
    C. Wash hands after gowning
    D. Remove watch and articles before gowning
    E. All except C.

8. Which of the following types of hand washing are most widely used in health center facilities before a procedure involving contact with tissues?
    A. Soap and running water
    B. Antiseptic and running water
    C. Alcohol rub
    D. None of the above.
9. Which of the following is/are the best barrier method for liquid contaminants?
    A. Gloves
    B. Masks
    C. Eye glasses
    D. Aprons and gowns
    E. All of the above.
10. The proper disposal of sharps includes the following except:
    A. Avoid recapping
    B. Dispose of sharps in puncture resistant containers
    C. Use gloves during disposal
    D. Do not attempt to detach needle syringes.
11. Which of the following processes ensures that the items are free of micro-organisms?
    A. Decontamination
    B. Cleaning
    C. Sterilization
    D. High level disinfections.

### 2.1.2.3. Medical Laboratory Technicians

***Directions: Answer the following questions accordingly***

1. Accurate analysis of specimens depends upon
    A. Collection
    B. Preservation
    C. Processing
    D. All of the above
    E. None of the above.
2. The most frequently performed parasitological test is
    A. Occult blood test
    B. Concentration technique
    C. Direct microscopy
    D. None of the above.
3. One of the following is not the function of cleaning and washing of articles
    A. Reduce the number of micro organisms
    B. Remove dirty materials
    C. Avoid survival of bacteria
    D. None of the above.
4. Which of the following chemical disinfectants kills all micro-organisms including viruses and spore forming bacteria?
    A. 70% Alcohol
    B. Phenol (3%)
    C. Halogens
    D. Household bleach
    E. C and D
    F. All of the above.

5. Specimens are not acceptable for laboratory tests when one of the following is noted.

   A. There is no patient's name identification number km
   B. The label on the request form and the label on the collection container do not match
   C. The wring collection tube has been used
   D. All of the above.

6. List the preferred method for preserving a urine specimen if the sample cannot be tested within 2 hours of being collected.

7. What is the main purpose of any waste disposal program in the laboratory?

**2.1.2.4. Sanitarians**

***Directions: Answer the following questions accordingly***

1. All are infectious waste found in health care facilities except:
   A. Tissues and materials or equipment that have been in contact with blood
   B. Pathological wastes such as organs, body parts and human fetuses
   C. Tissues and materials or equipment that have been in contact with body fluids
   D. All of the above
   E. None of the above.
2. Waste is not generated in which one of the following areas/rooms in health care facilities?
   A. Patient room
   B. Delivery room
   C. Kitchen
   D. Laboratory
   E. None of the above.

3. Describe the five main elements of an outbreak investigation in health care facilities.

a).....

b).....

c).....

d).....

e).....

4. What are the steps in the safe management of infectious waste in health care facilities?

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5. Describe the different parts of a single chamber incinerator.

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6. For disposal of which of the following wastes is infection control in a placenta pit used?

A. Pathological waste

B. Sharp

C. Garbage

D. All of the above

E. None of the above.

7. All are advantages of single-chamber incineration except:
    A. Good disinfection efficiency
    B. Drastic reduction of waste
    C. Inefficiency in destruction of thermally resistant chemicals and drugs
    D. No requirement for highly qualified operators.
8. Primary prevention against infection or contamination of food in Health care facilities includes:
    A. Proper handling of food products
    B. Use clean hands and garments in the food processing area
    C. No skin lesions on the food handler
    D. Refrigeration of the food
    E. All of the above
    F. None of the above.
9. Assessment of the physical facilities of Health care facilities includes the space, ventilation, cleanliness, durability and sanitation of all except in:
    A. Waiting rooms
    B. Infectious waste disposal pit
    C. Patient care room
    D. The health center environment
    E. All of the above.
10. All are the objectives of public education for health-care management of infectious wastes except:
    A. To prevent exposure to health care waste
    B. To create awareness and foster responsibility among patients and visitors
    C. To inform the public about the risk linked to health care waste
    D. All of the above
    E. None of the above.

## 2.2. Significance and brief description of the problem

Health Care Facility infections are major health problems. Implementation and innovation of different aseptic techniques and antibiotics reduced the rate of infection in Health care facilities significantly worldwide from the 19th Century onwards. The problem of infections in Health care facilities however is still a major concern in developing countries like Ethiopia. This is largely due to poor sanitary facilities, poor waste management and lack of awareness regarding disease transmission and control. However the severity and magnitude of this problem is different for different levels depending on the types of health services provided, the number and the types of patients served. Micro-organisms cause most of the infections in Health care facilities and have now become resistant to the commonly used antibiotics making the management of these infections very costly. Infections are usually associated with high mortality and morbidity and as a result caused immense economic, social and health problems. The best management which is less costly and more effective regarding these infections is prevention and control

## 2.3. Learning Objectives

### 2.3.1. General Objective

To give general highlights about the commonest infections and to enable the health center team to prevent and control infections in health care facilities.

### 2.3.2. Specific Objectives

After thoroughly reading this module, the student will be able to:

1. Identify the etiologic agents and sources of the commonest infections in health care facilities.
2. Describe the epidemiology and predisposing factors of the commonest infections in health care facilities.

3. Identify the standard precautions for infection prevention and control in health care facilities
4. Transmit health information and education for clients, family visitors and refresher training for staff on infection control in health care facilities
5. Organize an infection control and surveillance committee for routine monitoring, early detection and management of infections.

## 2.4. Case Study

W/o Shumbe Alako, an 18 year old primigravida mother from Koke peasant association of Igache Woreda, SPNNR, came a month ago to the Yirgachefe Health Center with a main complaint of abdominal pain of 10 hours duration. She had antenatal care in the same health center and no abnormality was detected both on repeated physical examination and during routine laboratory tests.

On her arrival to the health center, she was allowed to stay on the waiting benches for a few hours because the delivery room staff were, as usual, attending to a number of second stage mothers.. After a few hours the mid-wife in the delivery room observed W/o Shumbe pushing very hard and ordered the janitor to clean up the delivery couch. She had used the delivery couch earlier when she attended to the delivery of another laboring mother. The janitor informed her that she had already consumed the water in the tanker and the detergents. The desperate mid-wife, who feared W/o Shumbe may expel the baby on the soiled ground, put the laboring mother on the soiled couch and attended to the delivery. W/o Shumbe Alako delivered a beautiful female child. The mother was cheerful and the child was placed beside her in the bed for 4 hours.

A week after the discharge, W/o Shumbe came to the health center because she had developed a persistently high-grade fever for the past two days. The Public Health Officer at the outpatient department took her history and conducted a physical examination and nothing pertinent was found except a body temperature of $39^0$C. Thinking probably of acute febrile illnesses which is malaria, the Officer sent W/o Shumbe to the laboratory for a blood film examination. Contrary to the physician's expectation she was found to have a negative result for Plasmodium species. He sent her back home with empirical treatment for presumed malaria. He also gave her advice to come back after two days if she had no response or her condition got worse.

Though she took the anti-malarial drugs as ordered, her fever persisted. Then she noticed an offensive vaginal discharge for two days as well as severe abdominal pain. her husband brought her back to the health center because she was getting very ill. The diagnosis of puerperal fever was made. A specimen of the vaginal discharge and blood were taken and were urgently sent to the laboratory. The laboratory findings indicated the following:

- Gram negative rods
- WBC 11,000/$mm^3$
- Hgb 10 g/dl.

In the meantime the Officer noticed that W/o Shumbe was breathing very fast and losing control of herself. Though she had started antibiotics and IV fluids, unfortunately these were not successful. A day after the death of W/o Shumbe an urgent meeting was held at the Health Center Head's Office comsisting of the Health Center Team. They wanted to thoroughly investigate the reasons for the post partal death in the Health Center.

Firstly the Committee assessed the general condition of the delivery room. They found that the delivery room is crowded with clients and the staff were busy attending to successive laboring mothers. In addition they observed delivery sets are thrown here and there, adequate water is not available for cleaning delivery couches and that the room lacks appropriate places for disposal of wastes. They were also astonished to see placental tissues, fecal matters and blood in every corner of the room. Back at the Health Center Head's Office, the Committee designed appropriate measures to tackle the problems observed in the delivery room.

## 2.5. Definition

Infections in health care facilities are infections that occur in health care facilities like health centers, health posts, hospitals, etc

## 2.6. Commonest infections in health care facilities

Infection in HCFs has become a major health problem especially in the health institutions located in developing countries. Therefore identification of these infections, their source and some factors responsible for their acquisition is very important.

There are many microbes responsible for various forms of infection in health care facilities. For simplicity the most common infections and their etiologies are discussed in the following categories.

## 2.6.1. Bacterial infections

Bacteria are the major cause of infections in HCFs. The Gram-negative bacteria are most commonly isolated pathogens from all sites of infection. This is mainly because of the abundant anti-microbial that affects gram-negative bacteria for which the bacteria develops resistance.

The following are the most important bacterial infections that deserve every health professional's awareness in HCFs:

### 2.6.1.1. Urinary tract infections

Urinary tract infections include infections of the urethra, bladder, the ureters and the kidneys. Most cases of UTI are caused by gram-negative bacterias especially E.Coli. Escherichia coli is a normal flora in the gastro-intestinal system of humans but under certain conditions it might result in infections like urinary tract infection.

Most patients within health care facilities acquired UTIs after catheterization, instrumentation and/or operation in the lower urinary tract. Host factors also contribute for the risk of developing UTI in health care facilities.

### 2.6.1.2. Wound infection and abscess

Wounds can be broadly classified as traumatic (accidental) wounds and surgical wounds. In developing countries such as Ethiopia where sporadic disputes and poverty prevail traumatic wounds are the more common ones. These traumatic wounds are most of the time infected (dirty) wounds. Dirty wounds are more prone to multiple micro-organism contamination.

Commonly isolated bacteria include:

- Gram positive (both aerobic and anaerobic)
- Staphylococcus species
- Streptococcus especially in deep abscesses
- Clostridium species (Clostridium tetani, Clostridium perfringens)

- Gram negative
  - Escherichia coli
  - Pseudomonas aeroginosa

Special attention should be given to unclean burn wounds where micro-organisms like clostridium species and pseudomonas are mostly isolated.

#### 2.6.1.3. Air-borne infections

These are infections transmitted by inhalation of pathogenic (disease causing) micro-organisms. Pneumonia, which literally means acute infection of the lung, is one the leading causes of death, especially in children, in the developing world. Though streptococcus pneumoniae is a common cause at the community level, staphylococcus aureus is known for its aggressiveness in health care facilities.

Tuberculosis is the other common bacterial infection of the lung in health care facilities. This chronic infection of the lung is caused by Mycobacterium tuberculosis. With the advent of HIV, multi-drug resistance tuberculosis is becoming a problem that needs attention by all health workers in health care facilities.

#### 2.6.1.4. Relapsing fever

This is a common acute febrile illness in situations of poor hygienic and is caused by bacteria called borrelia recurrentis. Relapsing fever, if not identified early, can result in deadly complications. It needs joint management by all health worker teams in health care facilities.

### 2.6.2. Non-Bacterial causes of infections

Previously it was mentioned that bacteria play a major role in nosocomial infections. Though not as common as bacteria other micro-organisms like viruses, fungi, protozoas, helminthes and ricketssias also play a major role in causing infection in health care facilities.

The most common ones include:

#### 2.6.2.1. HIV/AIDS

Acquired immunodeficiency syndrome is a systemic viral disease caused by a virus called HIV (Human Immuno Deficiency Virus). Though it is a chronic illness with long periods of latency (3-12yrs), initial acquisition of the virus can occur in health care facilities due to negligence and accidents in handling specimens and equipment.

#### 2.6.2.2. Hepatitis

Viral Hepatitis is inflammation (infection) of the liver caused by viruses. The commonest causes are viral hepatitis - hepatitis A, B, C, D, E, and G. Feco-Oral route is the commonest way of transmission in cases of hepatitis A and E infection therefore they pose major problems in HCFs where sanitary conditions are very poor. On the other hand contact with contaminated blood and blood products is a major way of transmission of hepatitis B, C, D, and G in HCF so they pose major problems in facilities where universal precaution is not properly followed.

#### 2.6.2.3. Malaria

Malaria is an acute febrile illness most commonly found in the lowlands of Ethiopia. It is caused by protozoas of plasmodium species. Plasmodium falciparum and plasmodium vivax are the two most common etiologic agents in our country. Because of the high prevalence of malaria in our country identification and management of cases, as well as the setting up of preventive measures, are important issues to be performed by members of the health care team. Health care facilities, which are located in malaria endemic areas, should follow general preventive measures (like window iron mesh, bed nets, draining of marshy areas in the vicinity of the HCF...) to control malaria infection in the HCF.

### 2.6.2.4. Fungal infections

Dermatophytes (tinea), Candida and aspergillus species are the most frequently encountered fungal pathogens in health care facilities. “Ringworm” infections of the skin caused by tinea species are common in poor hygienic set ups in health care facilities.

Candida albicans is the candida species most commonly identified in health care facilities. It is the normal flora of the skin and gastro intestinal tract. Unsupervised or prolonged use of medication, which perhaps is due to a lack of awareness by health professionals, can result in the colonization of this pathogen in all body areas.

Aspergillus species are also common in the environment. Air is the principal route of transmission of aspergillus. Acquisition of this fungal species might result in chronic respiratory infections.

### 2.6.2.5. Helmenthic infection

Poor handling of stool specimens especially in the laboratory set-up might result in the common helmenthic infection. These common helmentic infections include ascariasis, taeniasis, and hookworm infections. Infection due to entrobius vermicuclaris, which is highly contagious, is also possible in health care facilities where hygienic care is poor.

### 2.6.2.6. Ricketsial disease

One important cause of acute febrile illness in health care facilities which arises due to poor sanitary conditions is typhus (caused by ricketsia typhi). The health care worker has to give due attention to hygienic control of the disease (like proper washing and ironing of bed sheets, pajamas, fumigation of wards...).

## 2.7. Epidemiology of infection in health care facilities

### 2.7.1. Sources of infection in health care facilities

In health care facilities the source of infection could be different equipment used for different procedures, the patient, the health personnel and other auxiliary staff or the inanimate environment itself.

The epidemiological problem of nosocomial infection may have three categories:

1. Infection present on admission
2. Infection appearing during hospitalization
3. Infection appearing after discharge

The source of most outbreaks in health care facilities is infected patients. These patients can release the pathogenic micro-organisms into the environment, probably in high doses, and can then infect other patients, attendants or staff in general.

Poorly handled food and water are also sources of infection in health care facilities, especially organisms like salmonella, shigella species and escherichia coli.

Although with the recent advent of HIV/AIDS people are becoming aware of using new or well-sterilized equipment, used and non-sterilized equipment are still also one source of infection in health care facilities.

In areas where fumigation and routine cleaning of health centers and their environment is not practiced the inanimate working environment itself is a center of infection.

Therefore identifying the source and the causative agent helps greatly in the control of infection in health care facilities.

## 2.7.2. Predisposing factors that contribute to infection in health care facilities.

### 2.7.2.1. Microbial factors

Theses are factors due to the nature of the micro-organism itself. Some micro-organisms are resistant to a number of drugs and become a cause for infection. What makes these micro-organisms resistant is mainly due to prolonged or improper use of medications.

### 2.7.2.2. Age

During the few months after birth, the infant, especially the premature one is very susceptible to bacterial infections. This is mainly because of poor development of resistance against infection. At the other extreme, older patients with cardiovascular diseases, urinary tract abnormalities or respiratory conditions are prone to infection while in health care facilities.

### 2.7.2.3. Trauma

Individuals in accidents that cause trauma are susceptible to infection. Traumatic wounds produced by crushing and tearing contain large amounts of dead tissue with poor vascularity. Additionally burns patients appear to lose so many proteins which might help them in immune resistance and are also prone to infection.

### 2.7.2 .4. Medications

Although most immuno-suppressive drugs are not ordered in health centers, patients taking these drugs can also have decreased immunity and are subjected to various forms of infection. Similarly patients taking corticosteroids are also liable to infection. Prolonged use of antibiotics may result in the destruction of the normal flora of our bodies. This might in turn lead to proliferation by aggressive

micro-organisms. Additionally prolonged use of antibiotics helps in the emergence of anti-microbial resistant bacteria.

#### 2.7.2.5. Procedures

Certain procedures need sterile techniques. Failure to follow these techniques leads to localized or systemic infection. One common example is catheterization. During this procedure aseptic techniques are needed otherwise there will be contamination of the urinary tract with skin or fecal bacteria. Patients will then present symptoms of a urinary tract infection.

#### 2.7.2.6. Immune Status of Patients and pre-existing co-morbidities

Especially these days when we have increasing numbers of patients with HIV, immune status is a major factor that contributes to infection in health care facilities.

Others factors include patients with diabetes mellitus and some with metabolic/genetic disorders are also prone to some forms of infection.

Pre-existing co-morbidities can directly on impact the immune system such as with HIV or cancer. Co-morbidities such as malnutrition or diabetes can impact on the immune system in an indirect but still potent manner as well. Malnutrition is a critical “host” factor that needs to be considered.

### 2.7.3. Transmission of infection

Infectious micro-organisms may reach the patient by direct contact with other patients, with health personnel, contact with contaminated materials (fomites) or contact with contaminated air droplets.

#### 2.7.3.1. Direct contact

On entry to health care facilities individuals who are said to be infectious should be isolated. Hand washing is the single most important isolation precaution

because it removes organisms acquired from infected people. If the patient is going to transmit the micro-organism by air it is better to place him in a private room. The health care personnel should wear protective devices if he/she is going to come into contact with potentially infectious fluids that can be transmitted between the patient and the health care worker.

#### 2.7.3.2. Airborne spread

Air is a major vehicle for dissemination of micro-organisms. The most common infections transmitted through airborn droplets include tuberculosis (especially multi-drug resistant TB), meningitis (especially meningococcal meningitis at times of epidemics) and others. Isolation is indicated if the patient is known to have great potential to transmit these micro-organisms.

