Reference Manual for
Health Care Facilities with Limited Resources

Infection Prevention and Control.

Module 5. Facility Management

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Module 5. Facility Management

Chapter 1. Facility Design, Traffic Flow, and Work Practices in Health Care Facilities

Key Topics

- The importance of facility design in infection prevention and control (IPC)
- Facility design and space requirements to minimize microbial contamination
- Traffic patterns and work practices to minimize microbial contamination

Key Terms

- **Air exchanges per hour** is a measure used to describe the number of times the whole volume of air in a given space will be completely replaced by a new air in 1 hour. An air exchange rate of 12 per hour in an operating theater (OT) means that the air in the room will be replaced 12 times per hour.
- **Central sterile supply department (CSSD)** is the specific department in the facility specializing in cleaning, processing using either high-level disinfection or sterilization, and distributing instruments, equipment, and other items. The CSSD staff are trained and certified to perform instrument processing tasks following a standard approach.
- **Cross-contamination** is the process by which bacteria and other microorganisms are unintentionally transferred from one surface, substance, or object to another.
- **Instrument processing areas** are places anywhere in the health care facility where soiled instruments, equipment, and other items are cleaned and processed by means of either high-level disinfection or sterilization.
- **Negative pressure airflow** occurs when a room has lower air pressure than adjacent areas, which keeps air from flowing out of the room into adjacent rooms or hallways. Negative pressure is used to contain potential airborne contaminants within the room to prevent the spread of infection. This is usually achieved by actively exhausting air from the room using mechanical ventilation.
- **Point of use** refers to the place and time where equipment, instruments, and supplies are used on patients (e.g., the patients' bedsides, procedure rooms, delivery rooms, OTs).
- **Positive pressure airflow** occurs when a room has higher air pressure than adjacent areas, which keeps air from flowing into the room from adjacent rooms or hallways. Positive pressure is used to protect the contents of the room from potential airborne contaminants from outside the room. This is usually achieved by actively drawing air into the room using mechanical ventilation.
- **Procedural barriers** are used to prevent cross-contamination of clean and dirty items while performing a procedure. They are used routinely during many procedures as part of IPC practices. They are especially important when there is limited space and the same space must be used to work with both clean and dirty equipment during cleaning, disinfection, and sterilization. An example of a procedural barrier is draining and disinfecting the sink and all countertops after cleaning and before starting the disinfection process.
- **Procedure areas** are areas where patients are examined and patient care procedures (e.g., pelvic examinations, wound care management, blood drawing, immunizations, IUD insertions and removals, and normal childbirth) are performed.

Background

Important aspects of preventing disease transmission in health care facilities include: minimizing microbial contamination of equipment (during use, transportation of soiled instruments, processing, storage, and transportation of processed instruments to point of care); minimizing microbial contamination of surfaces in patient care areas; removing contamination when it occurs (such as on instruments); and preventing the transmission of microorganisms to patients, visitors, and staff. Minimizing microbial contamination is especially critical in all areas where invasive and sterile procedures are performed, contaminated instruments are transported and processed, and sterile supplies are stored. These areas include clinics, procedure areas, operating suites, and instrument processing areas in a health care facility.

Microbial contamination can be substantial in highly trafficked areas and places where soiled surgical instruments and other equipment are initially processed. Basic principles of facility design, traffic flow, and work practices that can be applied to reduce microbial contamination include:

- Designating appropriate traffic flow for patients, health care workers (HCWs), and equipment to ensure safe separation between contaminated items and clean/sterile items.
- Developing policies and procedures that establish clear authority, responsibility, and accountability to ensure that these safe practices are adopted and practiced.
- Regulating the flow of visitors, patients, and staff using signs (e.g., authorized personnel only), reminders (e.g., red line on the floor), and physical barriers (e.g., closed doors). The amount of traffic and the number of individuals present in a designated area and their activities contribute to the number of microorganisms present in that area.
- Using work practices that prevent contaminated items from contacting clean items, such as working from dirty to clean. This is especially important if separate spaces for dirty and clean items are not available.
- Ensuring that staff understand the policies and procedures, for example, through new staff orientation and ongoing training, to guarantee safe handling of clean and soiled items.
- Ensuring appropriate ventilation of OTs, procedure areas, CSSDs, and instrument processing areas (see Table 1-1).
- Using fans in facilities without mechanical ventilation to optimize existing ventilation. The air should be drawn into the area and should be exhausted outside using one-way exhaust fans. Where mechanical ventilation or fans are not available, the only option is to use natural ventilation with open windows and doors fitted with mosquito nets.
- Designing new facilities and renovations with these principles in mind. For example, health care facilities should have a dedicated central location where soiled instruments can be reprocessed and that is physically separated from procedure areas.

Table 1-1. Appropriate Ventilation

Facility Area	Ventilation
Operating theater	Negative pressure airflow with a minimum of six air exchanges per hour
Procedure areas	Negative pressure airflow with 15 total air changes per hour, of which three should be outside air
CSSD	Positive pressure airflow with 10 air exchanges per hour
Instrument processing area	Negative pressure with 10 air exchanges per hour in packaging and sterilization area

Facility Design and Space Requirements

Health care facilities vary in the types of services they provide. For example, a rural clinic may offer a limited number of procedures (e.g., IUD insertion and removal, immunization, antenatal care, and minor surgery for suturing wounds or other trauma). Larger facilities, including district and referral hospitals, perform a wide variety of major and minor procedures and a high volume of surgical cases in addition to ambulatory procedures.

When planning new facilities, plan a separate area for instrument processing with adequate work space, sinks, countertops, and space for the anticipated amount of equipment that will require reprocessing. While this is important for all facilities, it is critical in those expecting a high volume of surgical procedures.

Procedure Area Design and Space Requirements

Specific space and equipment requirements to perform a particular procedure generally are the same regardless of the size of the facility.

Regardless of the size of the facility or the complexity of the procedure, it is critical to ensure that there is no cross-contamination during the handling, transporting, processing, and storage of instruments. Ideally, the following should be in place:

- Sterile supplies and instruments should not be stored in procedure areas.
- Instrument processing should be done in an area away from the procedure rooms or operating suites, ideally in a central location such as a CSSD.
- Traffic flow and work practices within the reprocessing area should allow for physical separation between clean and dirty processes to prevent cross-contamination.

Note: If clean or sterile equipment and supplies must be stored in the procedure room, store them in closed cabinets or covered containers with doors and covers closed during procedures to prevent cross-contamination from splashes, sprays, and aerosols during procedures.

To reduce the likelihood of cross-contamination, soiled instruments should be wiped down immediately at the point of use **but should not** be cleaned or reprocessed in procedure rooms. Cleaning instruments is a dirty process and can lead to extensive contamination of sinks and surrounding areas including surfaces, thus increasing the risk of cross-contamination to patients undergoing procedures in the area.

HCWs may need to work in spaces that are less than ideal. If this is the case, an area—a designated room or an existing space—could be repurposed and/or renovated into an instrument reprocessing area. If this is not possible, the existing space should be assessed to ensure that traffic flow and work practices are designed in a manner that utilizes procedural barriers and prevents cross-contamination (see Table 1-2).

Table 1-2. Transportation of Instruments to Prevent Cross-Contamination

Situation in Order of Preference	Transportation of Instruments
Central sterile supply area exists	Instruments should be transported in a covered container to a separate, dedicated central area within the health care facility (such as a central sterile supply area).
No central sterile supply area exists	Instruments should be transported in a covered container to a nearby separate instrument processing area.
No space for a nearby separate instrument processing area exists	Instruments should be transported in a covered container to an adjacent room, separate from the procedure room.
None of the above are possible	Instruments should be transported in a covered container to a dedicated sink in the procedure area: 1. Move the patient out of the procedure room before processing begins. 2. Clean instruments after the procedure is over. 3. Clean the sink used for cleaning instruments with disinfectant after every use and wipe down nearby surfaces after processing is complete.

Design and Space Requirements of the Operating Suite

As surgical procedure types and methods become more complex (e.g., from general surgery and obstetrics to more complex procedures, such as joint replacement and cardiac surgery, or by use of new methods such as laparoscopic or robotic surgery), the space and equipment needs increase.

Space requirements for operating suites

The following areas should be clearly designated to help ensure recommended traffic flow in the operating suites:

For operating theater team members and other staff:

- Changing room and work station
- Staff toilets
- Area for surgical hand scrub and putting on PPE

For instruments

- Designated instrument processing area/room (with separated clean and dirty areas)
- Space with cabinets for storing sterile and high-level disinfected items

For operating theater space

- Preoperative examination room/holding room.
- Theater large enough to allow movement of staff in the room without contaminating the staff performing surgery or the sterile field.
- Recovery area for patient observation after surgery (may be combined with the preoperative area).
- When resources are available, the best practice is to design the OT with mechanically ventilated clean air and positive pressure to ensure that air from the OT flows into the corridor and other adjacent areas. This prevents contaminants and microbes from adjacent areas moving into the OT. Circulating air should have a mix of fresh air and recirculating air and should be filtered to remove 90% of contaminants. (AAMI 2014):
  - If mechanical air handling is not available, use screens on the windows to protect against insects and help minimize dust.