#### 2.7.3.3. Contaminated fomites and fluids

Fomites are inanimate objects other than food and water. Therefore contact of any instrument with open wounds, mucous membrane or internal organs of the body represents a mechanism of transmission of infectious agents to patients. Therefore health professionals must use new or sterilized equipment while working with each patient.

## 2.8. Standard precautions in infection prevention and control

In this section you will learn the standard precautions for infection prevention and control. Standard precautions in the health care facilities include hand washing, barrier methods like wearing glove or, masks, the use of eye protection or face shields, putting on gowns, caps and foot wear, the prevention of injuries by sharp instruments, safe handling of processing instruments and client care equipments, good environmental cleanliness and waste disposal practice, and safe handling, transportation and processing of used or soiled linen.

## 2.8.1. Hand-washing

This is the easiest and cheapest method of infection prevention practiced by human-beings for centuries.

Staff should practice hand-washing on arrival at work, before and after contact with clients, after handling contaminated objects and specimens, before putting on and after the removal of gloves, after using the toilet and before leaving work places.

Both clients and their attendants should also be advised to practice hand-washing.

**Table 1: Types of hand-washing with respect to the recommended conditions**

| ***Types of hand-washing*** | ***Conditions for which it is recommended*** |
|---|---|
| a. Washing with soap and running water | • For most situations |
| b. Washing with antiseptic and running water | • Before procedures that involve contact with tissue under the skin (e.g. surgery, lumbar puncture, etc)<br>• For clients at high risk of acquiring infection e.g. new borne, AIDS patients. |
| c. Alcohol hand rubs. | • When washing with soap and water is not possible and hands don't have visible dirt. |

*Note:- For alcohol hand rubs, you can pour about 3 ml of alcohol or prepared alcohol cotton swabs and rub the hands together.*

- *Washing with soap and running water has to be thorough and prolonged (> 10 minutes)*

*t*

**Caution:** Alcohol can dry your skin. To prevent this you can mix alcohol (100 ml of 60-90% alcohol) with 2 ml of glycerin, propyl alcohol or sorbitol.

## 2.8.2. Barrier methods (Protective Wear)

### 2.8.2.1. Gloves

Proper use of gloves is an effective barrier for infection, protecting both clients and staff from pathogenic organisms.

There are three types of gloves:

a. Surgical gloves: These are used when there is contact with blood and tissues under the skin (e.g. operative procedures).
b. Single use or disposable gloves: Single use examination gloves are very thin and can easily be torn, thus their use is limited to procedures involving contact with intact mucous membranes and are disposed of after single use.
c. Utility or heavy-duty household gloves: These gloves are very thick, and used for contaminated equipment, handling medical or chemical waste and for housekeeping activities.

### 2.8.2.2. Masks

Masks protect people from organisms expelled from another person's mouth. It also protects the mouth from splashes of blood or other fluids from a potentially infected person (either client or health care worker). Either patients or health care workers, depending on who might get infected, often use masks.

### 2.8.2.3. Eye covers and face shields

Eye covers and face shields protect the health worker's eye, nose and mouth from splashes of blood or other body fluids.

#### 2.8.2.4. Gowns

Waterproof aprons prevent micro-organisms from the health worker's arms, body and clothing from entering the client and protect the health worker's skin and clothing from splashes of blood, other body fluids and soiling.

### 2.8.3. Handling, transporting and processing of fused or soiled instruments, linens and client care equipments

#### 2.8.3.1. Handling and disposal of sharp instruments

Injuries with needles and other sharp items are the leading causes of accidental infections of health workers by blood borne micro-organisms. Such injures to health workers usually occur:

- When recapping, bending or breaking hypodermic needles
- When they are struck by a person carrying unprotected sharp instruments
- When using many sharp instruments in small confined spaces and hands are difficult to see (e.g. operations in a cavity).
- When handling and disposing of waste containing sharp instruments
- When giving injections
- When sharp instruments show up in unexpected places like linen.

##### 2.8.3.1.1. Care during injections

Both client and health worker are at risk of infection during injections. The client could be infected if the needle, syringe or medication is contaminated and the health worker can be struck or splashed with blood if the patient suddenly moves.

To prevent these risks

- Always use new or properly sterilized syringes and needles for each client (one syringe and needle for one patient)
- Take proper care of the injection site
- Wash with water and soap if the skin has visible dirt.
- Clean with an antiseptic swab by wiping in a circular motion from the center outwards.

- Advise clients not to move during injections
- Compress the site, bleeding or not, with a cotton swab after the injection.

**2.8.3.1.2. Careful use of intravenous (IV) fluids and multi-dose vials**

Infections are often transmitted through the faulty use of these items, therefore to prevent these proper procedures should be followed:

a) Precautions while using IV fluids

- Clean the site with antiseptic before securing the IV fluids.
- Keep the IV cannulae or needle tightly held to the site of entry.
- When fluids are finished, recover the needle or catheter from the IV line and dispose of it in a sharps container. Put the catheter and IV line and remaining fluid into another container.
- Micro-organisms can survive and grow in IV fluids; discard already opened and used IV bags.
- Avoid unnecessary pricking of IV bags and IV lines with needles.

b) Precautions while using multi-dose vials

Drugs that are available in a vial can be used for several purposes. These require strict care not to become contaminated with micro-organisms during solution preparation and administration. The important cautions include:

- Checking for the absence of leaks or cracks on the vial.
- Checking that the solution is clear and does not have particulate materials except for Depo-Provera, which is milky.
- Wiping the lid of the vial with an alcohol cotton swab.
- Always using a new or sterile needle and syringe. Reusing the same syringe with multiple clients even if the needle is changed is not a safe practice.
- Never leaving one needle inserted into the vial cap for multiple dose uses. This will be a direct route for the entry of infection into the vial.

#### 2.8.3.1.3. Safe handling of sharp materials

Health workers can accidentally puncture each other when passing sharp materials during a procedure:

- Always pass sharp materials by “hands free” techniques. Pass sharp materials from one person to another without touching the item at the same time. Put the sharp material in a sterile kidney basin or other "safe zone" in the sterile operative field.
- Don’t cross the sterile working environment.
- Soak sharp materials in antiseptic solutions for a defined period before cleaning them.

*Note: For further details refer to the satellite module for Nurses.*

#### 2.8.3.1.4. Decontamination and disposal of sharp materials

Decontamination is the process of removing micro-organisms from the surfaces of an object. It should be done before disposal, after procedures or before being processed for reuse.

- Use 0.5% chlorine solution, drawing the solution in and out of the syringe and needle several times and soaking for 10 min; it is then ready for either disposal or processing for use.

*Note: For details of decontamination, please refer to the satellite module for Medical Laboratory Technicians.*

To avoid injuries and infection by sharps;

- Avoid recapping, bending, cutting or breaking needles.
- Don’t attempt to detach the needle from syringes.
- Dispose of sharps in puncture-resistant containers such as a metal box, a heavy cardboard box or an empty plastic jug. These should always be available in an area where sharps are used.
- Use heavy-duty gloves whilst disposing of sharp containers.

Disposal: Improper disposal of sharp materials causes infection and injuries throughout the community. In our society children are at a very high risk of infection and injury as they may use some sharp items and syringes for playing.

#### 2.8.3.2. Instrument processing

Proper handling and processing of instruments reduces infection transmission to clients and staff. This must be routine procedure before any clinical or surgical procedure. The four steps of instrument processing include decontamination, cleaning, sterilization or high-level disinfection (HLD), and use of storage.

##### 2.8.3.2.1. Decontamination

This is the first step in instrument processing for reuse. Decontamination makes the instruments safer to handle by killing many micro-organisms including viruses (such as hepatitis viruses and HIV) with decontamination solutions.

##### 2.8.3.2.2. Cleaning

Cleaning is the process that refers to scrubbing with a brush, detergent and water. It removes organic material, dirt and foreign matter that can interfere with sterilization or HLD and reduces the number of micro-organisms on instruments.

*Note: Use detergent to easily remove grease, oil and other foreign matter. If hand soap is used for cleaning, the fatty acids in the soap will react with the minerals of hard water leaving a residue or scum that is difficult to remove.*

##### 2.8.3.2.3. Sterilization or High Level Disinfection (HLD)

Sterilization ensures that items are free of micro-organisms killing all bacteria and their endospores, viruses, fungi, protozoa, etc. For this reason it is recommended for items like needles and surgical instruments that come into contact with blood or tissue under the skin.

Types of sterilization:

a. Steam sterilization (also called “autoclaving” or “moist heat under pressure”)

This is the most common type of sterilization used in health care facilities. It is done in an autoclave and requires moist heat under pressure, so it needs water and heat (from electricity or a kerosene burner). It is used for items that can be damaged by high temperature (e.g. surgical gloves).

b. Dry heat sterilization (electric oven)

This requires high heat (from electricity) for a specific period of time and has no need for water or pressure. This high temperature makes this method difficult to use for items that can melt or burn easily (e.g. gloves) thus it is only used for glass or metallic objects.

c. Chemical (“cold”) sterilization

Sterilization by soaking in substances such as glutaraldehyde is called chemical (“cold”) sterilization, which is best for heat sensitive items or when methods requiring heat aren’t available.

The effectiveness of any method of sterilization depends on the amount and type of micro-organisms, the organic material (blood, tissues or other body fluids), dirt and the amount of protection the item gives to the micro-organisms (e.g. in grooves). Therefore it is important to thoroughly clean instruments and other items before sterilization to reduce the number of micro-organisms, to eliminate fluids or tissue remains and to remove contaminants that can be collect in joints, grooves and the teeth of items.

d. High level disinfection (HLD)

In this sub section, you will be taught about methods used as an alternative to sterilization where the latter is not available or feasible. It kills all micro-organisms except bacterial endospores (causing tetanus, gas gangrene etc.), which makes it inferior to sterilization. It is suitable for

items that come into contact with broken skin or intact mucous membranes.

There are three types of HLD: boiling, chemical HLD, and steaming. You should have one of these HLDs available in your health facility to backup your sterilization.

1. HLD by boiling: This method only needs clean water and a heat source. Instruments can be boiled for 20 minutes; start timing when the water reaches a rolling boil.

2. Chemical HLD: It is used for heat sensitive items like laparoscopes or when a heat source is not available. This method differs from chemical sterilization as follows:

**Table 2. Difference between chemical HLD and chemical sterilization**

| ***Variable*** | ***Chemical HLD*** | ***Chemical sterilization*** |
|---|---|---|
| Chemical used | Glutaraldehyde or chlorine | Glutaraldehyde |
| Soaking time | 20 minutes | 10 hrs |
| Items rinsed with | Boiled water | Sterile water |

3. HLD by steaming:This is done in a steamer containing one to three tiers. It is best for gloves and cannula (MVA)

Generally both sterilization and high level disinfection kills all organisms (bacteria, viruses, fungi, etc), however endospores are killed by the former but not by the latter. Therefore sterilization is best for all instruments/items which come in contact with blood and tissues under the intact skin. Although HLD is used as an alternative to sterilization it is best for instruments /items that come in contact with intact mucous membrane or broken skin. You are advised to review

the different types of sterilization and HLD and the items/instruments for which they are suitable to use.

#### 2.8.3.2.4. Storage

In this sub section you are going to be introduced to the method of proper storage of processed items/instruments to prevent them from getting contaminated. Storage of instruments or other items should not be in solutions, store them dry. Micro-organisms can live and multiply in both antiseptic and disinfectant solutions and items left soaked in contaminated solutions can lead to infections in clients.

Therefore for optimal storage place sterile packs in closed cabinets in areas that are not heavily trafficked, that have moderate temperatures and are dry and of low humidity. Under such storage conditions and with minimal handling, properly wrapped items can be considered sterile as long as they remain intact and dry.

### 2.8.4. Environmental cleanliness and waste disposal

In the previous sections you have learnt about the major types of infection prevention and control such as hand washing, barrier methods and safe handling and processing of sharps and instruments. In this section you are going to be briefly introduced to environmental cleanliness and waste disposal at health care facilities. Maintenance of environmental cleanliness and good hygiene of health facilities is a cornerstone in promoting health and the prevention of disease. However this is not the case in Ethiopia where it is common to see a health facility compound with piles of medical waste as well as dirty wards and examination rooms. Health care facility cleaners and waste disposal staff in particular are at a higher risk of infection as they are exposed to blood, other body fluids, used sharps and other contaminated objects as a routine part of their jobs. Therefore improving the cleanliness and hygiene of these facilities is one of the major activities towards infection prevention and control efforts.

### 2.8.4.1. Environmental cleanliness and hygiene

#### 2.8.4.1.1. House-keeping

a) Guidelines for cleaning clinics

- Write and post a cleaning schedule
- Wear utility gloves when cleaning
- Use a damp or wet mop or cloth for walls, floors and surfaces instead of dry dusting or sweeping
- Scrub to remove dust or micro-organisms
- Wash surfaces from top to bottom,so that debris falls to the floor and is cleaned up last
- Change cleaning solutions whenever they appear dirty. As heavily soiled solution may not kill micro-organisms

b) Cleaning solutions

Three types of solutions are used for house-keeping in the health facilities. In your institution you should have all of them as they are used to clean the health facility in different situations.

Plain detergent and water: This is for general cleaning tasks and low risk areas. Detergents remove dirt and organic material and dissolve or suspend oil, grease etc. that can easily be remove by scrubbing.

Disinfectant (0.5% chlorine solution): This is used to clean up spills of blood and other body fluids. It rapidly kills and inactivates micro-organisms. Here you may use the common disinfectant sodium hypochlorite.

Disinfectant cleaning solution: This contains disinfectant, detergent and water.

c) Cleaning procedures and schedules

Rooms in a health facility can be classified into the following parts depending on the degree of contamination of the areas:

Low risk areas: These include administrative buildings, waiting rooms, etc. and are not contaminated with infectious micro-organisms and have minimal risk of infection. Routine cleaning (like your house) once a week is enough.

Latrines, toilets and sluice rooms: These are heavily contaminated and have risks of infection. They need cleaning daily with disinfectant solutions.

Client-care areas (operating theatres, procedure rooms, laboratories, areas where instruments are cleaned and processed): These have a potential for contamination with infectious materials and thus potential risk of infection to both staff and client. They need cleaning with a disinfectant solution daily. Clean spills of blood or other infectious materials immediately to prevent the spread of infection.

**2.8.4.1.2. Compound cleanliness and hygiene**

You are advised to refer to the topics that follow (under 3.5.2) and the satellite module for environmental health technicians.

**2.8.4.2. Handling and disposal of health care facility waste**

Health care waste is a waste generated by health care establishments, research facilities and laboratories. About 75 – 90% of this waste is “non risk” or “general waste”.but 10 – 25% of this waste is hazardous and may create various health risks.

**2.8.4.2.1. Types of wastes**

General wastes: These are similar to the household trash of the community and have no risk of infection. This accounts for 75 – 90% of wastes in HCFs.

Hazardous health care wastes: These account for 10 – 25% of all wastes from HCFs. This includes infectious wastes (laboratory cultures, blood tissue etc) sharps, pharmaceutical and chemical wastes (expired drugs, lab reagents,

disinfectants, film developers etc) and radioactive substances (unwashed liquids from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper).

**2.8.4.2.2. Benefits of proper waste disposal**

1. Reduces the risks of spreading infections to staff, clients, visitors
2. Reduces the risk of accidents to both client and staff
3. Provides clean working compounds and rooms
4. Decreases odors
5. Provides limited channel for attraction of insects and animals.

You should think of a clean health center with a clean compound and rooms as a conducive working environment for staff. It will be a place where clients prefer to come for treatment. You should keep your health facility clean.

**2.8.4.2.3. A waste management plan**

Every health facility should have its own health care waste management plan and assign a staff member as coordinator. The waste management plan has four components – sorting, handling, interim storage and final disposal.

Sorting*:* This is separating waste by type at the place where it is generated. Use different containers for medical and general wastes. Containers for sorting should be clearly labeled to prevent accidental contamination or injury.

Handling: Medical waste should be removed from generation sites daily. Avoid accidents during handling.

Interim storage*:* This means storing waste for a few hours before the final disposal but not more than one or two days.

Final disposal*:* General wastes can be taken to the regular community waste disposal point. Medical wastes and sharps can be disposed as follows:

a. Solid medical wastes: Use one of three methods of disposal;

Burning

- Wear utility gloves and shoes during disposal of medical waste
- It is the best method as it sterilizes and reduces the amount of waste in an incinerator or oil drum. Open burning is only used in the absence of these methods

Burying

- The next best option, the pit should have a fence or wall to limit access to it and prevent scavenging of waste

Transporting to an off site disposal site

- This is transporting to an open community dump and is the least desirable alternative. Educate people about how they should handle the waste to prevent themselves from potential accidents.

b. Liquid medical waste*:* You should always wear utility gloves and shoes when handling and transporting liquid medical wastes.

- Avoid splashing the liquid on to the floor, other surfaces, yourself or others.
- Carefully pour liquid waste into a sink, drain, flush toilet or latrines. Rinse with water to remove any remaining waste on these disposal sites. Disinfect the container with 0.5% for 10 min.

c. Sharps: Disposal of sharps is best done by burning in industrial incinerators. However industrial incinerators may not be available in most health facilities in this country. Therefore you may use a metal container for sharps, needles syringes etc. When it is two-

third full, put in a fuel and ignite it. Burn it until the fire goes out on its own.

## 2.9. Health education in the control of infection

Health education plays a major role in the control of infection in health care facilities for all involved parties. Teaching at different levels of sophistication is required for patients and their families, visitors, auxiliary staff and even health care professionals. Health care professionals may need only a “refresher” course given their experience.