Design and Space Requirements of Central Sterile Supply and Instrument Processing Areas

Central sterile supply department

All facilities should aim to process all instruments in a central location. Large facilities where a high number of procedures are performed should have a CSSD that is dedicated to cleaning, disinfection, and sterilization of the instruments and equipment (see Figure 1-1). A CSSD should ideally have the following:

- Clean/sterile storage areas separated from soiled areas:
  - At least two rooms, one for receiving soiled instruments and cleaning them, and the other for high-level disinfection, sterilization, and storage. Having two rooms to process the instruments helps ensure that there is no cross-contamination between the soiled items and clean/sterile items.
- Two sinks in the soiled area, one for removing gross contaminants and the other for rinsing instruments:
  - If two sinks are not available, procedural barriers should be used to help prevent cross-contamination (see the Procedural Barriers section in this chapter).
- A sink dedicated to hand hygiene.
- Sterile items stored in covered bins or storage cabinets to protect them from dust and contamination (see Module 6, Chapter 4, Sterilization of Reusable Surgical Instruments and Medical Devices).
- Airflow from the clean/sterile storage area to the decontamination area and exhausted to outside to prevent contaminants from flowing into the clean area. (AAMI 2014):
  - Air-conditioned single rooms with an exhaust or well-ventilated rooms are adequate options for health care facilities without mechanical ventilation systems. If an air-conditioned room with an exhaust is not available, as in many resource-poor settings, local exhaust can be achieved by placing a fan in the window to assist airflow. (SEARO/WHO 2004)
- A separate room for handling textiles (the linens used as drapes and wraps, gauze and cotton) in order to protect the sterile instruments from lint, which can cause inflammation and infection if deposited into surgical wounds.

All instrument processing areas

Ideally, all of the areas where instrument processing takes place in a facility should have the design and space described above for the CSSD. One area is needed for decontamination and cleaning of soiled instruments and equipment and another area or space is needed for high-level disinfection, sterilization, and storage of processed items (see Figure 1-2 A and 1-2 B). Instrument processing areas should be separated from procedure rooms and the OT suite. If the instrument processing area is adjacent to the procedure room/OT, ensure that the workflow (i.e., the physical flow of instruments from one place to another) prevents cross-contamination.

In smaller facilities, instrument processing areas with two separate rooms may not be available; in this case, physical separation of clean and contaminated work areas is required. If only a single room is available, soiled equipment should be received and cleaned in an area of the room well away from where instruments are high-level disinfected or sterilized and stored. These functions should be at least 1.2 meters (4 feet) from one another. If this is not possible, install a barrier to prevent splashing from the decontamination area to the preparation and packaging or sterilization areas. The flow of instruments should always be from dirty to clean. Clearly mark the "dirty" and "clean" areas with signs and/or painted lines on the floor to delineate the clean and dirty areas. Place barriers (such as screens or makeshift walls) between the areas if possible.

Figure 1-1. Example of a CSSD Floor Plan

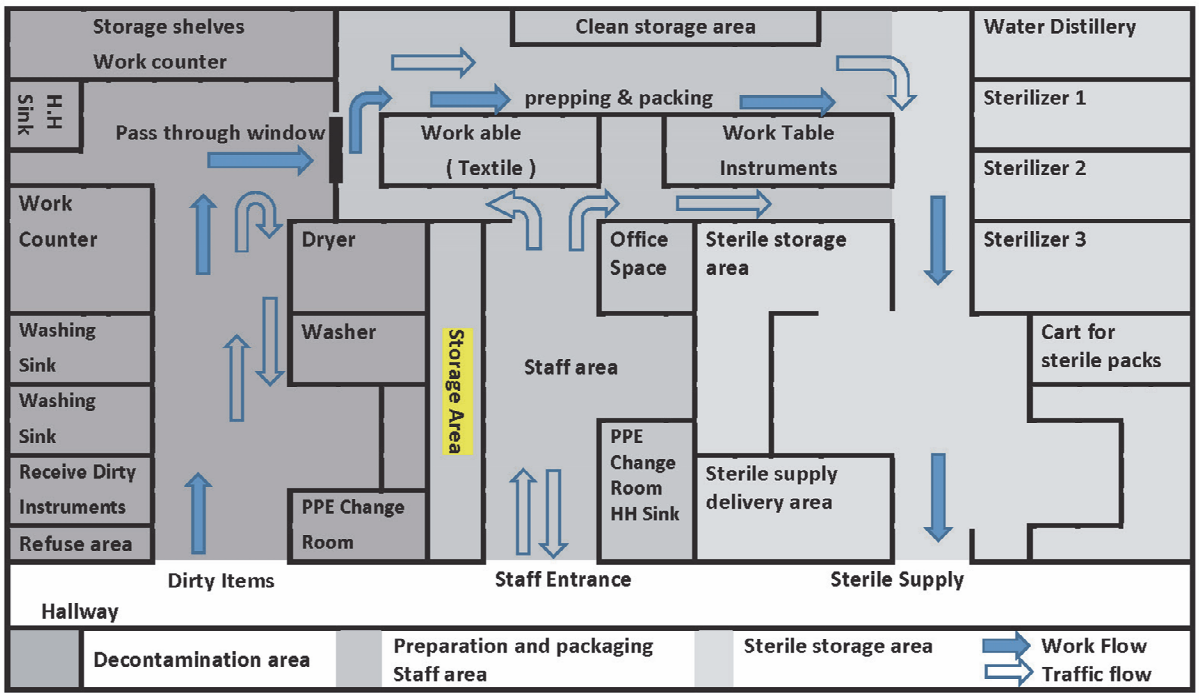
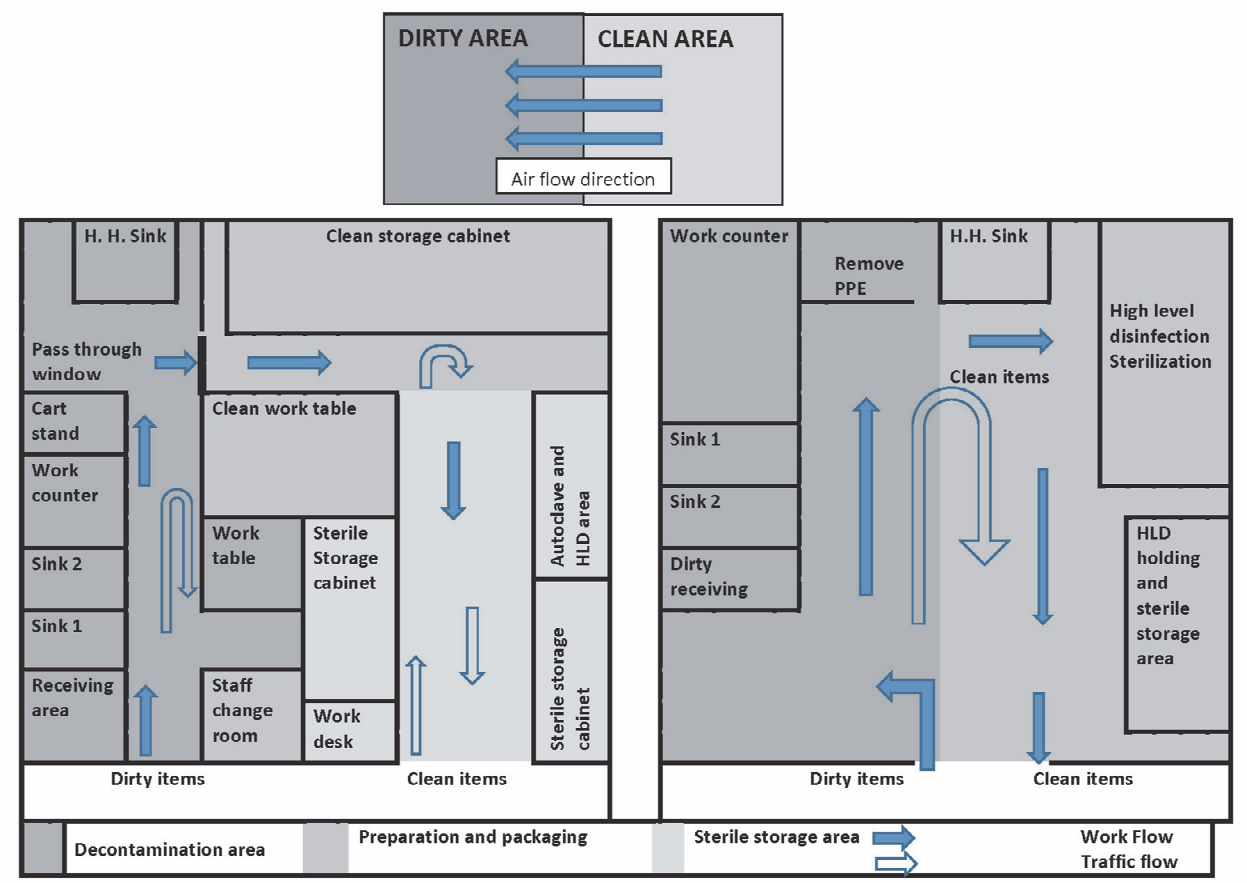


Figure 1-2 A and B. Floor Plans for Instrument Cleaning, High-Level Disinfection, and Sterilization Areas in a Clinic and Larger Facility



Adapted from: SEARO/WHO 1988.

The size of the instrument processing area depends on the facility's needs. Consider the volume of instruments to be reprocessed at any given time, packaging requirements, types of reprocessing methods, and equipment used. If an instrument processing area is being designed, it should be made large enough to act as the central area to handle all the instruments reprocessed at the health care facility in order to scale back the need to re-process instruments in wards, units, and procedure areas throughout the facility.

Traffic Flow, Procedural Barriers, and Work Practices to Minimize Microbial Contamination

Irrespective of current physical design, it is important to develop traffic flow and work practices to prevent cross-contamination and protect staff. Clearly defined traffic flow and work practices should be in place to ensure no crossing of clean and soiled items. Obviously, this is more difficult when space is limited.

Procedure Room Traffic Flow, Procedural Barriers, and Work Practices to Minimize Contamination

- Limit traffic to authorized HCWs and patients at all times.
- Permit in the procedure room only the patient and HCWs performing and assisting with procedures. For obstetrical procedures (e.g., normal delivery), a family member can be allowed in the room but

must maintain the appropriate personal protective equipment (PPE) and position related to the sterile field.

- Allow patients to wear their own clean clothing or a patient gown.
- Ensure that staff wear attire and PPE appropriate for the procedures to be performed (see Module 3, Chapter 1, Personal Protective Equipment).
- Place a leak-proof, covered waste container at the point of use for disposal of infectious waste (e.g., cotton, gauze, dressings) (see Chapter 5, Waste Management in Health Care Facilities, in this module).
- Have a puncture-resistant sharps container at the point of use for safe disposal of sharps (e.g., hypodermic needles and syringes, used suture needles, and disposable scalpel blades).
- Protect clean, high-level disinfected, and sterile items from dust and contamination by storing them in another location or in closed containers and cabinets.
- Have a separate sink for handwashing. Do not process instruments in the handwashing sink or wash hands in the instrument processing sink.
- Perform point-of-use cleaning by wiping gross contamination from instruments with gauze saturated with sterile water immediately after use.
- Collect used, non-disposable surgical instruments in a labeled, covered container at the end of the procedure. If instruments will not be immediately reprocessed, wipe them with gauze saturated with sterile water, or spray them with an enzymatic product to prevent blood and debris from drying on the instruments. Cover the container and transport it to the instrument processing area.

Transporting Soiled Instruments

Soiled instruments should be kept damp, transported to the processing area as soon as possible, and cleaned soon thereafter to avoid damage to the instruments. Surgical instruments become more difficult to clean properly if blood and body fluids are allowed to dry on them.

Usually, instruments are most contaminated immediately after use. Therefore, it is important to develop procedures to protect the staff transporting the items as well as patients, staff, and visitors in the health care facility during transportation of contaminated items from the point of use to the instrument processing area. These procedures should include:

- Contaminated items should be contained and identified as soiled during transport from the point of use to the instrument processing area:
  - Use a covered container, bin, or certain color bag (e.g., red).
  - Clearly mark the container, bin, or bag with a biohazard label or use another method to identify the contents as contaminated.
- Do not transport sterile items together on the same trolley/cart as soiled items (such as when sterile supplies are delivered and soiled items are collected from these locations):
  - Clean the trolley/cart after each use using a disinfectant (see Chapter 2, Environmental Cleaning, in this module).

Determine the best traffic flow to reduce contamination into and out of the OT and procedure areas, and within these areas, to prevent contamination.

Operating Suite Traffic Flow, Procedural Barriers, and Work Practices to Minimize Contamination

The operating suite is often divided into four designated areas that are defined by the activities performed in each area:

- Unrestricted area
- Transition zone
- Semi-restricted area
- Restricted area

Note: Signs should be posted in each area of the operating suite to clearly indicate the appropriate environmental controls and surgical attire required in the area.

The need for procedural barriers and use of surgical attire increases as HCWs move from unrestricted to restricted areas.

If possible, the operating suite should be located away from areas in the health care facility that are heavily trafficked by HCWs and patients and from windows that ventilate areas with infectious patients (such as patients with TB).

Unrestricted area

This area is the entrance from the main corridor, and other areas of the surgical unit are isolated from it. This is the point through which HCWs, patients, and materials enter the surgical unit. Patients' relatives, other visitors, and staff are allowed in this area.

Note: If supplies are being delivered to the OT, one staff member standing outside the surgical area should pass the items through the door to another staff member inside the OT to help reduce traffic.

Transition zone

This area consists primarily of changing rooms, workstations, and lockers. This is where surgical staff put on scrub suits and other PPE that allow them to move from unrestricted to semi-restricted or restricted areas in the surgical unit. Only authorized surgical staff should enter this area.

Semi-restricted area

This is the peripheral support area of the OT. This area includes preoperative and recovery rooms, storage space for sterile and high-level disinfected items, and corridors leading to the restricted area. Ideally, the instrument processing area should be outside the operating suite; if not, ensure that traffic patterns and work practices prevent cross-contamination using the following guidelines:

- Have doors that limit access to the restricted area of the OT (e.g., have signage, automatically closing doors).
- Limit traffic to authorized staff and patients at all times.
- Restrict staff with respiratory or skin infections or uncovered, open sores from entering the OT (see Module 4, Chapter 2, Infection Prevention and Control Aspects of Occupational Health in Health Care Settings).
- Ensure that everyone (except the patients) entering the semi-restricted area wears scrub suits and caps to cover their hair.
- Require staff to wear clean, closed-toe shoes that will protect their feet from fluids and dropped items.

- If instruments are processed here, have a separate work area for processing instruments.
- Have storage space for clean and sterile or high-level disinfected items with enclosed shelves to minimize the collection of dust and debris on stored items, or store items in covered bins.

Restricted area

This area consists of the OT, connecting hallways, and scrub sink areas.

Note: Never store instruments and other items in the OT.

For the hallways and scrub sinks:

- Limit traffic to authorized staff and patients at all times.
- Keep the door closed at all times, except during movement of essential HCWs, patients, supplies, and equipment. Scrubbed surgical staff must wear full surgical attire and cover their heads and facial hair.
- Face masks should be worn before performing a surgical hand scrub.

Within the OT

- Staff directly involved in performing procedures and patients undergoing surgery should be the only people allowed in this area.
- Access doors to the OT should be kept closed during the procedure and movement of staff should be restricted.

Before surgical procedures

- Place a plastic bag or leak-proof, covered, color-coded waste container for disposing of infectious waste (e.g., cotton gauze, old dressings) at the point of use but away from the sterile field.
- Place a puncture-resistant sharps container for the safe disposal of sharps (e.g., hypodermic needles and syringes, suture needles, and disposable scalpel blades) at the point of use but do not contaminate the sterile field.
- Place a leak-proof, covered container for soiled linen away from the sterile field.

Note: Only covered-toe shoes (rather than flip flops or sandals) should be worn in the OT because they provide protection from fluids and dropped instruments, including sharps.

- Organize tables, Mayo stands (i.e., stands with rollers and removable surgical trays), and saline stands side by side in an area away from the traffic patterns and at least 45 cm (18 inches) from walls, cabinets, and other non-sterile surfaces.
- Carefully assess and plan the procedure to ensure that the necessary equipment and supplies are available in the OT.
- Face masks should be worn by all persons in the room upon opening the first sterile package.
- Patients entering the OT should wear clean gowns or be covered with clean linen and have their hair covered.
- Patients do not need to wear face masks (except for source control if on Airborne Precautions under certain circumstances).

During surgical procedures

- If an instrument or supply is needed, request someone to bring the item to the door. Careful planning should keep this to a minimum.
- Limit the number of people and their movements in the OT to a minimum. The number of microorganisms increases with activity. Limiting HCWs' movements to decrease the amount of bacterial shedding (i.e., expelling bacteria from the body) and prevent air turbulence (i.e., unsteady movement of air) helps to minimize the spread of contaminants.

Note: If splashes or spills of blood or amniotic fluid are expected, wear a face shield and plastic or rubber apron.

- Keep the OT doors closed, opening them only for patients, surgical staff, supplies, and equipment. Leaving the door open disrupts positive pressure and air exchange parameters. This can lead to an increase in airborne contamination and may contribute to surgical site infections.
- Keep talking to a minimum in the presence of a sterile field. (Crolla et al. 2012)
- Scrubbed surgical staff should keep their arms and hands above their waists and within the operative field at all times and touch only sterile items or areas.
- Scrubbed staff should wear surgical attire, including long-sleeved gowns, caps to cover all hair, shoes to protect their feet, and masks to cover their mouths, noses, and any facial hair (for details see Module 3, Chapter 1, Personal Protective Equipment).
- Non-scrubbed staff should stay in the periphery (i.e., outer areas) of the OT, keeping their distance from sterile areas. They should not lean or reach over the operative field, staying—at a minimum—1 meter (3 feet) from the operative field.
- Face masks covering the nose and mouth should be worn by all persons in the room when the sterile field is set up, during the entire operative procedure, and until the case is complete and the sterile field is removed.

After surgical procedures

- Patients should be moved to the recovery area immediately after the procedure.
- Instruments and other items should be handled and transported after the patient has been moved. See the Transporting Soiled Instruments section in this chapter.
- Soiled instruments should not be brought back into the OT once they have been removed.
- The OT should be cleaned following procedures described in Chapter 2, Environmental Cleaning, in this module.

Instrument Processing Area

Traffic flow and work practices to minimize contamination

The instrument processing area is where instruments and equipment are cleaned, high-level disinfected or sterilized, and stored. Permit only authorized staff to enter this area. Staff should be specially trained in handling, processing, and storing instruments, equipment, and other clean, sterile, or high-level disinfected items and be required to demonstrate competency at these tasks on a regular basis (such as annually).

A CSSD consists of four areas:

1. Soiled receiving and cleanup area
2. Clean work area
3. Clean equipment storage area
4. Sterile storage area

Note: The CSSD is considered a semi-restricted area. Follow all recommendations for these areas.

Following surgery, immediately place soiled items in a covered container and transport it to the CSSD or designated instrument and equipment processing area following the guidelines in the Transporting Soiled Instruments section in this chapter. If immediate transport to the instrument processing area is not possible, follow the guidelines listed in the Procedure Room Traffic Flow, Procedural Barriers, and Work Practices to Minimize Contamination section in this chapter.