### 2.9.1. Health education to patients, families and visitors

Health education to patients should focus on areas such as

For patients who can support themselves

- Maintaining their personal hygiene and cleanliness such as body washing and hand washing before meals and after using toilets
- Having good communication with attendants and health professionals about the progress of their illness
- Reporting if their wound is causing pain or discharge, redness, swelling or fever
- Knowing the proper dietary intake and good drug compliance. This helps the patient to get well quicker and prevents infections in HCFs
- Practicing the standard precautions with strict follow up.

For health care attendants and visitors who sometimes are the cause of infections in patients

- Encouraging hand washing after using toilets and before feeding should be encouraged. In this regard pediatric patients are common victims of infection through contaminated care attendants
- Avoiding room congestion by attendants and visitors in order to avoid air-borne infections

- Discouraging giving non prescribed drugs
- Discouraging non-sterile manipulation of indwelling lines
- Caring and supporting the unconscious or the disabled (e.g. turning over frequently)
- Proper collection and handling of patient's vomitus, sputum or other bodily secretions
- Discouraging the application of scientifically unproven solutions or herbal medicines on wounds which may then play a major role and infection spread in health care facilities.

### 2.9.2. Basic training for auxiliary staffs of HCFs

This should focus on:

- Proper handling and washing of utensils, medical and surgical equipment and discharges from patients. These may other wise be a major source of infection
- Proper disposal of discharges from patients like placenta, debrided parts and other body fluids should be ensured
- Syringes, blades and other sharp disposable items should be discarded with great care to a safe place (sharp collection box or dust bins)
- Patient's bed should be cleaned before it is given to another patient
- Types and applications of standard precautions should be strictly followed.

### 2.9.3. Refreshment training for health professionals in the control of infection in HCFs

- Different techniques of sterilization and disinfection
- Sterile handling of certain groups of patients and instruments
- Proper handling, storage, transportation and washing of bed mattresses as well as disposal of solid and liquid wastes

- Provision of safe water and adequate water supply for the HCFs
- Provision of safe and nutritious food for the patients
- Assessing the temperature, air conditioning, illumination, cleanliness and proper housing conditions of the rooms in HCFs.
- Washing hands before and after examining patients, before buttoning ward coats, putting on and taking off gowns and before eating
- Type and application of standard precautions should be strictly followed.

## 2.10. Waste management and infection control committee

In the previous sections you have read about the common infections in health care facilities, their source, distribution, predisposing conditions, transmission and their impact on patients, staff and the community. You were then introduced to standard precautions for prevention and control in health care facilities and how to create awareness in staff (auxiliary and health), clients and their attendants and the community at large. In this section you will be learning about the waste management and infection control committee, its composition and duties.

The proper management of health care waste depends largely on good administration and an organized effort by all staff of the health care facility actively participating in safe handling, transporting and disposing of wastes to prevent infection. This requires the formation of a committee who can coordinate and monitor the overall waste management plan after its implementation.

### 2.10.1. The formation of waste management and infection control committee of a health care facility

The head of the health care facility (health center/health post) should form this committee and chair the team.

The committee (team) should have the following members:

1. Head of the health center or health post chairman
2. Heads of departments (environmental health, medical laboratory technology, delivery and in patient care, out patient care, MCH, minor OR and autoclaving, pharmacy, etc)
3. Waste management and infection control officer, preferably an environmental health technician, who will also act as the hygienist and address specific problems related to institutional hygiene.
4. Nurse
5. Supply officer
6. Head of cleaners or janitors (attendants, auxiliary staffs)
7. Health center manager

The head of the health care facility should formally appoint the members of the committee in writing, informing each of them of their duties and responsibilities.

Some of the responsibilities of the committee in common are

- Establishing investigation procedures
- Establishing reporting systems
- Reviewing services, antiseptic techniques used and procedures
- Undertaking health information dissemination to teams

## 2.10.2. Duties of members of the committee

### 2.10.2.1. The head of health center is responsible for the following tasks

- Formation of the waste management committee to develop a written waste management plan for the institution, stating duties and responsibilities of all members of staff regarding waste management and establish lines of responsibility
- Appointing a waste management and infection control officer to supervise and coordinate the waste management plan
- Allocating sufficient financial and personnel resources

- Monitoring the efficiency of the waste disposal system
- Insuring adequate training of staff on waste management

#### 2.10.2.2. Waste management and infection control officer

The waste management and infection control officer is directly responsible to the head of the health center, and should

- Control the internal collection of waste containers and their transport to the storage facility on a daily basis, the correct use of storage facilities and prevent unsupervised dumping of waste containers on the ground
- Supervise attendants and auxiliary staff assigned for waste collection and disposal
- Ensure waste containers, protective gloves and clothing and collection trolleys are available at all times
- Ensure that waste is disposed of in the specified time and location
- Ensure the training of staff of the health care facilities to make them aware of their responsibilities in waste segregation and storage
- Coordinate and monitor all departments regarding waste management efforts
- Advise the departments about infection control methods and monitor their proper implementation
- Ensure and co-ordinate surveillance of infection in HCFs.

#### 2.10.2.3. Nurse and health center manager

They are responsible for training nursing staff, medical assistants, health center attendants and ancillary staff on the correct procedures for segregation, storage, transport and disposal of waste. They should

- Participate in the training of staff
- Control the overall waste handling and disposal management as a support to the waste management and infection control officer
- Provide the necessary inputs for waste management and infection control of waste bags and containers, protective clothing etc.

#### 2.10.2.4. Department heads

They are responsible for segregation, storage and disposal of waste in their departments. Therefore they should

- Insure that all health and auxiliary staff are aware of the procedures of segregation and storage of waste and that all personnel comply with the highest standards possible
- Continuously work with waste management and the infection-control officer to monitor working practices for failures or mistakes
- Ensure that staff members in their departments are given training
- Encourage the nursing and medical staff to be vigilant that attendants and auxiliary staff follow correct infection control and waste management procedures at all times.

#### 2.10.2.5. Supply officer (optional)

He/she should

- Ensure a continuous supply of items required for waste management .

### 2.10.3. Surveillance for infections in health care facilities

The waste management and infection control committee of a health facility should establish a surveillance system as part of the infection control efforts. The surveillance system can be active or passive. Passive surveillance relies on routine data collection for other purposes while active surveillance relies on specific collection of data for hospital infection outbreak surveillance. The following are important steps in the surveillance for infection in health care facilities.

#### 2.10.3.1. Diagnosis of infections in health care facilities

The common infection syndromes in health care facilities are summarized in table 3 below

***Table 3: Common infection syndromes in HCF***

| | |
|---|---|
| Urinary tract infection | Post-abortal sepsis |
| Surgical wound infections | Neonatal sepsis |
| Puerperal sepsis | Meningitis |
| Fever | Pneumonia |

Steps in Diagnosis

1. Daily regular examination of patients to detect newly developed infections
2. Carry out "septic screening" in patients suspected of having infectious body fluids (blood, urine and aspirates) and have swabs of infected tissues sent for culture analysis before antibiotics are started
3. Identify any infectious agent in the laboratory, its sub type and drug sensitivity
4. Adjust treatment according to the drug sensitivity
5. Compile data by laboratory analysis on bacterial isolates and sensitivities to drugs

**2.10.3.2. Active surveillance**

Areas in the health care facility at high risk of infection need active surveillance. Culture examinations are essential but may not be available in the health centers as this requires transporting specimens to laboratories with the capacity.

Active surveillance requires as a minimum routine cultures from environmental specimens in operation theatres, intensive care units and burn units. These units care for high-risk patients in terms of possible infections. This routine monitoring will allow early detection of pathogenic organisms in the environment. Swabs from floors, sinks, windowsills and doorknobs should be cultured periodically. Tips of cannulas, medical equipment and disinfectants should be routinely cultured. Swabs of special equipment such as respirators and ambu bags should also be taken and cultured routinely.

### 2.10.3.3. Compiling data

To determine the presence of an outbreak regular compiling of data on the number of cases and the bacterial isolates is essential. The ward should keep records of patients with infections acquired in the HCF, the clinical manifestations and the micro-organisms isolated and drug sensitivities. This data is compiled weekly and then monthly.

The waste management and infection control committee should discuss the data regularly and review infection control strategies. They should then send the data to a central data collecting point (e.g. MOH).

The committee is responsible through its waste management and infection control officer to compile all information into a report and ensure regular follow up of an outbreak investigation as well as the training of health/auxiliary workers on infection control.

### 2.10.3.4. Investigation of an outbreak

An outbreak is an increase in the number of cases of an infectious syndrome. What do you do if you have an outbreak in a health facility?

The WMIC committee should designate a staff member to investigate the outbreak and coordinate different departments to bring the outbreak under control.

Steps for investigating an outbreak

1. Formulate a case definition.
2. Using the case definition show how statistically the current rates are significantly higher than pre-outbreak rates.
3. Review the medical literature.
4. Plot an epidemic curve with the number of cases on the Y-axis and time on the X –axis.

5. Review charts of infected patients and develop line lists containing demographic data (data of admission and procedures, ward location and dates) and potential risk factors.
6. Plot a time line with data for all common events. The number of cases is plotted on the Y-axis and the time interval between infection and potential risk factor on the X-axis.
7. Formulate a hypothesis regarding the source of infection and mechanisms of transmission.
8. Perform a case-control study, comparing infected patients of the same age, sex and service with exposure to potential risk factors.
9. Institute temporary infection control measures.
10. Obtain cultures of suspected common sources, just by referring the samples where cultures are available.
11. Continue surveillance to document efficacy of control measures.
12. Write a report of the investigation for the WMIC committee.
13. Review infection control policies related to the outbreak and revise if necessary.

## 2.11. Learning activities: Case study continued

Based on the history of W/o Shumbe in Section 1.4 of the Core Module, different points of discussion are incorporated in Satellite Modules. Discuss these points. Your teacher can help you.

# UNIT THREE

# SATELLITE MODULES

## 3.1. Satellite module for Public Health Officers

### 3.1.1 Introduction

**Purpose and use of the module**

This module can be used in the training of Health Officers that are in actual training or those already in service for infection control in health care facilities.

**Directions for using the module**

For a better understanding of this module, the Health Officers are advised to:

- Read the purpose, the use and the directions for using the module in section 3.1.2 and 3.1.3 and follow the instructions
- After doing so, do the pre tests in section 2.1 and then go through all the topics of the core module
- Then read the satellite modules for your respective profession with special emphasis to the subject matter. However don't forget to read the satellite module for the other categories
- Read the reference materials listed to supplement your understanding
- Do the post test pertaining your profession in section 2.1 of the core module and evaluate yourself by referring to the keys in unit seven

### 3.1.2 Learning Objectives (Specific objectives for Public Health Officers)

After reading this module the HO will be able to:

1. Know the most common types of HCF infections.

2. Know etiologies and risk factors for each category of infections in health care facilities.
3. Describe diagnostic methods for infections in health care facilities.
4. Describe the management, prevention and control measures of infections in health care facilities.
5. Know the HO's role in the control of HCF infections.

## 3.1.3. The common types of HCF infections

The most common types of nosocomial infections are

1. Urinary tract infection - 28%
2. Surgical wound site infection - 14%
3. Pneumonia -17%
4. Primary blood stream (intravenous catheter related) infection - 16%
5. Sepsis

### 3.1.3.1. Etiologies of the common HCF infections

**Table 1.1 Pathogen distribution (percentage) for major sites of nosocomial infections**

| Pathogen | UTI | Wound infection | Pneumonia | Blood stream infection | Total |
|---|---|---|---|---|---|
| Escherichial coli | 26 | 10 | 6 | 6 | 16 |
| Enterococci | 16 | 13 | 2 | 8 | 12 |
| Pseudomonas aeroginosa | 12 | 8 | 17 | 4 | 11 |
| Staphylococcus aureus | 2 | 17 | 16 | 16 | 10 |
| Coagulase negative staphylococci | 4 | 12 | 2 | 27 | 9 |
| Enterobacter spp. | 6 | 8 | 11 | 5 | 7 |
| Klepsiella pneumoniae | 6 | 3 | 7 | 4 | 5 |
| Candida albicans | 7 | 2 | 4 | 5 | 5 |
| Proteus mirabilis | 5 | 4 | 3 | 1 | 4 |
| Streptococcus spp. | 0 | 3 | 1 | 4 | 2 |
| Seratia marcescens | 1 | 1 | 4 | 1 | 2 |
| Citobacter spp. | 2 | 2 | 1 | 1 | 2 |

### 3.1.3.2. Clinical presentations

A common presentation of the HCF infection is the occurrence of new fever after admission, usually 48hrs. To diagnose a nosocomial infection one must use clinical clues from a patient's presentation, procedures that have been done to him/her, the treatment the patient is having and other risk factors. So a careful history, physical examination, laboratory and imaging diagnostic workups are important.

During patient evaluation particular attention should be paid to the respiratory system, genitourinary systems, gastro-intestinal tract (GIT) and musculoskeletal system.

**History:**

- Cough
- Chest pain
- Change in sputum characteristics (color, amount, content)
- Flank pain
- Dysuria, urinary frequency, costovertebral angle (CVA) tenderness, suprapubic pain,
- Diarrhea
- Headache
- Leg pain and swelling
- Other features related to the patient's admission, like current presence of urinary catheter, IV device, NGT, endotracheal tube, tracheotomy tube, surgical wound, new medication administered, etc. should be asked about.

**The physical examination:** This should be directed at possible sources of infection such as

- Wound sites for signs of inflammations like swelling, tenderness, hotness, redness and presence of pus

- Lungs (chest examination) for increased or decreased tactile fremitus, abnormal percussion note, rhonchi, crepitations, bronchial breath sounds, decrease in air entry, etc.
- Urinary catheter and the color of the urine, pus or other signs of inflammation around the urethral meatus and the proper connection of the catheter with the drainage tube
- IV device insertion site and wet dressing of insertion site, presence of pus, indurations or local heat
- Skin for rashes.

**Diagnostic work up**: CBC, B/F (Blood film), U/A (Urine analysis), sputum Graham stain or AFB stain, Graham stain of pus or other discharges from infection site, CXR.

### 3.1.3.3. Individual HFC infections

**1. Catheter related UTI**

**Incidence*:***

This is the commonest type of HCF infection that accounts for 40% of HCF infections.

**Risk factors**: The six principal risk factors are

a. Female sex
b. Prolonged duration of catheterization
c. Lack of appropriate catheter care like disconnection of the catheter and drainage tube
d. Open drainage.
e. Debilitated patients
f. Lack of proper aseptic technique during catheterization.

**Etiology**: Escherichia coli, enterococci and pseudomonas aeroginosa are the commonest pathogens in decreasing order (Refer to tab 1.1 for others).

**Pathogenesis*:*** This is different in males and females

Female: Periurethral colonization with pathogens trucking up the short female urethra.

Male: No periurethral colonization but intraluminar spread of infection to the bladder.

**Clinical presentation**: Most cause minimal symptoms

- Fever
- Pyuria
- Dysuria
- CVA tenderness
- Urinary frequency
- Supra pubic tenderness
- Flank pain
- Hematuria.

**Complication**: Gram-negative sepsis is the commonest complication

**Investigations**: WBC- leukocytosis, U/A –WBC, RBC, bacteria casts. Refer to the higher center for culture and sensitivity if there is no response to the usual antibiotics.

**Management** can be categorized into two: Antibiotics and supportive treatment

Antibiotics**:** Drug resistance is a common problem. Where urine culture facility is not available empirical antibiotic therapy to cover the commonest causative agents is the only option.

**Oral medications for patients with minimal symptoms**

- Ampcilillin
- Ciprofloxacin
- Ofloxacin
- Cotrimoxazole

**IV-medications for more severe illnesses including acute pylonephritis and urosepsis**

- Ampicillin + Gentamycin
- Ceftriaxone or ceftazidime

**Duration of treatment**: 7-21 days depending on the severity of infection and causative agent.

**Supportive treatments**

- Rehydration
- Analgesics
- Change catheter or if possible remove it

**Preventive measures**

- Proper catheter care
- To avoid unnecessary prolongation of catheterization period follow aseptic techniques during catheterization and catheter manipulation,
- Screening and treating pre-existing UTI before surgery
- Avoid unnecessary catheterization
- Use supra pubic cystostomy or condom catheters (for males) when prolonged catheterization is indicated.

**2. Wound Infection**

This is the second most common type of HCF infection. Evaluations of fever in the admitted patient should include examining wound sites. Wounds can be classified into two:

1. Accidental wounds (contaminated wounds): This is associated with high risk of infection.
2. Surgical wounds: These are associated with less risk of infection.

**Risk factors:**

**Host factors**

- Old age, infancy
- Malnutrition
- Immunocompromised state
- Immuno suppressive drugs like corticosteroids, and cytotoxic drugs
- Diabetic Mellitus
- Obesity
- Presence of infection at other sites
- Severe anemia

**Nature of the wound**:

- Extent of contamination of the wound
- Presence of foreign bodies
- Impairment of local circulation
- Presence and extent of devitalized tissues
- Duration of the wound before arrival to HCF

**3. Health personnel's factor**

- Improper tissue handling
- Inadequate debridment of devitalized tissues
- Unremoved foreign bodies and haematomas
- Inadequate fluid management
- Improper wound treatment like primary closure of grossly contaminated wound
- Not following aseptic techniques in handling and treating wounds
- Lack of prophylactic measures like antibiotics and tetanus anti-toxin.

**Etiology**: The commonest in decreasing order are (See table 1:1)

- Staphylococcus aureus,

- Enterococcus,
- Coagulase negative staphylococcus Spp.
- E.coli.