Note: Develop flow patterns to help ensure that contaminated items never come in contact with clean, disinfected, or sterile items.

Equipment and Supply Processing Area

Separate the "soiled" receiving/cleanup area (see Figure 1-2 A and 1-2 B) from the "clean" work area with a physical barrier (wall and door). If this is not possible, use a screen or paint a red line on the floor to designate separation between areas. The functions and equipment requirements for the four areas of a typical CSSD are summarized below.

1. "Soiled" receiving and cleanup area

In this area, soiled items are received, disassembled, washed, rinsed, and dried. The "soiled" receiving/cleanup area should have:

- A place to put on and remove PPE
- A sink for hand hygiene
- A receiving counter for soiled instruments and other items from the procedure room or OT
- Two sinks, if possible, one for cleaning and one for rinsing with a clean water supply
- A counter for drying clean equipment
- Instrument cleaning machines, if used
- Space to store equipment for diluting chemicals and the brushes and basins used

Note: Staff in the receiving and cleanup area should wear long-sleeved, fluid-resistant gowns; utility gloves; head covers; safety goggles or face shields; and plastic aprons (if needed) to protect themselves from spills and splashes.

2. "Clean" work area

In the clean work area, cleaned items are:

- Inspected for flaws or damage
- Packaged (if indicated) and are either sterilized or high-level disinfected
- Sent to storage after being packaged or air-dried and placed in a sterile or high-level disinfected container

Note: Staff entering the "clean" work area should perform hand hygiene and wear clean PPE (head cover and hospital laundered scrubs suit).

The clean work area should have:

- A large work table with chairs and good lighting
- Shelves for holding clean and packaged items
- A high-pressure steam sterilizer, a dry-heat oven, and a steamer or boiler

Note: Never bring soiled items into the "clean" work area.

3. Clean equipment storage area

Store new or cleaned equipment for cleaning instruments in this area. CSSD staff should enter the CSSD through this area. Equip the area with:

- Shelves (preferably closed) for storing cleaning equipment
- An office or desk for recordkeeping

4. Sterile or high-level disinfected storage area

Store sterilized packs and covered sterile or high-level disinfected items in this area. The following guidelines should be followed to keep sterile and high-level disinfected items sterile:

- Limit access to the storage area.
- Keep the storage area clean, dry, dust-free, and lint-free by following a regular housekeeping schedule.
- Store items in closed cabinets or shelves. Enclosed shelves or cabinets are preferred because they protect packages and containers from dust and debris. If items are stored on open shelves, ensure that the tops and bottoms of the shelves have solid covers to protect from dust and splashes from above or below.
- Store packages and containers with sterile or high-level disinfected items 20 to 25 cm (8 to 10 inches) off the floor, 45 to 50 cm (18 to 20 inches) from the ceiling, and 15 to 20 cm (6 to 8 inches) from an outside wall.

Note: Instruments sterilized without a protective wrap and or pack cannot be stored and must be used immediately.

- Do not use cardboard boxes for storage. Cardboard boxes are often dusty and soiled and may hide insects between the layers of cardboard.
- Date and rotate the supplies (e.g., first in, first out). This process serves as a reminder that the packages are susceptible to contamination and conserves storage space, **but it does not guarantee sterility.**
- Maintain sterility by maintaining the integrity of the packages. Sterile or high-level disinfected containers remain sterile until they are opened or an event occurs that threatens sterility (e.g., water leak).
- Do not stack heavy items on top of one another as the integrity of the wrap may become compromised.
- Dispense sterile and high-level disinfected items directly from this area.

Procedural Barriers

In instances where cleaning and further processing of instruments are done in the same area and where there is only one sink for both instrument cleaning and handwashing, use the following steps to create procedural barriers:

- Transport the soiled items to the processing room in a covered container.
- Put on fluid-resistant PPE.
- Clean the instruments following the manufacturers' instructions.
- Drain the sink and disinfect the sink and all countertops.
- Remove all PPE and dispose or discard for cleaning/laundering.
- Perform hand hygiene.
- Put on a new set of PPE.
- Package the instruments for sterilization or proceed to high-level disinfection.
- Once the high-level disinfection step is completed, remove PPE and perform hand hygiene.

Summary

Irrespective of the existing layout of the facility, design traffic flow and work practices in such a way that keeps soiled/contaminated instruments, equipment, and textiles separate from the clean and sterile instruments, equipment, and textiles, whether in the OT or in the CSSD. Appropriate traffic flow and work practices prevent accidental contamination of clean items and reduce the risk of infections to patients, HCWs, and visitors.

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Chapter 2. Environmental Cleaning

Key Topics

- Importance of environmental cleaning in health care facilities
- Proper use of personal protective equipment (PPE) by cleaning staff
- How to select and prepare disinfectant cleaning solutions
- Cleaning methods
- Guidelines for cleaning specific areas of health care facilities

Key Terms

- **Biofilm** is an accumulated, thin layer of bacteria and extracellular material that tightly adheres to surfaces (e.g., skin drains, urinary catheters) and cannot be easily removed. The presence of biofilm can increase the resistance of the bacteria to antimicrobial drugs and reduce the effectiveness of disinfectants and sterilization because products cannot penetrate the surface.
- **Cleaning** is the removal of visible dirt (e.g., organic and inorganic material) from objects and surfaces, normally accomplished manually or mechanically, using water with detergents or enzymatic cleaners. Cleaning is required before high-level disinfection or sterilization because tissue, blood, body fluids, dirt, and debris reduce the effectiveness of these processes.
- **Cleaning solution** is any combination of soap (detergent) and water, with or without a chemical disinfectant, used to wash or wipe down environmental surfaces.
- **Contact time** is the length of time a cleaning product must remain wet on the surface being cleaned for the disinfectant to kill the targeted microorganisms. Time of contact varies depending on the type of cleaning product and the targeted microorganism (e.g., bacteria, viruses, mycobacteria, spores). For use in health care facilities, the contact time for the organism that is most difficult to kill is routinely adopted.
- **Detergent** (term is used interchangeably with soap) is a cleaning product (e.g., bar, liquid, leaflet, or powder) that lowers surface tension of water, thereby helping to remove dirt and debris. Plain soaps do not claim to be antimicrobial on their label and require friction (i.e., scrubbing) to mechanically remove microorganisms. Antiseptic (antimicrobial) soaps do kill or inhibit growth of some microorganisms, but not all.
- **Disinfectant** is a chemical that destroys or inactivates microorganisms on inanimate (non-living) objects. Disinfectants are classified as low-, intermediate-, or high-level depending on their ability to kill or inactivate *some* (low- or intermediate-level) or *all* (high-level) microorganisms. While disinfectants may kill all microorganisms, they do not kill all spores. Commonly used disinfectants for low-, intermediate-level cleaning include phenols, chlorine or chlorine-containing compounds, and quaternary ammonium compounds (QUAT) and hydrogen peroxides (H_2O_2). These classes of disinfectants are often used to clean frequently touched surfaces in health care facilities.
- **Disinfectant cleaning solution** is a combination of a soap (detergent) and a chemical disinfectant. Several combinations are available commercially or can be prepared as needed at the health care facility (e.g., alkaline detergents with chlorine compounds). Not all soaps (detergents) and disinfectants are compatible.

- **Environmental cleaning,** in health care facilities, refers to the general cleaning of surfaces and equipment to reduce the number of microorganisms present and providing a clean and pleasant atmosphere.
- **Frequently touched surfaces** are surfaces in patient care areas in the health care facility with frequent hand contact. These surfaces include door handles, light switches, countertops, bedrails and ends of beds, patient charts, tap handles, hand rails, toilet flushes, rounding and medical trolleys/carts, buttons on monitors, telephones, and call bells.
- **Non-critical items,** for the purposes of cleaning and disinfection, are items that come into contact with intact skin but not mucous membranes (e.g., blood pressure cuffs, stethoscopes, and crutches). Most can be cleaned and disinfected at the point of use using a low-level disinfectant.
- **Sanitizer** is a chemical that reduces the number of bacterial contaminants on inanimate objects to safe levels, based on public health requirements (e.g., a chemical that kills 99.999% of the specific bacteria in 30 seconds under test conditions). They are used in food service but not for cleaning surfaces in health care facilities.
- **Scrubbing (frictional cleaning)** is the vigorous rubbing of a surface with a brush or other tool. This is the best way to physically remove dirt, debris, and microorganisms.
- **Soap** is a term used interchangeably with detergent; see the definition of detergent.
- **Terminal or discharge cleaning** is the process used to clean a patient's room after the patient has been discharged or transferred or to clean patient treatment areas including operating theaters (OTs) at the end of the day.

Background

In health care facilities, environmental cleaning refers to the general cleaning of surfaces and equipment The purpose of general environmental cleaning is to:

- Reduce the number of microorganisms that patients, visitors, health care workers (HCWs), and the community may come in contact with to help prevent infection
- Provide a clean and pleasant atmosphere for patients and HCWs

Contamination of surfaces in the health care environment plays an important role in the transmission of many pathogens (i.e., disease-causing bacteria, viruses, or other microorganisms) that cause health care-associated infections (HAIs). Pathogens, including multidrug-resistant organisms and others that cause HAIs, have been shown to contaminate and persist on surfaces in hospital rooms from hours up to months (see Table 2-1). These organisms can be transferred from surfaces to the hands of HCWs then to vulnerable patients (Weber et al. 2013).

"Contamination of the environmental surfaces in hospital (health facility) rooms plays an important role in the transmission of several key healthcare associated pathogens."

–Weber and Rutala 2013

Table 2-1. Persistence of Clinically Relevant Bacteria on Environmental Surfaces

Pathogen	Environmental Survival Time
Acinetobacter spp.	3 days–5 months
Bloodborne viruses such as hepatitis B virus or HIV	> 1 week
Candida albicans	1 days–4 months
Clostridium difficile	5 months
Ebola virus	Several hours to several days
Enterococcus spp. including vancomycin-resistant *Enterococcus faecium* (VRE)	5 days–4 months
Escherichia coli	*1.5 hours–16 months*
Gastrointestinal tract viruses (e.g., astrovirus, hepatitis A virus, polio, and rotavirus)	2 months
Haemophilus influenzae	12 days
Influenza	24–48 hours
Klebsiella spp.	2 hours– ≥ 30 months
Mycobacterium tuberculosis	1 day–4 months
Pseudomonas aeruginosa	6 hours–6 months
Respiratory viruses (e.g., corona, coxsackie, and influenza *viruses,* SARS, *or* rhinovirus)	24–48 hours
Salmonella typhi	6 hours–4 weeks
Staphylococcus aureus, including MRSA	7 days–7 months
Streptococcus pneumoniae	1–20 days
Streptococcus pyogenes	3 days–6.5 months
Vibrio cholera	1–7 days

Frequently touched surfaces are those surfaces in patient care areas that are frequently touched by HCWs' hands and patients (see Figure 2-1). Frequently touched surfaces include door handles, light switches, countertops, bedrails and ends of beds, patient charts, tap handles, hand rails, toilet flushes, rounding and medical trolleys/carts, buttons on monitors, telephones, and call bells. Frequently touched surfaces in other areas of the facility (e.g., examination rooms, procedure rooms) include door knobs, light switches, examination tables, weights on the scale, faucets, stirrups, and trolley handles (see Figure 2-1).

Figure 2-1. Frequently Touched Surfaces in an Examination Room

X=frequently touched surfaces

Source: Jhpiego.

Effective cleaning of the health care facility is based on how well the established environmental cleaning guidelines are followed. Investigations in the United States have demonstrated that less than half of hospital room surfaces are adequately cleaned. Several studies have shown that patients admitted to rooms previously occupied by patients infected with known pathogens are at higher risk of colonization or infection with the same pathogen. Improved cleaning of health care facilities has shown a decrease in HAIs (Carling et al. 2008; Passaratti et al. 2013; Weber and Rutala 2013; Weber et al. 2013). It is likely that similarly in resource-limited settings, environmental cleaning is often inconsistent and inadequate.

"Improved surface cleaning and disinfection can reduce the incidence of healthcare associated infections."

–Weber et al. 2013

Aspects of Environmental Cleaning

Use of PPE by Cleaning Staff

Cleaning staff in health care facilities are at risk of exposure to microorganisms, sharps injuries, and potentially harmful chemicals in cleaning products. PPE provides a barrier and thereby protects the wearer from these risks. Staff performing cleaning should always wear recommended PPE while carrying out their duties. PPE recommendations for cleaning staff include the use of:

- Reusable/disposable plastic aprons (preferably made from thick, liquid-resistant materials)
- Impermeable gloves (e.g., utility gloves for handling waste or cleaning highly contaminated surfaces and latex, vinyl, nitrile, or rubber gloves for other cleaning procedures)
- Protective footwear (e.g., rubber boots)
- In addition, the following may be required in certain circumstances:
- Eye and face protection (e.g., face shield, procedure/isolation mask, and eye protection) if splashes are anticipated (such as cleaning up a blood spill or diluting cleaning products)

- Long-sleeved, fluid-resistant gown for contact isolation
- Long-sleeved, fluid-resistant gown and eye and face protection for droplet isolation (e.g., face shield, procedure/isolation mask, and eye protection)
- N95 respirator for Airborne Precautions or if the cleanup procedure is expected to generate infectious aerosols
- PPE for highly infectious diseases in special circumstances (See Module 3, Chapter 2, Use of Personal Protective Equipment during Outbreaks of Viral Hemorrhagic Fever.)

Environmental cleaning staff should receive education on infection prevention and control and techniques and general principals of environmental cleaning to ensure that:

- The risk of exposure to contaminated items/surfaces and chemicals is understood when performing environmental cleaning procedures.
- The recommended policies and guidelines, including the use of appropriate PPE, are followed.
- The staff are competent in hand hygiene and putting on and removing PPE.

How and when to clean used PPE

If available, use disposable PPE items (e.g., face mask, respirator, gown, apron, face shield, and show covers) and dispose of them in designated containers for infectious waste. The reusable PPE items (e.g., plastic apron, goggles, and rubber boots) should be cleaned with disinfectant cleaning solution and then dried. PPE made from reusable textiles should be washed following laundry guidelines (see Chapter 4, Processing Reusable Health Care Textiles, in this module). (SEARO/WHO 2004)

Cleaning Products for Health Care Facilities

How to select cleaning products

Surfaces and equipment in health care facilities generally include non-critical items (contact intact skin but not mucous membranes). Therefore, low-level disinfection is required for these items and simply general cleaning those items that do not come into contact with patients. There are different categories, chemical compositions, and brands of cleaning solutions available for low-level disinfection of health care facilities. The following are categories of different cleaning products (see Key Terms):

- Soaps (detergents)
- Disinfectants
- Disinfectant cleaning solutions (soap/detergent combined with disinfectant)

Each category of cleaning products has its own individual properties and potential uses:

- Soap (detergent) is used to remove visible soil and organic matter (e.g., dirt, blood and body fluids) from objects and surfaces. This allows exposure of the surfaces to chemical disinfectants. Soap does not remove large numbers of microorganisms so is sometimes combined with a disinfectant to achieve both cleaning and disinfection using the same product.
- Disinfectants are chemicals that destroy or inactivate microorganisms on inanimate objects. Table 2-2 shows different chemicals within the category of “disinfectants.” (Rutala et al. 2008) A chlorine solution and quaternary ammonia (QUAT) are commonly used in health care facilities as a disinfectant for cleaning surfaces and equipment. (See Table 2-1 for appropriate disinfectants.)

Disinfectants are not effective in the presence of blood and body fluids or other organic matter so surfaces should be cleaned with soap and water first.

- Disinfectant cleaning solutions (combination of soap/detergent and disinfectant) remove the need for a two-step process required if using soap and disinfectant separately (i.e., wiping down with a new cloth and soap followed by wiping with disinfectant solution).

When prepared properly and used appropriately, disinfectants alone or in a disinfectant cleaning solutions are effective in removing microorganisms from frequently touched items and other surfaces in the health care environment. HCWs should carefully follow the manufacturer's instructions while using any disinfectant.

When selecting a disinfectant or other cleaning product, consider the following factors:

- Intended use (cleaning, disinfection, or both)
- Efficacy (does it claim to kill organisms that are commonly found in the local environment in the recommended contact time?)
- Acceptability (does it have an unpleasant smell, leave a film, damage surfaces?)
- Safety (are there side effects for those in contact with the disinfectant?)
- Cost and availability (does it fit the budget, is it easy to obtain in the required amounts?)
- Volume needed and size of product available based on facility requirements

Infection prevention and control staff should be involved in the decision-making process to ensure that the most appropriate products are selected (Table 2-2). Before a large amount is purchased, test the product to be sure they are acceptable to staff and patients. Once selected, conduct checks to ensure that the chosen product is diluted and used correctly.

Table 2-2. Common Low-Level Disinfectants Used for Environmental Cleaning in Health Care Facilities

Disinfectant	Recommended Use	Precautions
Sodium hypochlorite 0.5% or 1%	• General disinfectant • Kills bacteria, fungi, mycobacteria (e.g., tuberculosis), spores, and viruses • Not affected by hard water (water with a high mineral content) • Use 0.5% concentration for disinfection of surfaces/equipment contaminated with blood and body fluids	• Should be used in well-ventilated areas • Is a respiratory irritant (can cause breathing problems) • Appropriate PPE required while handling and using because it can cause skin irritation and burns • Should not be mixed with strong acids or ammonia to avoid release of chlorine gas* • Corrosive to metals in concentrations of 0.05% (500 parts per million [ppm]) or more • Inactivated by organic matter • Leaves cloudy residue on surfaces, damages plastics and rubber
Bleaching powder 14 g of 35% powder/L of water	• Toilets/bathrooms • May be used in place of liquid bleach if liquid bleach is unavailable	Same as above
Alcohol (70%) Isopropyl, ethyl alcohol, surgical spirit	• Use on smooth surfaces, tabletops, aprons, and other small surfaces on which bleach cannot be used (e.g., metal, rubber) • Can be used for surfaces including rubber stoppers on medication vials • Not recommended for large surfaces • Does not leave residue	• Flammable, toxic • Use in well-ventilated area and avoid inhalation • Keep away from heat source, electrical equipment, flames, hot surfaces • Allow it to dry completely before using the area
Quaternary ammonium compound (QUAT)	• General disinfectant for surfaces/equipment contaminated with blood and body fluids • Kills bacteria, fungi, and some (enveloped) viruses (HIV) • Has persistent antimicrobial activity when undisturbed	• Use in correct dilution and pour only enough for current use • Does not kill spores, TB, or non-enveloped viruses • Hard water, cotton/gauze, organic matter reduce its effectiveness
Iodophor	• More commonly used as an antiseptic than a disinfectant	• Causes damage to silicone catheters

Disinfectant	Recommended Use	Precautions
Phenolic	• General disinfectant for surfaces/equipment contaminated with blood and body fluids • Kills bacteria, fungi, TB, and viruses	• Absorbed by porous materials and irritates tissue • May cause discoloration of skin • Can cause hyperbilirubinemia (excess of bilirubin in the blood) in infants
Improved hydrogen peroxide	• General disinfectant for surfaces/equipment contaminated with blood and body fluids • Is not affected by organic matter • Non-corrosive and safe for workers	• Can be expensive, particularly if purchasing large quantities

* To find out if a cleaning solution contains ammonia, check the label. If noxious gases or strong odors result (e.g., chlorine or ammonium chloride gas) when chemicals are mixed, evacuate the area immediately until the space can be completely ventilated.