**Clinical features :**

- Fever
- Wound pain
- Purulent discharge (pus)
- Local heat
- Edema of wound with tight sutures
- Abscess, tenderness, induration
- ± Crepitation

**Investigation**: Usually diagnosed clinically or gram stain of pus or discharge from the wound.

**Management:** Can be divided into two

1. Local wound management and
2. Antibiotics

**Local wound management**

- Clean the wound with normal saline antiseptics
- Remove all foreign bodies
- Remove all devitalized tissues (normal tissues will bleed when it is cut) muscles contract and the color of the tissue also helps to differentiate
- Close the wound primarily if the risk of contamination is less and the patient arrived to the HCF within 8-10 hours
- When gross contamination is anticipated or the patient comes late do the above do not do primary wound closure. Instead cover the tissues like bones, tendons, nerves and blood vessels by approximating the overlying tissues

- Re-examine the wound after 2-3 days
- Dress with sterile gauze
- Undertake daily wound care
- If a surgical wound is infected remove the stitches over the infected area, drain the pus, clean and debride the area and do daily dressing

Note: Grossly contaminated wounds are wounds caused by RTA, war injuries, industrial injuries, with obvious contamination with feces, soil, cow dung and wounds caused by animal bites.

**Antibiotics**:

- Ampicillin, cloxacillin, CAF or metronidazole
- IV penicillin + Gentamycin
- Cloxacillin + CAF (chloramphenicol)/ Metronidazole
- ± Gentamycin
- Ceftriaxone/ceftazidime

**Prevention of wound infection**.

- Proper wound management is by far the most important and effective way of wound infection control and prevention. See the topic under local wound management
- Prophylactic antibiotics
- Local anti septic ointment like in burn wounds
- Administer IM tetanus antitoxin after skin test
- Correct underlying problems like malnutrition, anemia, Diabetic Mellitus,
- Treat pre-existing active infections
- Proper handling of the tissues during surgical procedures and wound management
- Follow aseptic techniques during any surgical procedures
- Use sterile gloves and other barriers

- Sterile medical equipment properly
- Adopt hand washing habits between patients during examination and any other medical procedure.

**4. Pneumonia**

**Epidemiology**. This is the third most common type of HCF infection. HCF acquired pneumonia is a life threatening illness raising mortality to as high as 50% if left untreated.

**Risk factors**

- Patients with altered mental status
- Patient with NGT
- Elderly
- Patients with severe underling illness
- High risk patients on antacid or H2-blockers for stress ulcer prophylaxis
- Immunosuppression.

**Etiology**: The commonest in decreasing order are (Refer to table 1.1)

- P. aeroginosa,
- St. aureus,
- K.Pneumoniae .

**Pathogenesis*:*** Colonization of the oropharynx and stomach is an important step and then aspiration occurs usually during sleep and facilitated by NGT, endotracheal intubations or delayed gastric emptying. As for gastric colonization, bacterial count in the stomach increases with raised PH, which is the problem with the H2 blockers or antacid administration gastric colonization causes retrograde oropharyngeal colonization.

**Clinical features*:*** Diagnosing nosocomial pneumonia is a difficult task and the criteria used are in the presence of risk factors.

**History:**

- Fever
- Cough
- Purulent sputum with or without change of color
- Patient need for respiratory support without other causes (fluid overload, pneumothorax, pulmonary thromboembolism, atelectasis)
- Chest pain.

**Physical Examination:**

- Tachypnea
- Tachycardia
- Decrease or increase tactile fremitus
- Dullness
- Rales
- Bronchial breath sound.

**Investigations:**

- WBC and Differential – Leukocytosis with neutrophil predominance
- CXR – for new and progressive infiltrates (if available)
- Sputum gram stain – in presence of minimal contamination of epithelial cells <10 and polymorphonuclear cells>25 per low power field, identification of common causative agents may help.

**Management: C**an be divided into two

1. Supportive care
2. Antibiotic treatment

Supportive care:

- Analgesics
- Fluid and electrolyte monitoring
- Chest physiotherapy

- Postural drainage

Antibiotics**:**

As antibiotic resistance is a major problem, knowledge of drug sensitivity patterns for flora at a particular HCF is important.

Empirical treatment of antibiotics depends up on

- Sputum gram stain
- Knowledge of prevalent HCF pathogens and
- Their drug sensitivity pattern

Empirical treatment (for mixed infection) for gram positive organisms use cloxacilin IV for 7 to 10 days.

For gram negative organisms

- Ciprofloxacin/ofloxacin ± gentamycin
- Ceftazidime /ceftriaxone ± gentamycin
- Ticarcillin clavulanate ± gentamycin
- Gentamycin IV for 7 to 10 days

**Prevention:** Raise the head of bed

- Withhold enteral PO feeding when there is mental alteration
- Proper cleaning of materials used in respiratory tract care
- Avoid aspiration by positioning
- Proper analgesics
- Provide frequent therapy to patients who have difficulty in managing secretions.

**5. Vascular catheter related Infections**

The commonest used intra vascular catheter in the health center facilities is peripheral vein cannula which is a source of infection in health care facilities

**Route of entry of spread**

- Transcutaneous migration at the skin infection site (the commonest route)

- Contaminated cannulas
- Hematogenous.

**Etiologies**

- Normal flora of the skin like staph. aures and strept. Epidermidis.

**Predisposing factors**

- Duration of catheterization>72 hours
- Plastic catheter >steel needle
- Cut down> precutaneous insertion
- Emergency>elective insertion
- Break down in skin integrity
- Number of canula manipulations
- Violations of aseptic rules

**Clinical features**

- Fever
- Local inflammation sign at insertion of the cannula
- Erythema
- Swelling
- Purulent discharge
- With or with out sign and symptoms of sepsis.

**Investigation**

- Gram stain from the insertion site

**Management**

- Removal of the cannula often will result in resolutions
- Antibiotics if signs of inflammations persist
- The drug of choice is ampicillin /cloxacillin for 5-7 days.

**Prevention**

- Proper training on appropriate way of securing I.V cannulas
- Apply appropriate antiseptic technique while securing I.V canulas
- For long I.V catheterization it should be changed every 48-72 hours

### 3.1.4. Learning Activities: Case study continued

Refer to the Case Study on in section 1.4 of the Core Module and discuss the following questions:

1. What are the main causes of puerperal fever?
2. Describe the environment of the delivery room W/o Shumbe had attended.
3. What are the responsibilities of the Health Center Team to stop infection?
4. What are pre-requisites to address prevention and control of infections?
5. Who is responsible for the development of infection at the Health Center level?
6. What are the poor environmental conditions that were observed in the delivery room?
7. What remedies do you suggest to correct such a situation?

# 3.2. Satellite module for Public Health Nurses

## 3.2. Introduction

### 3.2.1. Purpose and use of the module

The aim of this satellite module is to equip trainees with knowledge and skills required to take responsibility to identify and handle the source of infections effectively and to prevent and control infections.

**Directions for using the satellite module**

For a better understanding of this module, the Public Health Nurses are advised to:

- Read the purpose, the use and the directions for using the module in section 2.2.2 and 2.2.3 and follow the instructions
- After doing so, do the pre tests in section 1.1 and then go through all the topics of the core module
- Then read the satellite modules for your respective profession with special emphasis to the subject matter. However don't forget to read the satellite module for the other categories
- Read the reference materials listed to supplement your understanding
- Do the post test pertaining your profession in section 1.1 of the core m Translate the knowledge and skills in to practice through applications
- At the end of the module compare the pretest results to post test results
- Whenever further information is needed refer to the provided references.

## 3.2.2. Learning Objectives (Specific objectives for Public Health Nurses)

By the end of studying this module the Public Health Nurse should be able to:

- Implement the basic nursing procedures to prevent and control infections in HCFs

## 3.2.3. Nursing procedures in prevention and control of infections in health care facilities

### 3.2.3.1. Cleaning, Disinfection and Sterilization of Equipments

Equipment can easily become a reservoir for micro-organisms that can contaminate hospital patients and staff. The purpose of this section is to reduce the spread of micro-organisms through equipment and other supplies used for patient care.

### 3.2.3.2.Cleaning of equipment

Cleaning is the removal of all visible dust, soil and foreign materials from equipment and other medical supplies. This reduces cross-contamination in HCFs. Cleaning is also an important step in the process of disinfection and sterilization.

**Guidelines for routine cleansing of soiled equipments**

Without proper cleaning, disinfection and sterilization cannot be achieved. Soil remaining on the equipment will protect the microbes from contact with the cleaning agents and inactivate the cleaning agent.

**Cleaning agents and materials**

- Soap or detergent
- Cold or warm water
- Brush

**Procedure**

- Completely disassemble all items
- Follow directions for proper dilutions of soap or detergent
- Soak instruments in cold water for at least five minutes
- Using warm water, soap and brush, completely remove all blood, tissues food and other residue, paying special attention and small spaces and teeth of clamps or hemostats.
- Thoroughly rinse with water, as soap may interfere with the disinfection or sterilization process

## Disinfection of Equipment

Disinfection is a process that kills most pathogenic organisms. Therefore it is done in order to kill and to inhibit further growth of micro-organisms on inanimate objects.

Disinfection is usually accomplished with liquid although boiling is also effective. Disinfection is done for items that cannot be autoclaved or that do not need to be sterile (e.g. Bedpans).

In order to be effective, the disinfectant chosen must:

- Kill or inhibit the undesirable Micro-organisms
- Not be harmful to the equipment on which it is used
- Be used only on clean, rinsed instruments, because protein material and soap will inhibit a disinfectant
- Be used in the proper dilution (too much or too little disinfectant in water will not kill micro-organisms.

**Materials and disinfecting agents**

- Disinfectant solution

  *e.g.* . 1.2% phenol

  . 70% alcohol

. 0.5 – 1% chlorine bleach for virus

- Plastic bucket or container for soaking

**Procedure**

- Follow the manufacturer's directions for proper dilution of the disinfectant
- Choose the appropriate disinfectant solution
- Completely immerse the clean items in the disinfectant solution
- When chemicals are used, items must be soaked for 10 – 30 minutes
- If boiling is to be done, water must be at full boil for 30 minutes in order to kill or inhibit the growth of most micro-organisms
- Rinse the items thoroughly in sterile or boiled water
- Items soaked in alcohol do not need to be rinsed
- Dry the items with a sterile towel or allow them to air dry
- Use the sterile items immediately or store in dust – free containers.

### 3.2.3.3. Sterilization

Sterilization is used for all objects that are introduced directly into the blood or in the other normally sterile areas of the body and for certain objects entering non-sterile body cavities.

**Procedures**

- Clean very carefully all items prior to sterilization
- Open and separate all items before processing
- Choose the appropriate method of sterilization
- If autoclave is the method of sterilization insert proper indicator to show that the article is sterile
- When drums are used in the sterilizer tilt the drums and open the lids to allow air to drain out and to be replaced by steam
- Sterilize the items for the designated amount of time. Do not remove the batch before the drying cycle is complete

- Remove the items from the sterilizer
- Allow them to cool completely before storage.
- Use immediately or store in a sterile storage area

## 3.2.4. Preparing patient for surgical and non-surgical procedures

### 3.2.4.1. Pre-operative preparation of operative site procedures

To remove as many micro-organisms as possible from the surgical site including the patient's normal flora in order to reduce the risk of wound infection.

**Equipments / Supplies**

- Antimicrobial agent:
  *e.g*. 1% Tincture of iodine
- Povidone-Iodine (betadine)
- Tincture of chlorohexidine (hibitane)
- Sponges
- Forceps.

**Procedure**

- Use a sponge to apply the antimicrobial for a specified time
- Discard the sponge
- Scrub from the center (incision line) to the outside of the operative site
- Apply one of the above antimicrobial solutions on an area large enough to include the entire incision,
- Continue applying the solution to the surrounding area making a site large enough for the surgeon to work on during the operation without contacting unprepared skin.

Note**:** If tincture of iodine is used, allow it to dry completely, then remove with 70% alcohol to prevent burning.

### 3.2.4.2. Preparation of Intramuscularly and intravenous sites

**Purpose**: To remove as many micro-organisms as possible from the patients skin, including patient's own normal flora in order to prevent abscesses at the injection site.

**Preparation of intramuscularly site**

**Equipment / supplies**

- 70% Alcohol
- Cotton swabs

**Procedures**

- Clean the skin with an alcohol swab using a circular motion starting at a central spot and moving towards the outer zone
- Allow time for alcohol to dry on the skin prior to injection. This takes at least 30 seconds.

**Preparation of intravenous injection site**

- Antiseptic
  - 1-2% Tincture of iodine
  - Povidine-Iodine solution (betadine)
  - 70% alcohol
- Cotton swab

**Procedures**

- Apply the antiseptic agent liberally in a circular motion starting from a central spot and moving outwards
- Allow the antiseptic to dry on the skin. This takes at least 30 seconds prior to needle insertion

- Clean your fingers with alcohol before touching the site if vein palpitation is necessary.

### 3.2.4.3 Dressing techniques

**Purpose**

To prevent infection by keeping the wound clean, to promote healing and to make the patient comfortable.

**General guideline**

- Determine the need for dressing by the type of wound
    a. Abrasions tend to heal without dressing
    b. Lacerations may require dressing depending on the extent of injury
    c. Punctures may need dressing, also depends on the extent of injury
    d. Surgical incision may need dressing depending on whether there is drainage from the wound
    e. Burns
- Keep all articles that come in contact with a wound sterile by handling with sterile gloves or sterile forceps to prevent contamination of the wound.
- Prevent spread of infection by:
    a. Separating contaminated articles from clean articles
    b. Placing soiled dressings in a covered garbage container for disposal by incineration
    c. Washing you hands before and after the care of the wound.
- Keep wounds clean and dry to promote healing
- Hold dressings that require frequent changes in place with binders. This will protect the skin from irritation by eliminating the use of adhesive tape.

**Equipment**

- Sterile dressing set
- Forceps
- Small bowl

- Dressing material
- Sterile gauze
- Sterile gloves
- Covered garbage container
- Tape binder.

**Procedures for dressings**

**A. Dry dressings for clean wounds**

**Procedure**

- Wash your hands
- Collect all the necessary sterile items
- Explain the procedure to the patient and make him/her feel comfortable
- Remove the dressing and discard into a covered garbage container
- Wash your hands
- Clean the skin around the wound if indicated or ordered by the physician
- Check the wound for redness, warmth, swelling, increased pain or discharge or irritation and if present report the symptoms to the physician
- Apply a sterile, dry dressing and secure with tape, gauze or binder
- Wash your hands.

**B. Dry dressings for unclean (contaminated) wounds**

**Procedure**

- Explain the procedure to the patient
- Prepare a clean dry work area
- Wash your hands
- Collect all necessary clean and dry sterile items for changing the dressing
- Remove cloth or dressing with hands or clean forceps and discard into covered garbage container
- Check for signs of infection

- Wash your hands or rub with alcohol and air dry
- Pour cleaning or antiseptic solution into a sterile bowl
- Clean the skin around the wound with soap and water
- Clean the wound with a solution using a cotton swab for each downward stroke
- Apply a dry dressing with sterile gloves and sterile forceps, then secure with tape, gauze, or binders
- Wash your hands.

### 3.2.4.4. Isolation technique

The spread of infections within HCFs requires three essential elements; a source of infecting organisms, a susceptible host and a means of transmission for the organisms. The principle behind isolation techniques is to create a physical barrier that prevents the transfer of micro-organisms. The barriers created for effective isolation should be appropriate to the goal of preventing the spread of selected micro-organisms from the patient to the environment or from the environment to the patient.

**General procedures for isolation***:*

- Check the type of isolation ordered for the patient in order to plan for care
- Identify the type of infection or the reason for protective precautions
- Check the equipment on the door or in the anteroom and inside the room to be sure you have everything you need for the procedure you intend to perform.
- Wash your hands for infection control
- Gather any equipment you need
- Identify the patient to be sure you are performing the procedure on the correct patient
- Explain to the patient what you are doing

- Carry out the aspects of isolation technique necessary for the type of isolation ordered when entering the room
- Give care as planned
- Carry out the aspects of isolation technique necessary for the type of isolation ordered when leaving the room
- Involve the following criteria
    - All necessary equipment readily available
    - All aspects of the particular isolation procedure correctly carried out
    - Patient cared for safely and in a comfortable mode
- Record the care given appropriately.

**Specific isolation procedures**

A variety of specific procedures are used as part of isolation. These include how to enter and leave the room and procedures to care for equipment and supplies in the isolation room.

**Preparing the room**

Preparation of the room for isolation depends on the type of isolation required but the following general preparations are recommended

- A private room with running water
- A sign on the outside of the door indicating what preparation is needed before entering the room and which type of isolation is being carried out
- A stand of some sort (often a bedside stand is used) placed just outside the door to hold isolation laundry badge, gowns, masks, gloves and other items specific to the care of an individual patient
- A waste basket lined with plastic
- Thermometers and blood pressure equipment, including a stethoscope, which should be left in the room
- Special containers as needed for used needles, syringes and instruments.

**Entering the room**

One component of care that will prove helpful as you prepare to enter an isolation room is organization. Make sure you have all the equipment you need before you are gowned. In the room you may need to wear a gown, a mask and gloves depending on the specific situation.

Determine which items you need to wear and follow the specific directions below for those items

- Obtain needed equipment
- Wash hands for infection control
- Put watch in plastic bag
- Put on gown, gloves and mask as needed.

**Gown**

An isolation gown is used to protect the care provider's clothing from micro-organisms that can be spread on clothing. Gowns are worn depending on the type of isolation such as strict and respiratory isolation. They are also worn when providing direct care to a patient who has drainage or secretions that may contain infectious organisms. Isolation gowns may be made of washable cotton cloth or disposable paper.

**Basic Considerations**

- Wash your hands. Take off any rings because the regular hand washing procedure may not remove micro-organisms lodged beneath them
- If the room doesn't have a wall clock and you need a watch to perform some aspect of care, remove your watch and place it in a transparent plastic bag so that it is protected but visible
- Put on a gown, making sure that all parts of your uniform are covered and that the ties are fastened securely.

**Masks**

Masks protect against airborne micro-organisms and droplet nuclei on which they are carried (for details refer to the core module).

**Gloves**

Gloves are always used in isolation in the same way that they are used for other patients. Gloves should be kept inside the room so that they can be put on and changed as needed when providing care (for detail refer core module).