Preparing Diluted Solution of Sodium Hypochlorite

Sodium hypochlorite solution is a common and affordable disinfectant frequently used in health care settings. A pure sodium hypochlorite product is always preferred in the preparation of hypochlorite solutions. If not available, generic versions of sodium hypochlorite solutions (e.g., household chlorine bleach) can be used. Table 2-3 lists formulas for making 0.5% sodium hypochlorite solution from different kinds of products with given concentrations.

Note: A 0.5% dilution of chlorine is the standard disinfectant for materials and surfaces contaminated by blood or body fluids as recommended by the World Health Organization. (SEARO/WHO 2004)

Table 2-3. How to Prepare 0.5% Sodium Hypochlorite Solution from Different Products and Available Concentrations

Product	Chlorine Available	How to Dilute to 0.5%
Sodium hypochlorite – liquid	5.25–6.15%	1 part bleach to 9 parts clean water (1:9)
Sodium hypochlorite – liquid	3.5%	1 part bleach to 6 parts clean water (1:6)
NaDCC (sodium dichloroisocyanurate) – powder	60%	8.5 grams to 1 liter clean water (8.5 g:1 L water)
NaDCC (1.5 g/tablet) – tablets	60%	6 tablets to 1 liter clean water (6 tablets:1 L water)

Adapted from: SEARO/WHO 2004.

Household bleach typically contains 5.25–6.15% sodium hypochlorite (although this varies according to country). Hypochlorite solutions can be represented as ratios (1:10), percentages (%), or parts per million (ppm). Table 2-4 describes conversions between these. (SEARO/WHO 2004)

Table 2-4. Chlorine Available in Various Hypochlorite Dilutions

Bleach Solution	Dilution	Chlorine (%)	Chlorine (ppm)
5.15–6.25%	None		52,500–61,500
	1:5	1%	10,000
	1:10	0.5–0.6%	5,250–6,150
	1:100	0.05–0.06%	525–615
	1:1000	0.005–0.006%	53–62

Source: Rutala et al. 2008.

Storage

The preferred method for diluting disinfectants is to prepare a fresh amount daily and put it in an appropriately labeled container. If a larger amount must be prepared, it should be stored in tightly sealed containers, clearly labeled with the name of the solution and the expiration date. For example, chlorine solution can be stored at room temperature for up to 30 days in a capped, opaque plastic bottle; it loses its effectiveness once exposed to light. In case of leakage, do not store chemicals above sterile supplies or near medications or food items. To avoid accidental ingestion or harmful exposure to disinfectants, store chemicals in a restricted or locked area.

Cleaning Methods

Overview

The general principles for cleaning health care facilities are summarized below:

- Appropriate PPE must be worn to protect the workers from chemical and biological hazards.
- Any equipment/items/areas visibly contaminated with blood or body fluids should be cleaned immediately using appropriate PPE. (See the section How to Clean Spills of Blood and Other Body Fluids in this chapter).
- Soap should be used to remove soil and debris before or along with a disinfectant, as needed.
- Contaminated and high-risk areas (e.g., frequently touched surfaces, toilets/bathrooms, isolation rooms, and OTs) should be cleaned at least daily with a disinfectant cleaning solution. A cleaning bucket containing soap alone quickly becomes contaminated; a disinfectant alone is not as effective at removing dirt and debris.
- Walls, windows, blinds, and high surfaces that are not contaminated with blood or body fluids or do not regularly come into contact with hands of patients and HCWs may be cleaned less frequently and with soap (no disinfectant).
- Cleaning should always progress from the least soiled areas to the most soiled areas. Room cleaning should be performed in the following order:
    1. Periphery of the room
    2. Frequently touched surfaces
    3. Areas close to the patient
    4. Floors

5. Toilet/bathroom areas

- When cleaning wards, isolation rooms, and procedure or dressing rooms, soiled utility rooms and toilet/bathroom areas should be cleaned last.
- Cleaning should always progress from high (e.g., ceilings and walls) to low areas so that the dirtiest areas and debris that falls on the floor will be cleaned up last. Cleaning should be performed in the following order:

  1. High damp dusting and cleaning of visible soil from walls
  2. Wet wiping of frequently touched surfaces with detergent/disinfectant
  3. Mopping of floors

- Dry sweeping, dry mopping, and dusting should be avoided to prevent dust, debris, and microorganisms from floating into the air and landing on clean surfaces. Airborne fungi and bacteria can cause upper and lower airway, pulmonary, and wound infections, and, in some cases, systemic infectious diseases in immunocompromised people, such as people with HIV, premature infants, the elderly, and the critically ill.
- Using contaminated cloths to clean surfaces can result in contamination of HCW hands, equipment, and other surfaces.
- Cleaning cloths, mops, and cleaning solutions should be changed regularly, when visibly soiled, after cleaning an isolation room, and after cleaning the most soiled areas (see below for details).
- Cleaning equipment must be kept clean and in good repair.
- (Bush et al. 2006; Rutala et al. 2008)

Common Methods of Cleaning Areas in Health Care Facilities

Damp dusting

Damp dusting should be performed regularly on horizontal surfaces above shoulder level. Since these areas are not frequently touched, a soap solution without disinfectant may be used. Guidelines for damp dusting:

- Use an appropriate disinfectant cleaning solution to dampen the cloth.
- Complete damp dusting before starting other cleaning in the room.
- Start at the highest places and work toward the lower places (top to bottom).
- Perform damp dusting in a systematic way, using a starting point as a reference to ensure that all surfaces are cleaned.
- Check for stains that may indicate possible leaks from water lines when conducting high dusting (e.g., ceilings and walls). Leaks should be repaired as soon as possible because moist walls and ceilings provide a reservoir for fungal growth.

Wet wiping and mopping

Wet wiping is the preferred process for cleaning and disinfecting frequently touched surfaces (see Figure 2–1) in patient rooms and procedures areas. Either reusable cloths that are laundered and dried or single-use disposable wipes can be used for wet wiping.

Wet mopping is the most common and preferred method to clean floors. Mop heads or cloths that are laundered and dried properly can be reused.

For both processes, disinfectant cleaning solution must be changed regularly (see below). Cleaning solutions consisting of soap and water alone can become increasingly contaminated with bacteria during cleaning. This can result in heavy microbial contamination from wet mops and cleaning cloths and increase the amount of bacteria entering patient care areas. To prevent this kind of contamination, there are three techniques recommended for wet wiping or wet mopping:

1. Single-bucket technique. One bucket of disinfectant cleaning solution is used. The solution must be changed regularly or when visibly dirty because the effectiveness of the antimicrobial agent decreases as the amount of soil and organic material present in the solution increases.
2. Double-bucket technique. Two different buckets are used: one containing a disinfectant cleaning solution and the other containing rinse water. The cloth/mop is always rinsed and wrung out before it is dipped into the cleaning solution. The double-bucket technique extends the life of the cleaning solution (i.e., fewer changes are required), saving both time and material costs. The rinse water should be changed when dirty.
3. Triple-bucket technique. The third bucket is used for wringing out the cloth/mop before rinsing, which extends the life of the rinse water.

Wet wiping cleaning method

- Moisten a clean cloth or wipe with a disinfectant cleaning solution from a basin or bucket.
- Wipe surfaces with the wet cloth; surfaces should remain damp with the disinfectant cleaning solution for the length of contact time specified on the manufacturer's label.
- Change cleaning cloths regularly (e.g., every three patient rooms or at least every 60 minutes), if visibly dirty, or after cleaning an isolation room to avoid transferring contaminants from one surface to another. (Rutala et al. 2008)
- If reusable cleaning cloths are used, they should be decontaminated regularly to prevent surface contamination during cleaning (see instructions in the How to Clean Used Cleaning Equipment section in this chapter).

Wet mopping method

- Clean the floor with a clean, wet mop using a bucket that contains the disinfectant cleaning solution.
- Mop the area in a systematic way (e.g., front of the room to back of the room) so that there is no need to walk over the clean, wet surface until it is completely dry.
- Mop patient rooms before mopping the bathrooms attached to the rooms or located separately.
- Floors should be mopped after the room has been cleaned because dust/dirt/drips from surfaces will fall to the floor during room cleaning.
- Mops should be cleaned when dirty or daily and after mopping an isolation area to avoid transferring contamination from one surface to another.
- Change the disinfectant cleaning solution regularly (e.g., every three patient rooms or at 60-minute intervals), when visibly dirty, or after cleaning an isolation room. (Rutala et al. 2008)
- Change and launder reusable cleaning cloths regularly to prevent surface contamination during cleaning (see the How to Clean Used Cleaning Equipment section in this chapter).

Flooding floors

Areas with floor drains can be flooded with disinfectant cleaning solution. The cleaning solution should be drained away using the floor drain. Any excess fluid should be removed using a mop that absorbs the remaining fluid left on the floor.