**Double bagging**

You may use a double-bagging technique for contaminated items removed from an isolation room. One nurse inside of the room and another nurse outside carry out this procedure. This procedure may be used for wet linen or for items that are being sent to another department. Basic steps are

- If you are the inside nurse, place used items in appropriate containers. Take care not to fill the bags too full, as it makes double-bags difficult to handle without breaking. Carefully close and secure the bag.
- If you are the outside nurse form a cuff on another bag, spreading it to receive the bag from the nurse on inside. The cuff protects your hands from contact with the contaminated items inside the bag.
- If you are the inside nurse place the bag holding the contaminated items directly into the bag being held by the outside nurse. Be careful to touch only the inside of the bag.
- If you are the outside nurse fold over and carefully secure the top of the outside bag.
- Mark the bag in the manner prescribed by the facility for proper sterilization or for the destruction process to be carried out
- Color coding dangerous bags might help the staff to notice it from a distance.
- Dispose of the bag in the proper place.

**Caring for linen**

Care should be taken to touch only the inside of the laundry bag with the soiled linen or contaminated hands (refer to core module).

**Leaving the room**

This procedure assumes that you are wearing a gown, mask and gloves. It can be modified if you are not using all three.

- Complete your work in the room
- Remove your gloves and dispose of them as described previously
- Unite waist ties
- Wash your hands
- Untie neckline ties, dropping the gown over
- Roll off the gown, touching the inside only and turning the gown inside out as you take it off.
- Touching the ties only, untie your mask and discard it in a wastebasket or, if it is a cloth mask, in a laundry hamper.
- Wash your hands
- Using a paper towel as a barrier on the doorknob, open the door. Discard the paper towel inside the room
- Wash your hands outside the room.

**Table – Summary of isolation precautions**

| | Contact isolation | Droplet isolation(droplet>5microns) | Airborne isolation(droplet<5microns) |
|---|---|---|---|
| Room | Preferably private or cohort with other patients with same microorganism | Preferably private or cohort with other patients with same microorganism privet | Privet with door. keep door closed |
| Gloves | When in contact with infective materials or patient contact | When in contact with infective materials or patient contact | When in contact with infective materials or patient contact |
| Gown | When in contact with infective materials or patient contact | When in contact with infective materials or patient contact | When in contact with infective materials or patient contact |
| Mask | Not necessary | If within 1m of patient | Must be worn when entering room |
| Patient care equipment | When in contact with infective materials or patient contact | When in contact with infective materials or patient contact | When in contact with infective materials or patient contact |
| Patient transport | Avoid if possible | Avoid if possible-patient must wear mask | Avoid if possible-patient must wear mask |

## Isolation preparations

Two main systems are used for placing the patient in isolation; disease-specific isolation precautions and category–specific isolation precautions.

### Disease-specific isolation precautions

Under this each infectious disease is considered separately and guidelines that use only those procedures considered necessary to attain the goal are then setup. An advantage of this system is that it is adaptable to individualized care

plans. It is also more logical because it minimizes unnecessary precautions and equipment use.

**Category specific isolation precautions**

This approach has separate instructions for diseases fitting into various categories which are determined by how the organisms are transmitted. The five types of isolations generally used in this system are; strict isolation, respiratory isolation, wound and skin precautions, enteric precautions and blood/body fluid precautions.

**3.2.4.5. Learning Activity*:* Case study continued**

Refer to the case study on in section 1.4 of the Core module and discuss the following questions:

1. What are the main causes of puerperal fever?
2. Describe the environment of delivery room W/o Shumbe had attended.
3. What are the responsibilities of the Public Health Nurse to stop infection?
4. What remedies do you suggest to correct such a situation?

# 3.3. Satellite module for Medical Laboratory Technicians

## 3.3.1. Introduction

### 3.3.1.1. Purpose and use of the module

This module can be used in the training of medical laboratory technicians that are in actual training or those already in service for infection control in health care facilities. This satellite module is believed to provide the specific tasks and skills in infection control in health center laboratory and achieve these objectives. This satellite module also emphasizes safety precautions in the laboratory setting.

### 3.3.1.2. Directions for using the module

For a better understanding of this module medical laboratory technicians are advised to follow the following directions:.

- Read the purpose, the use and directions for using the module under the Introduction above and follow the instructions
- After doing so, do the pre-tests in section 1.1.and then go through all topics of the core module
- Then read the satellite module of your respective profession with special emphasis to the subject matter. However don't forget to read the satellite module of other categories
- Read the reference materials listed to supplement your understanding
- Do the post-test pertaining to your profession in section 1.1 of the core module and evaluate yourself by referring to the keys in unit 7.

### 3.3.2. Learning Objectives (Medical laboratory technicians specific)

At the end of reading this satellite module the laboratory technician will be able to:

- Identify different specimen collection procedures and proper handling for infection control
- Use appropriate laboratory techniques and procedures that help in identifying infectious agents
- Implement safety precautions for the prevention of infection in the laboratory setting
- Identify the source of disease and monitor the development of infections and dangerous pathogens
- Know how to properly prepare and dispose of the various types of waste products generated in the laboratory (like sharp materials and liquid and solid wastes)
- Know how to properly decontaminate a work area when a hazardous spill has occurred and in general how to keep work areas clean.
- Know the basic steps of first aid measures.

### 3.3.3. Collection and handling of laboratory specimens

Accurate analysis of specimens depends on proper collection, preservation and preparation of the sample in addition to the techniques and methods of analysis used. The precise laboratory information needed by the physician cannot be obtained unless consideration is first given to the proper collection of a specimen. Improperly collected specimens often results in incorrect identification. The consequence of this could be very serious to the patient. During specimen collection the specimen container should be leak-proof to avoid contamination and should be labeled properly with a patient's name, identification number, date and time of collection, specific specimen source and examination requested.

Several different kinds of specimen are analyzed routinely in clinical laboratories but the specimen most often tested is blood, stool, urine and sputum. The specific requirements for specimen collection are discussed throughout each procedure in this satellite module.

### 3.3.3.1 Stool Specimen

The most frequently performed parasitological procedure is the stool examination. The detection and identification of parasites such as an adult worm, larvae, eggs, trophozoite and cysts depends on proper collection.

Stool specimen should be collected in a clean container made of cardboard, preferably plastic-covered. The specimen should be collected and covered without being contaminated with urine. The amount collected depends on the test to be done. During collection follow the following procedure correctly:

**Procedure**

- Provide the patients with specimen containers with tight-fitting lids
- Collect sufficient quantity of stool. It should contain at least 4 ml ($4cm^3$) of stool
- Examine the stool as soon as possible
- If specimens cannot be examined in the above time-frame, put them in an available preservative (e.g. formaldehyde solution).

### 3.3.3.2. Blood specimen

Any discussion concerning blood specimens must begin with collection procedures for blood. There are two general sources of blood for clinical laboratory tests; peripheral or capillary blood and venous blood. This applies to all areas of the clinical laboratory. For small quantities of blood for some hematological determination, capillary blood is suitable. This is obtained from the capillary bed by a puncture of the skin. The tip of the finger is the site most commonly punctured. For large quantities of blood a puncture is made directly

into a vein using a sterile syringe and needle. A vein in the upper forearm (or antecubital fossa) area is most often chosen for vein puncture as these veins are easily palpable and fairly well fixed.

Special precautions need to be taken when collecting specimens, especially blood specimens and when testing specimens and handling infected materials. Safety measures involved in the collection of blood include the careful handling and disposal of syringe and needles. Do not collect capillary blood by mouth suction.

Specimen containers must be leak-proof. A special carrying tray should be used for collecting blood. It should have separate compartments for holding clean equipment, specimens and contaminated articles. The careless handling of a specimen may result in the contamination of fingers and working surfaces and particularly in the formation of aerosols (air born droplets). The inhaling of infected aerosols is a common cause of infection.

**3.3.3.3. Sputum specimen**

A patient suspected of pulmonary tuberculosis should submit three sputum specimens for microscopy. The chances of finding tubercle bacilli are greater with three sputum samples than with two samples or one sample. Secretions build up in the airways overnight so an early morning sputum sample obtained deep from the lung (not saliva) is more likely than a sample later in the day to contain tubercle bacilli. It may be difficult for an outpatient to provide three early morning sputum samples. Therefore in practice sputum sampling follows this procedure:

**Types of Sputum Collection**

**Spot – Morning – Spot**

**Day one** – Sample One: patient provides and "on the spot" sample under supervision when she/ he presents themselves to the health institution.

**Day two** – Sample two: patient brings an early morning sample

**Day three**- Sample three: patient provides another "On the spot" sample under supervision.

Advantage:

- It can be done in one day
- The patient will not suffer any more delays than would have been done in the three morning specimen procedure (i.e. the rate of infection will be decreased).

Disadvantage:

- It may give a false negative result.

**Morning - Morning - Morning (3M)**

- Collect three consecutive morning sputums by providing sputum cups

Advantage:

- It concentrates the bacilli so it avoids false negatives.

Disadvantage:

- Time consuming.
- The client may not comply with procedure or may not return samples.
- Increases the rate of infection.

**3.3.3.4. Urine Specimen**

Before specimens are collected the containers must be cleaned and thoroughly dried. Disposable containers of plastic or coated paper are available in many sizes and are provided with lids to reduce bacterial and other types of contamination.

A freshly voided urine specimen is adequate for most urinalysis except the microbiological culture. The patient should be instructed to void directly into a clean, dry container or a clean, dry bedpan so the specimen can be transferred to an appropriate container. Catheterization can be used if a urine specimen is likely to be contaminated with vaginal discharge or menstrual blood. All specimens should be immediately covered and taken to the laboratory. If the sample is going to be delayed the technician should know how to preserve it and which method of preservative is used for preserving the sample.

**Methods of Preservation of Urine**

In urinalysis if the sample is going to be delayed the lab technician should use either of the following preservatives:

**Physical method**

**Refrigeration:** This is most satisfactory of all preservation methods. The chemical changes that occur in the urine can be slowed down by refrigeration at 2-8$C^0$ . Freezing shouldn't be used always unless you want to transport it because it will destroy formed elements (RBC, WBCs).

**Chemical methods**

In this method we use different chemicals (refer table 1 below). The chemicals should be proportional to the urine volume and the sample should be handled carefully, despite this it may contain dangerous infectious agents like HBV.

**Table 1: Type of preservatives with their advantages and disadvantages**

| Types of preservatives | Advantage | Disadvantages | Other information |
|---|---|---|---|
| Refrigeration | No interference with Chemicals | Raises specific gravity<br>Precipitates urates | Prevents bacterial growth for at least 24 hrs |
| Freezing | For transportation of specimens (i.e. to send to referral hospital) | Destroys formed elements | |
| Toluene | Best for preservation of chemical constituent (like Ketone bodies) | It is flammable | Add 2 ml of toluene per 100 ml of urine |
| Thymol | Preserves glucose and 5 elements well | Interfere with protein test | Add small dissolving 5 mmdm/100ms of urine |
| Boric acid | Preserve protein and formed elements | Precipitates uric acid | Keep $P^H$ (of urine at about 6) |
| Formalin (formaldehyde) | Excellent sediment preservative | Interferes with copper reduction test for glucose | 1 drop 40% per 30 ml of urine<br>10 ml for 24 hrs<br>Prevents bacterial growth |

### 3.3.3.5 Swabs and other body fluids

Most bodily fluids contain highly infectious micro-organisms so special precautions should be taken during collection and handling. For example spinal fluid, pericardial fluid, synovial fluid and plural fluid should be with drawn from the corresponding body areas via a needle and syringe. The sterile fluid should be placed in a sterile vial which is sealed. The vials are placed and transported to the reference laboratory after doing routine testing.

During swab sample collection and processing the swab should be sterile to avoid contamination to the client as well as the sample itself.

- Specimens can become airborn when the stopper is popped off a blood-collecting container or a urine tube is centrifuged.
- When the cap is being removed from a specimen tube or a blood collection tube, the top should be covered with a disposable pad or a special protective pad. The tube should be held away from the body and other clients. With regarding to the staining procedure, refer to the following text:

## 3.3.4. Laboratory techniques and procedures

### 3.3.4.1. Direct saline preparation for stool examination

Routine microscopic examination of stool specimens with physiological saline helps to detect and identify the stages of some parasitic organisms. It is simple and rapid. A small amount of stool is mixed with a drop of physiological saline on a slide and examined microscopically. A direct saline preparation allows observation of pus cells, red cells, cysts of protozoa, helminthes ova, and helminthes larvae.

**Procedure**

- Place a drop of physiological saline (0.85% W/V) in the center of the slide. With an applicator stick, pick up a small portion of the feces (approximately 2mg which is about the size of a match head) and put one drop of saline on it.
- Mix the feces with the drops to form homogenous suspensions
- Cover the drop with a cover slip
- Examine the preparation using the 10x objective for motile forms, cysts and oocysts of intestinal protozoa and for any ova or larvae of helminthes.

### 3.3.4.2. Gram staining technique

One of the important aspects of the gram stain is that it can be used to classify bacteria into major categories of clinical relevance. Bacteria, due to the acidity of their protoplasm, take up alkaline dyes (e.g. gentian violet) and are stained blue. Iodine penetrates the bacterial cell wall and forms a colored complex with the alkaline dyes. A decolorizing agent (e.g. acetone) removes this colored complex from some bacteria but not others. A red counter stain (e.g. dilute carbol fuchsin) stains bacteria that are decolorized and provides background staining for contrast. Bacteria that retain the colored complex and stain blue are known as “Gram positive”. Whereas bacteria that are decolorized and take up the red counter stain are known as “Gram negative”.

Gram stains can also be a valuable piece of information for the physician. There are situations in which individuals with a bacterial infection are so in need of immediate treatment that the time for identification of the bacterium based on a biochemical test as well as antibiotic sensitivity is not realistic. The physician is faced with the decision as to which antibiotic to use in treatment.

In order to avoid contamination carefully adhere to the following procedure: .

**Method of staining**

- Prepare a smear on a clean glass slide. Allow the smear to dry at room temperature
- Fix the smear by passing it (smear uppermost) 3 times over a flame or fix with alcohol
- Place the slide on the staining rack
- Cover the smear with 0.5% gentian violet and leave for 1 minute
- Wash the smear in a thin stream of clean water to remove the excess stain
- Cover the smear with lugol’s iodine and leave for 1 minute
- Wash the smear in a thin stream of clean water

- Decolorize the smear by slowly adding 50% acetone/alcohol solution. Do not over decolorize the smear. This stage should last 15 seconds
- Counter stain by covering the smear with safranin or with dilute carbol fuchsin. Leave for 30 seconds
- Wash the smear in a thin stream of clean water to remove excess stain
- Allow the smear to drain dry, the smear is now ready for examination.

### 3.3.4.3. Ziehl Neelsen staining technique

This technique is the most widely used method in the identification of AFB from sputum smears in small laboratories. A smear is made on a slide and fixed to prevent the specimen from being washed off. The slide is then heated to melt the waxy substance found on the cell wall of the bacteria which enables the stain to penetrate and stain the organism. This is the principle of the test. In order to avoid contamination and pollution of the environment carefully adhere to the following procedure:

**Procedure**

- During collection assemble all the necessary materials and obtain the sample according to the standard procedure
- Using a piece of stick transfer purulent material of the sputum to a slide and make a thin smear.
- Allow the smear to air-dry in a safe place
- Fix the smear with one or two drops of 70% ethanol (or methanol) for two to three minutes or by passing the slide about three times over a flame
- Wash the stain with clear water
- Cover the smear with 3 % acid alcohol for about 2 minutes until the smear looks pale-pink
- Wash off the stain with clear water
- Cover the smear with methylene blue (malachite green) stain for 30 seconds

- Wash off the stain with clean water
- Wipe the back of the slide and place in a draining rack for the smear to air dry
- Finally examine the smear microscopically with the oil immersion objective (100x) to look for AFB.

### 3.3.5. Safety precautions in the laboratory settings

The premise of standard precautions is that it is relatively simple to protect transmission of infectious agents from client to health worker or other clients. Standard precautions were developed because similar blood and bodily fluids are assumed to be equally infectious. At a latter point the specimens may be proven to not be infected.

Infection can occur during the process of specimen collection, or from handling, transporting or testing of the specimens. Infections are frequently caused by accidental aspiration of infectious materials, accidental inoculation with contaminated needles or syringes, animal bites, sprays from syringes, aerosols or from the uncapping of a specimen tube or centrifuge accidents. Some other sources of laboratory infections are cuts or scratches from contaminated glassware.

A simple precaution that should always be taken is to properly label all containers and specimens. This ensures that hazardous materials will be handled appropriately.

Clinical laboratories present many potential hazards simply because of the nature of the work done there. In addition to biological hazards, open flames, electrical equipment, glass ware, chemicals of varying reactivity, flammable solvents and toxic fumes are but a few of the other hazards present in the clinical laboratory.

It is important to establish a safety policy for every laboratory. Carefully plan the safety policy taking into account the hazards that may occur and the availability of safety appliances. Practice safety measures at all times. Constantly remind laboratory users of safety procedures through training and by placing posters at appropriate sites. If posters are not available make your own. Safety measures include precautions against infections, chemical hazards, fire and electrical hazards.

### 3.3.5.1. Precautions against infections

Safe personal behavior

- Wear protective laboratory coats and gloves. Remove protective clothing before leaving the laboratory
- Treat infectious fluids immediately and carefully to avoid spills
- Cover wounds and broken skin with water proof bandages
- Decontaminate work surface before and after use
- Wipe up any spills immediately and dispose of them safely/properly
- Do not smoke, eat or drink in the laboratory
- Wash hands with soap and water before leaving the laboratory or attending to another patient
- Don't use contaminated materials to collect samples (like blood)
- Do not bite nails, chew pencils
- Do not use contaminated gloves to handle patients
- Do not sit on work-benchs
- Do not store food or drink in the laboratory refrigerator.