Fogging

Do not perform disinfectant fogging for air and surface disinfection for general infection control in routine patient care areas (Rutala et al. 2008). Thorough routine cleaning by staff wearing appropriate PPE is the recommended method for environmental cleaning. These recommendations refer to the fogging of chemicals (e.g., formaldehyde, phenol-based agents, or QUAT) as a way to decontaminate environmental surfaces or disinfect the air in patient rooms or OTs. The recommendation not to perform fogging is based on lack of evidence that fogging kills microorganisms on surfaces or in the air and the adverse effects experienced by HCWs and others nearby.

Recently, newer technologies involving the release of vapors into hospital rooms and OTs (e.g., ozone mists, vaporized hydrogen peroxide) and the use of UV-C light for room decontamination have become available. Evidence regarding the effectiveness of these new technologies is emerging; however, there is currently not enough evidence to make clear recommendations regarding these newer technologies.

How to Clean Spills of Blood and Other Body Fluids

When cleaning spills of blood or body fluids, workers should clean spills of blood, body fluids, and other potentially infectious fluids **immediately** using the following guidelines:

- Wear utility or non-sterile gloves (and a face shield if splashing is likely).
- Remove visible organic matter with absorbent material (e.g., disposable paper towels discarded into leak-proof, properly labeled waste receptacles).
- Use 0.5% chlorine solutions (a 1:10 final dilution of 5% household bleach solution) to deactivate bloodborne pathogens:
    - For small spills, soak up the visible blood/body fluid with disposable, absorbent material (e.g., disposal cloths), if available. Discard the absorbent material in a covered container for infectious waste. Disinfect the area by wiping with a cloth soaked in 0.5% sodium hypochlorite solution).
    - For large spills, flood the contaminated area with 0.5% sodium hypochlorite solution, if feasible. Allow the disinfectant to sit for 10 minutes before mopping up. Protect this area so that it does not create a hazard where someone could slip on the wet floor and get hurt.
- Clean any visible material using a cloth soaked in a 0.5% chlorine solution.
- Follow initial cleaning with a final disinfection using a 0.5% chlorine disinfectant cleaning solution. (Rutala et al. 2008)

Cleaning Specific Equipment and Items in Health Care Facilities

The items listed below, which are commonly found in patient care areas, should be cleaned daily and when visibly soiled. For any blood or other body fluid spills, regardless of the type of equipment or location, clean them immediately (for more information, see the How to Clean Spills of Blood and Other Body Fluids section in this chapter).

- **Non-critical equipment** (e.g., stethoscopes, blood pressure cuffs): Wipe daily and whenever visibly soiled with a cloth dampened with a disinfectant cleaning solution.

- **Curtains**: Change and launder curtains according to the health care facility's routine cleaning schedule, when visibly soiled, or after the discharge of patients with Contact or Droplet Precautions. Launder as per instructions in Chapter 4, Processing Reusable Health Care Textiles, in this module.
- **Walls, windows, ceilings, and doors**: Spot clean when visibly dirty with a damp cloth, soap, and water. In general, routine damp dusting is adequate for these areas (see the Patient Areas and Areas Where Patient Materials Are Prepared or Reprocessed section in this chapter).
- **Floors**: Clean floors at least daily and as needed using a wet mop, soap, disinfectant, and water (see the section on Patient Areas and Areas Where Patient Materials Are Prepared or Reprocessed in this chapter).
- **Sinks**: Scrub daily or more often as needed with a separate cloth or brush and a disinfectant cleaning solution. Rinse with water. Drains and associated biofilm can be a source of contamination if water splashes back from the drain during the use of sinks.
- **Toilets and latrines**: Scrub daily and more often as needed with a separate mop, cloth, or brush using a disinfectant cleaning solution.
- **Soiled reusable textiles**: Collect soiled reusable textiles daily (or more often as needed) in closed, leak-proof containers. Launder as per instructions in Chapter 4, Processing Reusable Health Care Textiles, in this module.
- **Waste**: Collect waste, using heavy utility gloves, from all areas of the health care facility at least daily or more frequently if needed. This keeps waste containers from overflowing and reduces the spread of microorganisms (see Chapter 5, Waste Management in Health Care Facilities, in this module).
- **Waste containers**: Use heavy utility gloves to clean infectious waste containers after emptying each time. Clean non-infectious waste containers when visibly soiled and at least once a week. Use a disinfectant cleaning solution and scrub to remove soil and organic material.
- **Cleaning cloths and mops**: Launder separately from other hospital textiles. Launder as per instructions in the section on How to Clean Used Cleaning Equipment, in this chapter.
- (Rutala et al. 2008; SEARO/WHO 2004)

How to Clean Used Cleaning Equipment

Equipment that is used for cleaning should be cleaned at least daily, after use in an isolation room, when dirty, or when soiled with blood or body fluids. Follow these steps for disinfecting the equipment used to clean in health care facilities:

STEP 1: Empty mops, buckets, and containers. Rinse and ring out mops and cloths. Discard cleaning solution.

STEP 2: Disinfect cleaning equipment (mop and broom handles, buckets, brushes, cleaning carts, etc.) by wiping down with a disinfectant cleaning solution.

STEP 3: Wash reusable cleaning cloths or mops separately from other soiled health care textiles. If hot water (70–80°C [158–176°F]) is not available for laundering, soak in clean water with bleaching solution (0.005–0.015% or 50–150 ppm) for 30 minutes before washing.

STEP 4: Rinse with detergent and then water to remove the bleach.

STEP 5: Launder (may omit Steps 3 and 4 if hot water [70–80°C, 158–176°F] is available for laundering).

STEP 6: Dry completely as soon as possible in a clothes dryer or in the sun. (Cloths and mop heads that remain damp are heavily contaminated with microorganisms.)

(CDC 2003; Rutala et al. 2008; SEARO/WHO 2004)

Schedule and Procedures for Cleaning Specific Areas of the Health Care Facility

Areas of a health care facility differ in terms of levels of microbial contamination and the risk of transmission of the microbes present on environmental surfaces. The chosen cleaning solutions and techniques should be based on the needs of each specific area of the health care facility. Appropriate choices help prevent transmission of microorganisms from surfaces to patients and reduce the amount of supplies needed (Rutala et al. 2008). Table 2-5 describes the differing levels of risk of microbial transmission in various functional areas in health care facilities. Each area is also described in detail below.

In health care facilities, planned environmental cleaning schedules should be written out and monitored frequently for compliance. (CDC 2003)

Table 2-5. Areas of Health Care Facilities and the Level of Risk of Transmission from Environmental Surfaces

Area	Examples	Surface Contamination	Risk of Transmission from Surfaces to Patients	Type of Cleaning Solution
Areas with no patient contact, no materials used for patient care are prepared, no reprocessing, and no blood and body fluids	Administrative offices	Low risk	No/low risk	Soap
Areas where patients spend time or where materials used for patient care are prepared or reprocessed	Waiting rooms, admissions, outpatient clinics, wards, intensive care units, post-operation recovery rooms, examination rooms, equipment rooms, medication rooms, pharmacy, kitchen	Medium to high risk	Medium risk to intact skin	Soap/disinfectant solution
Areas in which sterile procedures are performed or sterile or injectable products and supplies are prepared	OTs, procedure rooms, medication compounding areas, IV fluid preparation areas, sterile supply areas, burn dressing rooms	Moderate risk	Medium to high risk to non-intact skin or sterile body areas	Soap/disinfectant solution but using special techniques
Floors		High risk	Some risk, floors are re-contaminated minutes after cleaning	Soap/disinfectant solution

Areas with No Patient Contact

Regular domestic cleaning is all that is required for areas with no patient contact, no materials used for patient care are prepared, no reprocessing, and no blood and body fluids, such as administrative offices. Waste should be removed daily. Floors should be mopped, mats shaken out, and the area should be wet dusted at least weekly or as needed. (SEARO/WHO 2004)

Patient Areas and Areas Where Patient Materials Are Prepared or Reprocessed

The environment plays an important role in the potential transmission of microorganisms in patient areas or where materials used for patient care are prepared or reprocessed. Surfaces to be cleaned can be divided into three groups:

1. **Surfaces with minimal hand contact (e.g., high surfaces, walls, and ceilings)** can be cleaned with soap and water; no disinfectant is required.
2. **Surfaces with frequent hand contact (frequently touched surfaces)** should be wiped at least daily and whenever visibly soiled using a cloth dampened with a disinfectant cleaning solution. See Table 2-2 for options.
3. **Floors** should be mopped at least daily and whenever visibly soiled using a mop dampened with a disinfectant cleaning solution. See Table 2-2 for options

   (Rutala et al. 2008; SEARO/WHO 2004)

Patient Rooms/Patient Treatment Areas

Patient rooms and patient treatment areas should be cleaned at least daily and after a patient is discharged using terminal cleaning guidelines described in the Cleaning Methods section in this chapter. The same cleaning process **also** applies to rooms where patients are under Transmission-Based Precautions. Any cleaning equipment used in the rooms of patients under Transmission-Based Precautions should be cleaned and disinfected before it is used in another room. Meticulous cleaning and disinfection can prevent the spread of multidrug-resistant organisms and using 0.5% chlorine solution is the best option for *C. difficile*, which is endemic in some settings. (CDC 2003)

Procedure rooms

Procedure rooms should be cleaned with a disinfectant cleaning solution **after each procedure** and whenever visibly soiled. This includes, but is not limited to, all horizontal surfaces, frequently touched surfaces, equipment, and furniture used for procedures. Clean blood spills or other body fluid spills immediately as described in the How to Clean Spills of Blood and Other Body Fluids section of this chapter.