Safe handling of specimens:

- Handle all specimens with care. Regard every specimen as potentially infective
- Flame metal instruments (e.g. platinum loops, points of forceps) at arm's length to avoid spattering
- Avoid spillage of specimens

- Keep specimen tubes in racks
- Do not mouth a pipette. Use rubber teats or pipette fillers
- Avoid accidental pricks with used needles, lancets and other sharp Instruments.

### 3.3.5.2. Precautions against chemical hazards

- Do not mouth a pipette chemical and reagents, instead use rubber teats, rubber bulbs, or a pipette filler
- Wipe up water immediately after spillage
- Label all laboratory bottles and containers clearly to show the nature and strength of contents, date prepared, appropriate safety warning (e.g. poison, flammable, corrosive). Read each label carefully before using any reagent.
- Do not taste unknown chemicals; smell chemicals with caution
- Recognize and understand the standard commercial warning signs that appear on labels such as 'Flammable, Oxidizing, Corrosive, Toxic, or Harmful'
- Follow the manufacturer's instructions for safe storage of chemicals.

### 3.3.5.3. Cleaning, disinfection, sterilization and disposal of laboratory materials and processed samples

The cleaning, disinfection, sterilization and disposal described in this satellite module are intended for health centre laboratory work. Selecting practicable and safe methods of treating reusable and disposable items depends on the cost and availability of chemicals and fuels as well as the time constraints of technicians working alone.

Remember to handle all laboratory items, contaminated bodily fluids and excreta as potentially infectious. It is important to keep the laboratory workplace in a clean and neat condition.

### 3.3.5.4. Cleaning and washing

Cleaning and disinfection of the working surface after contact with blood or other potentially infectious materials is of prime importance. Most disinfectants are less active in the presence of high concentrations of protein such as blood and other bodily fluids. These spilled fluids should first be absorbed as completely as possible with disposable towels or gauze pads prior to disinfection.

Cleaning and washing has two purposes:

1. To reduce the number of organisms contaminating an article. The article must be dried after cleaning or washing to avoid multiplication of surviving bacteria.
2. To remove dirt, grease and other organic matter (e.g. blood, feces) from an article.

### 3.3.5.5.. Disinfection

Disinfection is the removal of some or all pathogenic organisms from an item. Disinfection does not always destroy spores or bacteria (e.g. tetanus spores). Disinfectant methods commonly used in the health center laboratories include boiling water at $100^0$C or chemical disinfection.

**Chemical disinfection**

Chemical agents are less effective than heat for disinfection. The following groups of chemical agents are commonly used in the laboratory for disinfection:

1. Alcohol (e.g. methyl alcohol, ethyl alcohol, isopropyl alcohol) doesn't kill bacterial spores and fungi
2. Phenols (3%) or a phenol-containing solution kills a wide range of vegetative bacteria and some viruses including HIV. It doesn't kill bacterial spores and the hepatitis B virus
3. Halogens such as chlorine-releasing compounds (household bleach, 5%, bleaching power) and iodine kill viruses including HIV, vegetative bacteria, spores and fungi

4. Aldehyde (e.g. formalin, glutaraldehyde) are highly lethal to all micro-organisms such as vegetative bacteria viruses, fungi and spores.

Chemical agents work in several ways. These include

- Protein denaturation as with alcohol, phenols and aldehydes
- Disruption of cell membranes as with halogens.

Chemicals disinfectants must be used at the recommended concentration for the correct length of time. Antiseptics are weak disinfectants and are not effective for disinfection in the laboratory.

**3.3.5.6. Sterilization**

Sterilization is the killing of all living micro-organisms on an item. These micro-organisms may be pathogenic or non-pathogenic. They include bacteria fungi, spores (bacterial and fungi) and viruses. Sterilization methods used in the health center laboratory are flaming, steaming under pressure (autoclaving at $121^0$ C for 60 minutes at a pressure of 15 Ib or steam sterilizing), and incineration.

During flaming if you are using a flame with a bunsen burner use the blue part of the flame. With flaming all living organisms are killed when an item is exposed to the flame.

**3.3.5.7.. Disposal of Wastes**

After use all materials and processed samples should be properly disposed of according to their nature. For example infectious wastes like blood and blood products, contaminated sharps, pathologic wastes and microbiological wastes should be packed in a colored container with universal biohazard symbols. For additional information refer to the satellite module for environmental health students.

### 3.3.5.8. First-aid measures for medical laboratory technicians

Knowing what to do immediately when an accident occurs can help to reduce suffering and the serious consequences of an accident.

All laboratory workers should have a basic knowledge about first-aid with particular attention to the type of accident that may occur in the laboratory. They should also know what emergency actions need to be taken if an outpatient or blood donor collapses in the laboratory.

All adequately equipped first-aid boxes should be kept in the laboratory in a place that is known and accessible to all staff members. The box should be clearly marked. All laboratory personnel should know the following measures:

### 3.3.5.9. Emergency measures for a cut

If the cut is small

- Wash with water
- Apply pressure with a piece of cotton wool
- Disinfect the area with a skin anti-septic such as tincture of iodine or 70% alcohol
- Cover with a water-proof bandage

If the cut has been caused by contaminated glassware

- Encourage bleeding
- Seek medical help immediately
- If there is serious bleeding from limbs raise the injured limb to reduce the bleeding
- Apply pressure

### 3.3.5.10. Emergency measures for nasal bleeding

- Seat the person upright with the head slightly forward
- Tell the person to pinch firmly the soft part of his or her nose for at least 10 minutes and breathe through his or her mouth

- If the bleeding doesn't stop seek medical help

### 3.3.5.11. Emergency measures for chemical burns of the skin

- Wash immediately in running water
- Neutralize with $Na_2CO_3$ (sodium bicarbonate) powder if it is an acid burn
- Neutralize with boric acid powder if it is an alkali burn
- Seek additional medical attention

### 3.3.5.12. Emergency measures for chemical eye burns

- Wash the affected eye as quickly as possible under running tap water or with water from an eye wash
- Neutralize with 5% sodium bicarbonate solution if it is an acid burn, and neutralize with 5% acetic acid or vinegar (diluted 1 in 5) if it is an alkali burn
- Seek medical attention.

### 3.3.5.13. Emergency measures during swallowing of alkalis and acids

- Immediately rinse the mouth with water
- If acid has been swallowed, neutralize by drinking 8% W/V magnesium hydroxide suspension, milk of magnesia
- If an alkali has been swallowed drink three or four caps of water, lemon juice or 5 % acetic acid
- Seek medical assistance

***Note:*** When an acid or alkali has been swallowed do not encourage vomiting.

## 3.3.6. Learning Activities*:* Case study continued

Refer to the case study in section 1.4 of the Core module and discuss the following questions:

1. What are the responsibilities of the Health Center Team to stop infection?
2. Who is responsible for the development of infection at the Health Center level?

3. What laboratory tests do you suggest to diagnose such a situation?
4. What would be the role of the laboratory technician in collecting samples and culturing the specimen?

## 3.4. Satellite module for Sanitarians

### 3.4.1. Introduction

#### 3.4.1.1. Purpose and use of the module

This module can be used in the training of sanitarians that are in actual training or those already in service for infection control in health care facilities.

#### 3.4.1.2. Directions for using the module

For a better understanding of this module the Sanitarians are advised to follow the following directions:

- Read the purpose, the use and direction for using the module in section 1.1 and 1.2 and follow the instructions
- After doing so, do the pre tests in section 2.1 and then go over all the contents (topics) of the core module
- And then read the satellite modules of your respective profession with special emphasis to the subject matter. However don't forget to read the satellite modules of the other categories
- Read the reference materials listed to supplement your understanding
- Do the post test pertaining to your profession in section 1.1 of the core module and evaluate yourself by referring to the keys in unit seven.

### 3.4.2. Learning Objectives (specifically for Sanitarians)

After completion of this satellite module the Sanitarian will be able to:

1. Identify source and type of infectious waste in the health care facilities.
2. Describe steps in safe management of infectious waste in health care facilities.

3. Ensure the availability of a hygienic food supply, adequate and safe water supply, safe handling of medical equipment and linens and good housing condition in health care facilities.
4. Identify the role of the Sanitarian on the infection control committee in health care facilities.
5. Plan different methods of training in management of infectious wastes in health care facilities.

## 3.4.3. Types and sources of infectious wastes

### 3.4.3.1. Types of infectious wastes

**Biological wastes** are suspected of containing pathogens (bacteria, viruses, parasites or fungi) in sufficient concentration or number to cause disease in susceptible hosts. These categories :

- Infectious agents from laboratory work
- Wastes from deliveries and minor surgeries contaminated with infectious diseases (e.g. tissues and materials or equipment that have been in contact with blood or other body fluids)
- Waste from infected patients (e.g. excreta, dressing, vomitus, diarrhea, from infected or surgical wounds, clothes heavily solid with human blood or other body fluids)
- Any other instruments or materials that have been in contact with infected persons.

**Pathological wastes** such as wastes consisting of tissues, organs and body parts, human fetuses, blood and bodily fluids.

**Sharps** are items that could cause cuts or puncture wounds including hypodermic needles, scalpels and other blades, infusion sets, broken glass and nails. Whether or not they are infected, such items are usually considered as “highly hazardous potentially infectious health-care waste”.

### 3.4.3.2. Sources of health-care wastes

Infection control in health care facilities requires identification of the sources where the wastes are generated or produced. Development of a sketch map indicating the source is very important. From this information the following areas can be identified as the potential sources of infectious wastes in the health center:

**Patient rooms:** Mainly infectious waste such as dressing bandages, sticking plasters, gloves, disposable medical items, used hypodermic needles and intravenous sets, bodily fluids and excreta, contaminated packaging and meal scraps**.**

**Minor surgical operating and delivery room**: Mainly anatomical wastes such as tissues, fetuses, other infectious wastes and sharps.

**Laboratories:** Mainly wastes generated from handling of stool, urine, blood and other bodily fluids.

**Support units:** Mostly non-infectious waste generated from dieting, patient ward, pharmacy and surrounding area with a small percentage of infectious wastes.

### 3.4.3.3. Outbreak investigation

Health care facility infectious disease out breaks often get more attention because they are due to unique organisms, unique circumstances (e.g. contaminated instruments or solutions) and/or other unique but controllable events. Thus an outbreak or epidemic offers a chance to make a major impact by eliminating or controlling the source or conditions leading to it.

Recognizing an outbreak often depends on good baseline surveillance in the health care facilities. The routine tabulation of infections will establish the “normal” rates from which an outbreak provides a distinct variation and leads one to consider the possibility of an out break.

Epidemic outbreaks are most likely to result in blood stream infection, then surgical wound infections, pneumonias, gastrointestinal infections, sepsis and lastly in meningitis. However when an outbreak occurs an investigation should be undertaken so that the problem is identified as to time, place, situation, organism and affected individuals. This may allow appropriate measures to be taken to abort the outbreak or to prevent further outbreaks.

Full scale outbreak investigations are carried out by the epidemiologist in conjunction with the infection control practitioner. The ultimate goal of the investigation is to determine the control measures for the outbreak of the involved disease.

There are five main elements in any outbreak investigation:

Identification of the problem

- Write a case definition
- Epidemiologic description
- Formulate hypothesis
- Implement control measures to stop the outbreak infection.

Therefore primary caregivers must be watchful for subtle signs of infection for the occurrence of epidemics by making sanitary surveys on environmental health conditions and by evaluating the routine record of patients admitted to the health center. To tackle this problem there should be adequate sanitary measures in the health center.

## 3.4.4. Safe management of infectious wastes

### 3.4.4.1. Waste management

All activities, administrative and operational, and all those who are involved in the handling, treatment, conditioning, storage and deposal of waste should participate in waste management.

### 3.4.4.2. Waste generation

Waste generation depends on numerous factors such as established waste management methods, type of health care establishment, hospital specialization, proportion of reusable items employed in health care activities and proportion of patient treatment on day-care basis.

Action to be taken in health care waste management:

- Assessment on (quantitative and qualitative) waste production
- Evaluation of local treatment and disposal options
- Segregation of health care waste from general waste
- Establishment of internal rules for waste handling
- Assignment of responsibilities within the health-care establishment
- Choice of suitable or better treatment and disposal options

### 3.4.4.3. Segregation and packaging

**Segregation*:*** This is the systematic separation of solid waste into designated categories. Careful segregation and separate collection of health-care facilities waste may be some what onerous for health personnel but it is the key. Sound management of health care waste segregation can substantially reduce the quantity of health care waste that requires specialized treatment. To make separate collection possible, health personnel at all levels, especially sanitarian, nurse, supportive staff and cleaner should be trained to sort the waste they produce in the wards, treatment rooms, operating theatres, laboratories, etc.

where tissues, solid items and organs are separately stored. Separate containers for sharps are also needed.

The following important points should be noted

- Infectious wastes are to be disposed of in the same way. They should not be collected separately
- Sharps are collected separately and incinerated
- Infectious stools from patients should be collected in baskets because of the need for disinfection
- Discharge to sewers or to the environment may contribute to the spread of the disease
- Plastic or metal containers for infectious waste should be disinfected, for example with sodium hypochlorite (bleach) before reuse. The bags should be sealed or containers firmly closed before they are filled to three-quarters of their capacity. The equipment should be simple, robust and locally available.

**Safe handling and storage**

**Handling*:*** This is the functions associated with the movement of solid waste materials, excluding storage, processing and ultimate disposal.

**Storage*:*** This is the placement of waste in a suitable location or facility where isolation, environmental and health protection, and human control (e.g. monitoring for radioactivity, limitation of access) are provided.

Health care facilities cleaning personnel should be informed about the potential risks posed by handling. They should be trained in safe handling procedures and should wear protective aprons and gloves. The waste should be collected daily. General waste may be stored in convenient places that facilitate collection by any method of disposal, but infectious waste should be stored in a closed room. Waste should not be stored close to patients or where food is prepared.

### 3.4.4.4. Treatment and disposal of infectious waste in health care facilities

Health care facilities with very limited resources should reuse sharps such as glass syringes with needles and scalpels. Only items that are designed for reuse i.e. that withstand the sterilization process, should be reused in this way. Before reuse scalpels, syringes, needles and other sharps must be thoroughly cleaned and sterilized; disinfection alone is inadequate. Any failure in the sterilization process may result in the transmission of severe infections.

For health care establishments with few resources and applying minimal waste management programmers affordable treatment and disposal methods for infectious waste may be classified into three categories:

- Thermal processes
- Disinfection
- Containment processes

**Thermal processes**

Static-grate single-chamber incineration

Waste may be burned in a simple furnace with a static grate and natural airflow. De-ashing, loading,and unloading operations are carried out manually. The low heating value of properly segregated health care waste is high enough for combustion. The burning efficiency may reach 90 - 95%, i.e. 5 - 10% of the material may remain unburnt in the ashes and slags. The operating temperature will be around $300^{o}$c,which will kill most micro-organisms.

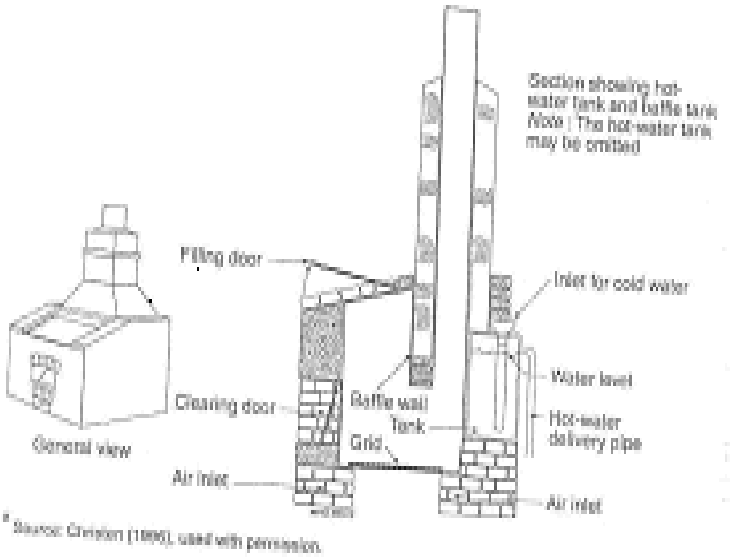
**Advantages**

- Good disinfections efficiency
- Drastic reduction of waste; the weight and volume residual ashes and
- slages are about 20% those of the original waste
- No requirement for highly qualified operators
- Relatively low investment and operation costs

**Disadvantages**

Generation of significant emissions containing atmospheric pollutants including flue gases and fly ash, may produce odors which can be limited by not incinerating halogenated plastics

- Periodic removal of slag and soot necessary
- Inefficiency in destruction of thermally resistant chemical and drugs




*Source: A manual on infection control, 1992*

Figure1: Bailleal single chamber incinerator

**Drum or brick incinerators**

Where a single chamber incinerator is not affordable or available simple confined burning may be applied. A steel drum or wall of bricks or concrete can be erected over a screen or fire grate and covered with a second screen to prevent dispersion of ashes or light material. The waste is placed inside and burned with the help of manual ventilation and the addition of kerosene if necessary. Constant supervision is essential to prevent any spread of fire to the surrounding area. The combustion efficiency may reach 80 - 90% and kill 99% of the micro-organisms. The temperature of the fire will not exceed 200$^{o}$c and this process

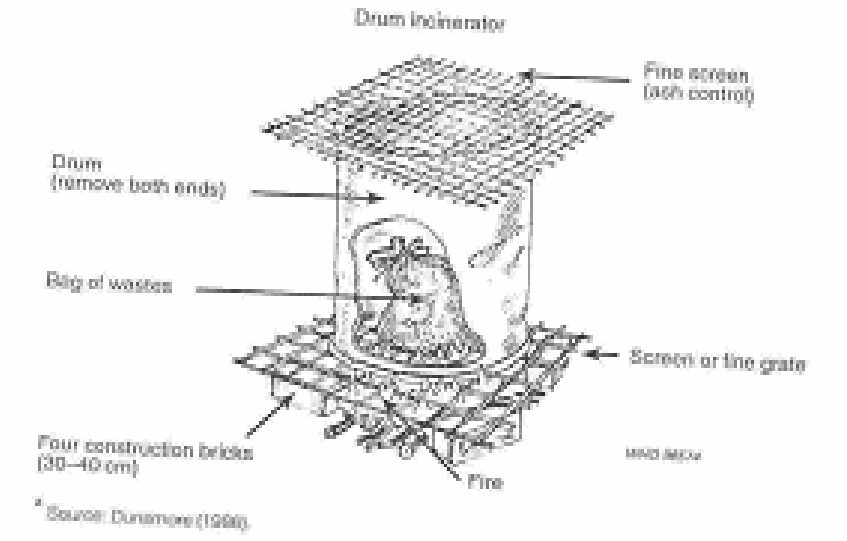
should be used only in emergency situations or when other treatment methods could not be complemented.

**Advantages**

- Drastic reduction of weight and volume of the waste
- Very low investment and operation cost.

**Disadvantages**

- Relatively poor destruction efficiency
- Massive emission of black smoke, particulates and toxic flue gas.




*Source: A manual on infection control, 1992*

Figure.2 Drum incineration

**Burning in open air**

If the above method is not available possible open air burning of infectious waste (excluding pathological waste) should be carried out only as a last resort in rural dispensaries, isolated health posts or emergency situations. Burning should be performed downwind of, and as far as possible from, the facilities or other

communities. The area within which the burning is carried out should be fenced to prevent unauthorized persons and animal from entering.

Confined burning e.g. in a drum incinerator should always be preferred, as the risk to personnel of contact with the waste or with partly burned residues is then lower.It has to be noted however that the burning process emits toxic gases and particulates into the atmosphere.

**Advantages**

- Same as for drum or brick incinerator.

**Disadvantages**

- Same as for drum or brick incinerator
- Burning may be incomplete and non-uniform.

**Disinfection**

Disinfection is an efficient but possibly costly process. For safe operation it requires trained technicians provided with protective equipment and is therefore not recommended for treating all infectious health-care waste. However the process can be useful in specific cases, such as disinfection of reusable sharps, linens or disinfection of stools from cholera patients.

**Autoclaving**

Autoclaving is an efficient wet thermal disinfection process. Typically autoclaves are used in health care facilities for the sterilization of reusable items and these units allow for the treatment of only limited quantities of waste. They are therefore generally used only for highly infectious waste such as linens, cultures and sharps. Even a primary health care unit with very limited resources should be equipped with an autoclave.

**Advantages**

- Efficient
- Environmentally sound
- Relatively low investment and operation costs
- Long lasting and low maintenance

**Disadvantages**

- Qualified operators essential
- Inadequate for anatomical, pharmaceutical and chemical wastes and waste that are not easily penetrated by steam.
- The health center autoclave used for sterilization has limited capacity for treatment of certain quantities of waste.

**Chemical sterilization of reusable sharps**

Chemical sterilization of scalpels, syringes with needles and other reusable sharps may be considered as an alternative or complementary method to thermal sterilization. After thorough cleaning and drying, the sharps are placed in a tank and exposed to a strong disinfecting gas or liquid, such as ethylene oxide, formaldehyde or glutaraldehyde.

**Advantages**

- Highly efficient (may be more efficient than thermal sterilization)

**Disadvantages**

- Trained operators essential
- Costly when the chemical disinfectants are expensive
- Uses hazardous substance that necessitates safety measures

**Chemical disinfection of infectious stool**

Buckets containing stool or vomitus of patients with acute diarrhea may be disinfected through addition of chlorine oxide powder or dehydrated lime oxide (CaO). For example, vibrio cholera, the causative agent of cholera is not very resistant and its elimination does not require the use of very strong chemical disinfectants. In emergency situations these measures should also be applied in the field to prevent the spread of the disease (e.g. cholera epidemics). This procedure could be applicable for disinfection of infectious stool and vomitus produced from the patient.

**Advantages**

- Efficient disinfection
- No need for highly trained operators

**Disadvantages**

- Limited utility to certain bodily fluids
- Not significant compared with the benefits

**Containment Processes**

Placenta pit

Infectious wastes such as placenta, tissues, organs and others which are normally solid and semi-solid in nature are important problems in health care facilities since the environment can be contaminated due to improper handling and disposal methods.

Since wastes contain pathogenic micro-organisms that can pollute the soil and water and affect the health of individuals appropriate disposal methods are required. Thus a placenta pit designed in various sizes and depths for the disposal of infectious wastes is necessary to make harmless it's pathogencity through natural and biological activities in the burial pit.

Therefore site selection for excavation of the pit should take into consideration factors to minimize pollution of water sources and contamination of the soil as well as other sanitary considerations necessary to protect the environment and safeguard the health of individuals and community.

## 2.4.5. Health care facilities hygiene and infection control

Management of health-care waste is an integral part of health-care facilities hygiene and infection control. Health care waste should be considered as a reservoir of pathogenic micro-organisms that can cause contamination and give rise to infection. If waste is inadequately managed these micro-organisms can be transmitted by direct contact, in the air or by a variety of vectors. Infectious waste contributes in this way to the risk of nosocomial infections putting the health personnel and patient at risk.

This section outlines the basic principles of prevention and control of infection that may be required in health care facilities. It should be stressed here that other environmental health considerations such as adequate physical facilities, water supply and sanitation facilities for patient, visitor, and health worker are also important.

### 3.4.5.1. Area of exposure to infectious disease

Many potential biological agents exist in health care unit environments. Those working in laundries, housekeeping, laboratories, nursing stations and dietary sections are highly exposed to biohazards from the patients they handle, from the specimens they collect and from the clothes, needles and pans they handle and from their general day to day activities. The following areas are potential exposures to infectious diseases in health care facilities:

**Laboratory**

Health personnel such as laboratory technicians and other health professionals working on biological specimens are at risk with biological hazards in the laboratory. Specimens such as blood, pus, stool and other tissue samples may lead to exposure of the workers to infections.

**Laundry**

Workers in laundries are exposed to discharges from patients by virtue that they are constantly in contact with soiled linens, night dresses and washable articles that are sent to the laundry for cleaning every day.

**Housekeeping**

Everything that comes in contact with the patient's room must be cleaned whether the occupying patient had an infectious process or not. This includes cleaning the floor, all furniture and bathrooms with a cleansing agent. Disposable equipment should be thrown away after use. Reusable objects must be cleaned thoroughly before sterilization of blood, tissue or bodily secretions. These may interfere with the sterilization or disinfection process. The use of a brush for cleaning purposes helps to remove material in small grooves or depressions in instruments.

Housekeepers in health care facilities are the single highest group exposed to infectious biological agents during handling of sharps, linens, blood and bodily fluids, excreta and other infectious wastes. Individual bedding must be washed at least weekly .Other surfaces should be cleaned between use or daily depending on the items.

**Dietary**

Food borne disease outbreaks can occur in health care facilities which may affect patients, personnel and visitors. While such outbreaks are extremely rare when they do occur they are responsible for large numbers of cases of gastro-enteritis.

Patients may be at increased risk of food borne illnesses because of intrinsic problems with immuno-suppression underlying illnesses achlorhydria (age, antacid use) and prior use of antibiotics.

The most common bacterial causes of food associated outbreaks are salmonella species or enteropathogenic Escherichia coli. Almost all of such outbreaks are attributable to contaminated food generally involving an infected food handler, although cross contamination between patients can occur. It is important for the infection control practitioner to know the common types of organisms that could be involved so as to be able to launch an appropriate investigation. An investigation must be able to define sources, mode of spread and method of prevention of spread. Investigation of possible food borne outbreaks must include collection of case control data on types of food eaten by both affected and well individual so as to find specific food that was associated with the transmission of the outbreak and exclude others that were not.

Food handlers should not only observe proper cleaning procedures for food and of their own hands and utensils but also be well educated about food preparation procedures. Efforts with food handlers should emphasize the importance of these basic principles of personal hygiene, especially hand washing, the importance of individual food worker diseases, the proper inspection and handling and serving and storing of food and the proper methods of waste disposal.

Primary prevention against infection or contamination of the food include:

- Proper handling of food products (raw or cooked)
- Use clean hands and garments in the food processing areas
- No skin lesion on the food handlers
- Refrigeration of the food products at a safe temperature in order to prevent growth of bacteria
- Adequate cooking of foods.

Food preparation areas require sinks and towel supplies separate from diaper changing facilities. Hands must be washed with soap before food preparation. Food should be refrigerated and any unused food should be discarded within 24 hours.

**Water**

Water systems are an integral part of any health care facility and must be maintained so as to deliver sterile non-infectious water. Since the water supply is unique to health care unit, periodic check ups for the potability of the drinking water is very crucial. This will generally consist of "coliform" counts per milliliter of water. In this circumstance the annual or more frequent assessment of water purity should be recorded by the infection control committee.

**3.4.5.2. Methods of reducing infectious disease**

Good personal hygiene practices are important in cleanliness and in the prevention of body and breath odors. Good hygiene can also serve to promote relaxation and increased circulation. The following are methods of reducing infectious disease in health care facilities:

**Bathing**

Bathing with warm water is helpful to keep open pores and sweat ducts which helps prevent skin infections. However excess use of strong hand and bodily soaps may cause skin drying or irritation which can increase the risk of some infections. After bathing drying between toes and other skin folds assists in preventing fungal infections.

When skin becomes infected, infected area as well as uninfected skin becomes more heavily colonized and an increased number of micro-organisms are shed. This results in higher probability that bacteria will be transferred to inanimate objects and other people by direct contact or by air via contaminated skin flakes.

**Shampooing and finger-nail cleaning**

Hair has the potential to carry pathogenic bacteria. Since head or body hair is continuously and erratically shed the hair should be kept clean. In critical circumstances such as cooking, surgery or operation of delicate machinery, hair should be kept under cover with an appropriate covering.

While finger-nail cleaning and clipping has aesthetic importance, their role in disease transmission is unknown. Certainly the area under the nail can serve as a potent reservoir for bacteria. It would appear wise to ensure nail cleanliness in the general hygienic approach to infectious disease prevention.

**Hand washing**

Hand washing is the single most important procedure for preventing infection. Most of the important pathogens in the health care facilities are transmitted by the hands of health care workers from patient to patient. Careful hand washing reduces the transmission of infection dramatically. For example 50% reduction rates in diarrhea were observed in centers adopting a careful hand washing regime.

Proper hand washing is defined as a vigorous brief rubbing together of all surfaces of lathered hands, followed by rinsing. The components to good hand washing include:

- Soap
- Running water
- 10 seconds of friction
- Turning off faucet with paper towel

The purpose of hand washing is to remove microbial contamination acquired by recent contact with infected or colonized patients or environmental sources.

Hand washing is always important

- After touching wounds
- After using the rest room
- Before preparing food or eating food
- In addition, hand washing is indicated after situations involving contact with mucous membranes, blood and bodily fluids and after touching inanimate objects that are likely to be contaminated.

**Fecal waste disposal**

Proper disposal of waste is an important component of general sanitation. Availability of flush toilets, good sewage drainage and disposal site are very important in control of infectious disease transmission in health care facilities. For example infectious diarrhea often spreads from person to person either by the vehicle of contaminated food or water or by hand to hand to mouth contact. Appropriate hand-washing after defecation is a modern concept. Bathing with soap and water is an excellent decontaminant except for the rare circumstances when dealing with extremely contagious fecal organisms such as shigella.

**Vector control**

Insect vectors are important infectious diseases transmitted in health care facilities. They are classified into biological and mechanical vectors. Biological vectors such as mosquitoes, fleas, lice and mechanical vectors such as house flies and cockroaches are responsible for the transmission of infection in health care facilities from infected case to susceptible individual where poor environmental sanitation, cleanliness and personal hygiene may be a problem.

Therefore appropriate prevention and control measures should be well organized and conducted to get rid of this problem in health care facilities.

**Food preparation habits**

Food poisoning, ingestion of contaminated food or water, can be related to bacteria, bacterial toxins, parasites, viruses or toxic food. In health care facilities outbreaks, toxin producing Escherichia coli, shigella or salmonella are the most frequent causes of food-transmitted enteric infections. Inadequate refrigeration is one of the most common factors implicated in food borne outbreaks

**Things to be considered in food preparation**

1. Personal hygiene

Frequently there are multiple factors associated with an outbreak including inadequate refrigeration, contaminated equipment used in food preparation and poor personal hygiene of food preparation personnel.

2. Cooking and storage

Generally foods should be heated to internal temperatures of $74^{O}$c ($165\ ^{O}$F) but lower temperatures for longer periods may be equally effective. Cooked or processed foods must be held at $40\ ^{0}$C ($104\ ^{0}$F) or cooler. The danger zone is $7.2\ ^{0}$C to $60\ ^{0}$C ($45\ ^{0}$F to $140\ ^{0}$F) which is the temperature range for rapid multiplication of virtually all bacteria. No green, raw vegetables should be consumed unless it is from an approved source or prepared in the most hygienic manner.

**Physical facilities**

Health care facilities have different buildings for performing routine day to day activities. Therefore these physical facilities should be arranged in such a way that to have adequate space, ventilation, cleanliness, durability, sanitary and other important facilities for prevention and control of infection. The following areas are to be considered in infection control of the health care unit:

**Waiting rooms**

Many health centers have a waiting room area at the entrance where patients may come for direction to appropriate wards or units and where visitors may be transiently accommodated. In waiting rooms sick patients may be waiting for

medical care and since infectious diseases are very significant portion of the reason why patients seek medical care this presents a potential for transmission of disease to others in the waiting room region. Most patients, despite the fact that they may have an infectious problem, are not highly contagious. However certain classes of patients such as those with severe cough, high fever or rashes should be promptly placed in separate facilities as potentially representing a transmissible infection.

In waiting room areas parents with children are separated from adult patients because of the high risk of spread of pediatric infectious diseases. There must be employees who can work in a waiting room area to direct the patient and visitor flow. These individuals will need the appropriate training to recognize the possibility of infectious risk and direct patient accordingly.

The rules for patients' visitation and ward visitation should permanently be posted in the waiting room so as to guide visitors. The health care workers who work in the visiting areas should know the regulations and the reasons for them so as to provide compassionate and appropriate help.

**Patient care rooms**

Much of the data on health care facility room cleanliness or disinfection is based on common sense rather than on specific studies designed to evaluate infectivity. Cleanliness of patient care areas is important and surfaces of window ledges, floors and tables must be readily cleanable with soap and water. Environmental bacterial contamination of such things as floors, sinks, doors, handles and table tops can be readily demonstrated but have shown little potential for transmission to patients.

This apparent anomaly, the close physical presence of bacteria without potential infection, is probably due to the fact that very close patient contact between the floor and patient's wound, for example, generally does not occur. Thus since we

do not conduct patient care on the floors of patient's rooms, there is no apparent need to develop a culture for sterility. Thus the necessity for keeping supply items and inanimate surfaces clean in the health care facilities is in large part aesthetic.

**The health center air**

When the air circulation within the health care facility is not maintained in such a way that clean air is brought in from the outside, adequate ventilation does not remove particulate material. The particulate material is responsible for airborne transmission of infectious disease agents. Transmission of mycobacterium tuber culosis, varicella zoster virus, small pox, influenza, measles and possibly rubella and mumps is very possible. Air-borne transmission of other diseases appears to be very infrequent. Therefore health care facilities should provide adequate ventilation and spacing to avoid this problem.

**Training**

A policy for the management of health care waste cannot be effective unless it is applied carefully, consistently and universally. Training health care personnel in implementing the policy is thus critical if a waste management program is to be successful. The overall aim of training is to develop awareness of the health, safety and environmental issues related to health care waste and how these can affect employees in their daily work. It should highlight the roles and responsibilities of health care personnel in the overall management programme. Health and safety at the work place and environmental awareness are the responsibility of all and in the interests of all employees to be trained.

**Public education on hazards linked to infectious waste in health care facilities**

Promotion of the appropriate handling and disposal of medical waste is important for community health and every member of the community should have the right to be informed about potential health hazards.

The objectives of public education on health-care waste are as follows:

- To prevent exposure to health-care waste and related health hazards, this exposure may be voluntary, in the case of scavengers, or accidental, as a consequence of unsafe disposal method
- To create awareness and foster responsibility among patients and visitors to health care establishments regarding hygiene and health care waste management
- To inform the public about the risk linked to health-care waste, focusing on people living or working in close proximity to or visiting health-care establishment, families of patients treated at home and scavenges on waste dumps.

The following methods can be considered for public education on risks, waste segregation, or waste disposal practices:

- Poster exhibition on health care waste issues including the risk involved in scavenging discarded syringes and hypodermic needles
- Explanation by the staff of health care establishments to incoming patients and visitors on waste management policy. This may be difficult to achieve, in which case the distribution of leaflets should be considered.
- Information poster exhibition in health care facilities at strategic point such as waste bin locations, giving instruction on waste segregation. Posters should be explicit, using diagrams and illustrations to convey the message to as broad an audience as possible, including illiterate people.

**Education and training of health care personnel**

All health care personnel, include medical doctors, should be convinced of the need for a comprehensive health care waste management policy and related training and of its value for the health and safety of all. This should ensure their collaboration in the implementation of such a policy. Separate training activities should be designed for and targeted to four main categories of personnel:

- Health-care facility managers and administrative staff responsible for implementing regulations on health-care waste management
- Medical doctors and health officer
- Sanitarian, nurse, laboratory technician, pharmacy technician and health assistant
- Cleaners, porters, auxiliary staff and waste handlers

**Content of the training**

Staff education programs should include:

Information on and justification for, all aspects of the health-care waste policy

- Information on the role and responsibilities of each hospitals staff member in implementing the policy
- Technical instructions, relevant for the target group, on the application of waste management practices

**Training of health-care waste management operators**

The minimal training for waste management operators should include:

- Information on the risks associated with the handling of health-care waste
- Procedures for dealing with spillages and other accidents
- Instructions on the use of protective clothing

The training needs will obviously depend on the type of operations and the operations performed but may include specific topics such as operation of incinerators and waste transportation.

**Training for staff who transport waste**

The health-care establishment itself may carry out the transportation of waste. The waste handlers should be aware of the nature and risks of the transported waste. In particular the transport staff should be trained in the procedures listed

below. They should be able to carry out all procedures in accordance with the instructions without help from others:

- Correct procedures for handling, loading and unloading waste bags and containers
- Procedures for dealing with spillages or other accidents
- The wearing of protective clothing and strong foot wear at all times
- Availability at all times in handling, transporting and disposal of infectious waste
- Documentation and recording of health care waste, e.g. by means of a consignment note system, to allow waste to be traced from the point of collection to the final place of disposal.

### 3.4.6. Learning Activities

Refer to the Case Study on in section 2.4 of the Core module and discuss the following questions.

1. Describe the environment of the delivery room W/o Shumbe had attended.
2. What are the responsibilities of environmental health to stop infection?
3. What are pre-requisites to address the prevention and control of infections?
4. What are the poor environmental conditions that were observed in the delivery room?
5. What remedies do you suggest to correct such a situation?

# UNIT FOUR

# ROLE AND TASK ANALYSIS

**Table 4.1 Knowledge Objectives and Essential Tasks of the Health Center Team (Health Officers, Public Health Nurses, Medical Laboratory Technicians, and Sanitarians)**

| | Learning Objectives | Health Officer | PHN | Med Lab Tech | Sanitarian | Learning Activities |
|---|---|---|---|---|---|---|
| **Knowledge** | Define and Describe the types of commonest infections in health care facilities.<br><br>List the etiologies and predisposing factors for HCF infections<br><br>Describe the magnitude and contribution of HCF infection to overall community problems<br><br>Explain the standard precautions in infection prevention and control in health care facilities<br><br>Describe the assessment of HCF infections and its investigation<br><br>Describe the principle and treatment methods of HSF infections | Define and Describe the types of commonest infections in health care facilities.<br><br>List different causes of HCF infections and their association with the different risk factors<br><br>Pinpoint the prevalence and contribution of HCF infection to overall community problems<br><br>Describe the standard precautions in infection prevention and control in health care facilities<br><br>Enumerate the clinical manifestations and complications of HCF infections<br><br>Explain how to treat HCF infections and the principles underlying it | Define and Describe the types of commonest infections in health care facilities.<br><br>List different causes of HCF infections and their association with the different risk factors<br><br>Pinpoint the prevalence and contribution of HCF infection to overall community problems<br><br>Describe the standard precautions in infection prevention and control in health care facilities<br><br>Describe the clinical manifestations and complications of HCF infections<br>Describe how to administer the treatment and advise the patients | Define and Describe the types of commonest infections in health care facilities.<br><br>List different causes of HCF infections and their association with the different risk factors<br><br>Pinpoint the prevalence and contribution of HCF infection to overall community problems<br><br>Describe the standard precautions in infection prevention and control in health care facilities<br><br>Describe the different methods of laboratory investigations for HCF infections.<br>- | Define and Describe the types of commonest infections in health care facilities.<br><br>List different causes of HCF infections and their association with the different risk factors<br><br>Pinpoint the prevalence and contribution of HCF infection to overall community problems<br><br>Describe the standard precautions in infection prevention and control in health care facilities<br><br>-<br><br>- | Define and characterize the types of commonest infections in health care facilities.<br><br>List the different causes of HCF infection and associated predisposing factors<br><br>Explain the burden of infections in HCFs<br><br>Outline and explain the standard precautions and infection prevention control in HCFs<br><br>Investigate causes and record and report the results of HCF infections<br><br>List the different methods of treatment for HCF infections |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Knowledge** | Describe diagnostic methods for infections in health care facilities<br><br>Describe the management, prevention and control measures of infections in health care facilities<br><br>Identify different specimen collection procedures and proper handling for infection control<br><br>Know how to properly prepare and dispose of the various types of waste products generated in HCF<br><br>Know how to properly decontaminate a work area when a hazardous spill has occurred and in general how to keep work areas clean.<br>Know the basic steps of first aid measures | List the diagnostic methods for infections in health care facilities<br><br>Describe the management, prevention and control measures of infections in health care facilities<br><br>-<br><br>Know how to properly prepare and dispose of the various types of waste products generated in the wards<br><br>Demonstrate how to properly decontaminate a work area when a hazardous spill has occurred and in general how to keep work areas clean.<br><br>Know the basic steps of first aid measures | List the diagnostic methods for infections in health care facilities<br><br>Describe the management, prevention and control measures of infections in health care facilities<br><br>-<br><br>Know how to properly prepare and dispose of the various types of waste products generated in wards<br><br>Demonstrate how to properly decontaminate a work area when hazardous spill has occurred and in general how to keep work areas clean.<br><br>Know the basic steps of first aid measures | List diagnostic methods for infections in health care facilities<br><br>Describe the prevention and control measures of infections in health care facilities<br><br>Identify different specimen collection procedures and proper handling for infection control<br>Know how to properly prepare and dispose of the various types of waste products like sharp materials, liquid and solid wastes generated in the laboratory<br>Demonstrate how to properly decontaminate a work area when a hazardous spill has occurred and in general how to keep work areas clean.<br><br>Know the basic steps of first aid measures | List diagnostic methods for infections in health care facilities<br><br>Describe the prevention and control measures of infections in health care facilities<br><br>-<br><br>Know how to properly dispose of the various types of waste products generated in the HCFs<br><br>Demonstrate how to properly decontaminate a work area when a hazardous spill has occurred and in general how to keep work areas clean.<br><br>Know the basic steps of first aid measures | and describe what advice should be given to patients<br>Description of the diagnostic methods for infections in health care facilities<br><br>Description of the management, prevention and control measures of infections in health care facilities<br>Identification of different specimen collection procedures and proper handling for infection control<br><br>Proper preparation and disposing of the various types of waste products like sharp materials, liquid and solid wastes generated in the laboratory and wards<br><br>Proper decontamination of the work area when hazardous spill has occurred and generally keep the work areas clean.<br><br>Know the basic steps of first aid measures |

**Table 4.2. Attitude Objectives and Essential Tasks of the Health Center Team (Health Officers, Public Health Nurses, Medical Laboratory Technicians, and Sanitarians)**

| | Learning Objectives | Health Officer | PHN | Med Lab Tech | Sanitarian | Learning Activities |
|---|---|---|---|---|---|---|
| **Attitude** | U hold the idea that HCF infections are caused by micro-organisms | Educate the community about the agent and the source of common infections in HCFs | Educate the community about the agent and the source of common infections in HCFs | Educate the community about the agent and the source of common infections in HCFs | Educate the community about the agent and the source of common infections in HCFs | Educate the community about the agent and the source of common infections in HCFs |
| | Believe in the importance of standard precautions in HCF infection prevention and control | Instruct in the important standard precautions in HCF infection prevention and control | Instruct in the important standard precautions in HCF infection prevention and control | Instruct in the important standard precautions in HCF infection prevention and control | Instruct in the important standard precautions in HCF infection prevention and control | Advise the community about the use of standard precautions to reduce infections in HCFs |
| | Believe in conducting health education for clients, families and refresher training for staff in infection control | Conduct health education for clients, family visitors and refresher training for staff on infection control in health care facilities | Display the importance of health education for clients, families visitors and refresher training staff in infection control | Conduct health education for clients, family visitors and refresher training for staff on infection control in health care facilities | Conduct health education for clients, family visitors and refresher training for staff on infection control in health care facilities | Advocate the importance of health education for client families, visitors and refresh for training staff |
| | Believe in organizing surveillance committee for monitoring, defection and management of infections | Advise infection control and surveillance committees for routine monitoring, early detection and management of HCF infections | Advise infection control and surveillance committees for routine monitoring, early detection and management of HCF infections | Advise infection control and surveillance committees for routine monitoring, early detection and management of HCF infections | Advise infection control and surveillance committees for routine monitoring, early detection and management of HCF infections | Advise infection control and surveillance committees for routine monitoring, early detection and management of HCF infections |
| | Believe in utilization of health services to facilitate the treatment of HCF infections | Advise the community to promote utilization of health services for cases of HCF infections | Advise the community to promote utilization of health services for cases of HCF infections | Advise the community to promote utilization of health services for cases of HCF infections | Advise the community to promote utilization of health services for cases of HCF infections | Advise the community to promote utilization of health services for cases of HCF infections |

**Table 4.3. Practice Objectives and Essential Tasks of the Health Center Team (Health Officers, Public Health Nurses, Medical Laboratory Technicians, and Sanitarians)**

| | Learning Objectives | Health Officer | PHN | Med Lab Tech | Sanitarian | Learning Activities |
|---|---|---|---|---|---|---|
| **Practice** | Identify the causes and the source of common infections in HCFs and demonstrate their appropriate management | Demonstrate the management principle; identify the etiologic agents and sources of commonest infection in HCFs | Apply control measures of etiologic agent and source to prevent common infections | Identify the etiologic agents and sources of commonest infection in health care facilities. | - | Identify the cause and its complication and manage the case by selecting appropriate treatment plan |
| | Identify the standard precaution in infection prevention and control | Demonstrate the standard precautions in infection prevention and control in health care facilities | Participate in prevention and control of cross infection by using standard precaution in infection prevention and control in HCFs | Demonstrate the standard precautions in infection prevention and control in health care facilities | - | Demonstrate the standard precautions in infection prevention and control in health care facilities |
| | Conduct health education for clients, families and refresher training for staff in infection control | Conduct health education for clients, family visitors and refresher training for staff on infection control in health care facilities | Carryout health education for client, families, visitors and refresher training for staff in infection control | Conduct health education for clients, family visitors and refresher training for staff on infection control in health care facilities | Conduct health education for clients, family visitors and refresher training for staff on infection control in health care facilities | Health education for client families visitors and refresh for training staff |
| | Organize infectious control committee for routine monitoring early defection and management of HCF infections | Organize infection control and surveillance committee for routine monitoring, early defection and management of HCF infections | Organize infection control committee for routine monitoring early defection and management of infection | Organize infection control and surveillance committee for routine monitoring, early defection and management of HCF infections | Organize infection control and surveillance committee for routine monitoring, early defection and management of HCF infections | Organize infectious control committees for routine monitoring early detection and management of HCF infections |
| | Demonstrate how to do laboratory tests to isolate the causes of HCF infections | - | - | Demonstrate how to do laboratory tests to isolate the causes of HCF infections | - | Demonstrate how to do laboratory tests to isolate the causes of HCF infections |
| | Demonstrate the process of assessing HCF infections | Take appropriate history and perform proper physical examination of HCF infections | Take vital signs and determine evidence of HCF infections | Perform important lab tests to detect HCF infections | - | Demonstrate the process of assessing HCF infections |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Practice** | Demonstrate procedure of cleaning, disinfection and sterilization according to the given outline | - | Demonstrate correct cleaning procedure, disinfect and sterilize equipments in HCFs, prepare patients for surgical and non-surgical procedures | Demonstrate correct cleaning procedure, disinfect and sterilize equipments in HCFs | - | Cleaning, disinfecting, and sterilizing of equipments and preparation of patients for non-surgical cases |
| | Plan different methods of training in management of infectious waste in health care facilities | Plan different methods of training in management of infectious waste in HCFs | Plan different methods of training in management of infectious waste in HCFs | Plan different methods of training in management of infectious waste in HCFs | Plan different methods of training in management of infectious waste in HCFs | Planning different methods of training in management of infectious waste in HCFs |
| | Implement safety precaution for the prevention of infection in the laboratory setting | - | Implement safety precaution for the prevention of infection in the laboratory setting | Implement safety precaution for the prevention of infection in the laboratory setting | Implement safety precaution for the prevention of infection in the laboratory setting | Implement safety precaution for the prevention of infection in the laboratory setting |
| | Ensure the availability of hygienic food supply, adequate and safe water supply, and safe handling of medical equipment and linens and good housing conditions in health care facilities | Ensure safe handling of medical equipment and linens and good housing conditions in health care facilities | Ensure safe handling of medical equipment and linens and good housing conditions in health care facilities | Conduct food and water analysis and check safe handling of lab equipment and good housing conditions in health care facilities | Ensure the availability of hygienic food supply, adequate and safe water supply good housing conditions in health care facilities | Ensuring the availability of hygienic food supply, adequate and safe water supply, safe handling of medical equipment and linens and good housing conditions in HCFs |

# UNIT FIVE

# GLOSSARY AND ABBREVIATIONS

## GLOSSARY

***Container:*** Vessel in which waste is placed for handling, transportation, storage, and/or eventual disposal. The waste container is a component of the waste package.

***Decontamination:*** Reduction of microbiological contamination to a safe level.

***Disinfection:*** Treatment aimed at reducing the number of vegetative micro-organisms to safe or reactively safe levels.

***Disposal:*** Intentional burial, deposit, discharge, dumping, placing or release of any waste material into or on any air, land or water.

***Handling:*** The functions associated with the movement of solid waste materials, excluding storage, processing, and ultimate disposal.

***Incineration:*** The controlled burning of solid, liquid or gaseous combustible wastes to produce gases and residues containing little or no combustible materials.

***Municipal waste:*** General waste for collection by municipalities generated mainly by households, commercial activities and street sweeping.

***Recycling:*** A term embracing the recovery and reuse of scrap or waste material for manufacturing or other purposes.

***Segregation:*** The systematic separation of solid waste into designated categories.

***Sterilization*****:** A reduction in micro-organisms of more than $10^6$ achieved by physical, chemical or mechanical methods or by irradiation.

***Storage:*** The placement of waste in a suitable location or facility where isolation, environmental and health protection and human control (e.g. monitoring for radio activity, limitation of access) are provided.

***Waste generator:*** Any person, organization or facility engaged in activities that generate waste.

***Waste management:*** All activities, administrative and operational, involved in the handling, treatment, conditioning, storage and disposal of waste.

# ABBREVIATIONS

AFI - Acute Febrile Illness
AIDS - Acquired Immuno Deficiency Syndrome
CHW - Community Health Worker
EH - Environmental Health
HCFs - Health Care Facilities
HIV - Human Immunodeficiency Virus
HLD -High Level Disinfection
HO -Health Officer
IV -Intravenous
MCH -Maternal and Child Health
MLT -Medical Laboratory Technician
MOH -Ministry Of Health
OR -Operation Theatre
PHW -Public Health Worker
TB -Tuberculosis
TTBA -Trained Traditional Birth Attendant
WM - Waste Management
WMIC - Waste Management and Infection Committee
UTI - Urinary Tract Infection
STI - Sexually Transmitted Infections
TAT - Tetanus Antitoxin

# UNIT SIX

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# UNIT SEVEN

# ANNEXES

## Annex 1: Answer Keys

### 2.1. Keys for the Core Module (all Categories)

**Q.No. 1. D**

**Q.No. 2. D**

**Q.No. 3. B**

**Q.No. 4. E**

**Q.No. 5. A**

**Q.No. 6. E**

**Q.No. 7. E**

**Q.No. 8.** Patients, families, and visitors need to have health education. Also the auxiliary staff and the health professionals need basic or refresher training because all of the above mentioned groups of individuals are responsible for the control of infections in HCFs.

**Q.No.9.** Head of the health center, department heads, and hygienist.

**Q.No. 10.**

- Formation of waste management and infection control committee
- Appoint waste management and infection control officer
- Allocation of sufficient financial and personnel resources
- Monitor the efficiency of waste disposal system
- Insure adequate training of staff on waste management

**Q.No. 11.**

- Active surveillance
- Passive surveillance

**Q.No. 12.**

- Urinary tract infections
- Surgical wound infections
- Puerperal sepsis

**Q.No. 13.**

The answer is found in the core module on page 39.

**Q.No. 14.**

a. Ensuring that the auxiliary staff are aware of the procedure in segregation and storage of wastes and check that all of them are at the highest standard.
b. Work with waste management committees.
c. Ensuring that staff members in their departments are getting training.

## 2.2. Keys for the satellite modules (Specific Professional Categories)

### 2.2.1. Health Officers

**Q.No.1. E**
**Q.No.2. B**
**Q.No.3. A**
**Q.No.4. E**
**Q.No.5. A**
**Q.No.6. B**
**Q.No.7. D**
**Q.No.8. C**

### 2.2.2. Public Health Nurses

**Q.No.1. D**
**Q.No.2. B**
**Q.No.3. E**

**Q.No.4. D**

**Q.No.5. A**

**Q.No.6. C**

**Q.No. 7. E**

**Q.No. 8. B**

**Q.No. 9. E**

**Q.No. 10. C**

**Q.No. 11. C, D**

### 2.2.3. Medical Laboratory Technicians

**Q.No. 1. D**

**Q.No. 2. C**

**Q.No. 3. D**

**Q.No. 4. E**

**Q.No. 5. D**

**Q.No. 6.** Refrigerator

**Q.No.7.** To isolate any possible hazardous waste from all health workers, laboratory personnel, and clients.

### 2.2.4. Sanitarians

**Q.No. 1. E**

**Q.No. 2. E**

**Q.No. 3.** a. Identification of the problem

b**.** Write a case definition

c. Epidemiological description

d. Formulate a hypothesis

e. Implement control measures to stop the outbreak

**Q.No. 4.** a. Waste generation

b. Segregation and packaging

c. Handling and storage

d. Treatment and disposal

**Q.No. 5.** a. Chemning

b. Furnace

c. Ash pit

**Q.No. 6. A**

**Q.No. 7. C**

**Q.No. 8. E**

**Q.No. 9. E**

**Q.No. 10. D**