Examination rooms

In examination rooms, the waste and linen containers should be emptied, floors mopped, and all frequently touched surfaces **disinfected at least daily**. Clean up spills of blood and body fluids immediately as described in How to Clean Spills of Blood and Other Body Fluids section in this chapter. Clean any medication preparation areas at least once daily or when visibly soiled; follow the safe injection practices and guidelines on preventing transmission of bloodborne pathogens.

Between each patient, the following procedure should be completed:

- Change linen/paper on the examination table and pillow or wipe down the table and pillow (e.g., vinyl exam table, plastic-covered pillow) with disinfectant if there are no paper coverings.

- Place any used linen in the designated dirty/soiled-linen containers.
- Place any trash in designated trash containers.
- Remove any used instruments or equipment to be reprocessed.
- Clean any items that came into contact with the patient's non-intact skin.
- (CDC 2011)

Waiting rooms/admission areas

Waiting rooms and admission areas should have waste containers emptied, floors mopped, and all frequently touched surfaces disinfected **at least daily**. A more frequent wipe-down schedule of frequently touched surfaces may be necessary in high-traffic areas (i.e., areas that large number of people go through) and during respiratory virus seasons or outbreaks of infectious diseases. Clean up spills of blood and body fluids immediately as described in the How to Clean Spills of Blood and Other Body Fluids section of this chapter.

Floors

Because the traffic varies in different areas of the health care facility (e.g., procedure rooms, OTs, examination rooms, hallways, and waiting areas), the floor cleaning schedules should also vary. Descriptions on how and when to clean the floors in these different areas are listed in the specific areas in this section of the chapter. Floors can become contaminated with microorganisms in several ways (e.g., microorganisms from settling airborne dust and dirt, contact with shoes and other objects used by patients and HCWs, equipment used in patient care). Blood and body fluid spills also contaminate floors.

The routine treatment of clean floors with disinfectants has been shown to have no significant impact on the incidence of HAIs. Recent studies have found that contamination from floors rapidly finds its way to the hands of patients and to frequently touched surfaces inside and outside the room. Cleaning floors with an effective disinfectant does reduce the numbers of bacteria; however, a few hours after floor disinfection, the bacterial count usually returns to pre-treatment levels. (Deshpande et al. 2017)

Sterile Procedure Areas and Sterile or Injectable Product and Supply Preparation Areas

Preparation areas, sterile procedure areas, and sterile and injectable product and supply preparation areas are considered high-risk areas. These include procedure rooms and OTs, which require special considerations due to the high risk of disease transmission related to potential exposure of sterile body areas and non-intact skin—intact skin provides a barrier to the majority of microorganisms. It is very important that these areas in the health care facility be maintained as clean as possible to keep them free from microorganisms from skin flakes, hair, insects, dust, lint, mold, dirt, or anything else that would be harmful to patients and staff.

Cleaning Procedure Rooms and Operating Theaters

General Guidelines

- Cleaning staff must wear OT attire, including hair and beard covering, when cleaning in procedure rooms or OTs (see Module 3, Chapter 1, Personal Protective Equipment, for examples). Surgical masks are not necessary.

- Cleaning must NOT be conducted in the presence of any open sterile packs or sterile instruments because it can cause contamination of the sterile instruments.
- Before the first procedure of the day, all flat (horizontal) surfaces (e.g., tables, chairs, surgical lights, equipment, tops of cabinets) should be wiped with a clean, lint-free cloth moistened with disinfectant to remove dust and lint that may have collected overnight.
- OTs should be cleaned after each surgical or invasive procedure with a lint-free cloth moistened with disinfectant.
- Terminal cleaning (e.g., mopping floors and scrubbing all surfaces from top to bottom) of the OT and scrub/utility rooms should be done at the end of each day and each 24-hour period during the regular work week. Terminal cleaning is not necessary between surgical procedures.
- Unused rooms should be cleaned once every 24 hours during the regularly scheduled work week.
- All areas of the surgical suite, scrub sinks, scrub or utility areas, hallways, and equipment should be totally cleaned according to the guidelines given in this chapter regardless of whether they were used during the 24-hour surgery period.
- The double- or triple-bucket method is recommended for cleaning the OT and other surgical areas of the operating suite.
- Use new (clean) cleaning cloths and mops for each room to prevent the possibility of transferring microorganisms from room to room.
- Use microfiber materials, if available, to clean floors and surfaces of OTs. Microfiber materials can also be wetted with disinfectants.
- (AORN 2013; Rutala et al. 2008)

Note: Never dry mop or sweep the OT, which causes dust, debris, and microorganisms to become airborne and contaminate clean surfaces. Instead, wet mop the OT.

Types of cleaning methods

There are two types of cleaning methods recommended for OTs and procedure rooms: intermittent and terminal cleaning. The following are guidelines for each type of cleaning:

- **Intermittent cleaning** is to be done between each patient treatment and surgical case, but not at the end of the day:

  STEP 1: Clean blood and body fluid spills as recommended in the section on blood and body fluid spills in this chapter.

  STEP 2: Collect and remove all waste from the OT in closed, leak-proof, color-coded waste containers. Replace with clean, empty waste containers (see Chapter 5, Waste Management in Health Care Facilities, in this module).

  STEP 3: Close and remove sharps containers from the OT when they are three-quarters full. Replace with empty sharps containers.

  STEP 4: Remove soiled linen in leak-proof, covered, soiled-linen containers and replace with empty containers (see Chapter 4, Processing Reusable Health Care Textiles, in this module).

Note: If walls and ceilings are deteriorating or damp, cover them with clean plastic sheets during surgical procedures or treatments to avoid any possible contamination of the surgical/ procedure areas.

STEP 5: Soak a cloth in disinfectant cleaning solution and wipe down all surfaces. Work from top to bottom so that any debris that falls on the floor will be cleaned up last. This includes the following items to be disinfected:

- **OT beds**. Take apart and wipe all surfaces and mattress pads with a disinfectant cleaning solution according to the manufacturer's recommendation.
- **Instrument tables (e.g., trolleys, Mayo stands) and other flat surfaces**. Wipe all flat surfaces that have come in immediate contact with a patient or body fluids with a disinfectant cleaning solution.
- **Center of the OT that surrounds the OT bed**. Mop with a disinfectant cleaning solution.

- **Terminal cleaning** is completed after a patient is discharged from a patient room, or at the end of the day for an OT or treatment or procedure area:

  STEP 1: Remove covered instrument buckets. A clean bucket should be placed in the room at the beginning of each day.

  STEP 2: Remove the covered contaminated-waste container and replace it with a new, empty container appropriate for infectious waste (see Chapter 5, Waste Management in Health Care Facilities, in this module). Containers should be cleaned and disinfected.

  STEP 3: Close, remove, and replace sharps containers when the container is three-quarters full. Do not allow the container to fill to the top.

  STEP 4: Remove soiled linen to be sent for laundering in a closed, contaminated-linen container and replace it with a new linen container ready for use (see Chapter 4, Processing Reusable Health Care Textiles, in this module).

  STEP 5: Soak a cloth in disinfectant cleaning solution and wipe down all surfaces. Work from top to bottom so that any debris that falls on the floor will be cleaned up last. These include the following items to be disinfected:

  - **Walls and ceilings**—wipe with a damp cloth, detergent, and water as needed for visible soil.
  - **OT lamp**—wipe with a damp cloth and disinfectant cleaning solution.
  - **OT table**—top, sides, base, legs, and any accessories (e.g., leg stirrups) with a damp cloth and disinfectant cleaning solution.
  - **Chairs, lamps, sinks, tabletops, and counters**—wipe with a damp cloth and disinfectant cleaning solution.
  - **Floors**—clean with a wet mop using a disinfectant cleaning solution or flood the floor with disinfectant followed by removal of the water into floor drains using a mop. Flooding minimizes the spread of microorganisms and increases the contact time of disinfectants with the surface to be cleaned. It is necessary, however, to leave the floor wet for several minutes. Flooding is best done at night or at times when there is minimal activity in the area to avoid individuals slipping on the wet floor.
  - **Vents (air, heating, or air conditioning**)—wipe with a damp cloth, soap, and water.

Note: Cleaning the filters in air conditioners regularly will help them run more efficiently and decrease the growth of molds in them.

Monitoring Cleaning

Traditionally, cleaning was evaluated by visual inspection and it is still the most frequently used method in low- and middle-income country settings. Collecting environmental cultures to test for microorganisms on

different surfaces is also used to monitor surface cleaning. This is not recommended as routine practice, since the meaning of the presence of microorganism on surfaces is difficult to interpret. However, environmental culturing have a role in very specific circumstances such as during an outbreak when a source of contamination is suspected. (SEARO/WHO 2004)

Multiple methods of monitoring environmental cleaning have been developed for health care facilities such as ATP (adenosine triphosphate) bioluminescence and fluorescent dye.

- ATP bioluminescence is based on testing for residual soil after a surface or a device has been decontaminated to ensure that effective cleaning has taken place. A swab is taken from the clean surface for testing, and if positive, the test cartridge will illuminate and change color. ATP is a common component of all organic matter (including but not limited to body fluids) and it is present in large amounts. ATP can be measured with high sensitivity and can quickly provide an objective measurement of the presence of organic matter, not only blood and body fluids.
- The use of fluorescent dye has been shown to closely correlate with colony counts on environmental surfaces (Rutala and Weber 2013). The dye is applied to a surface as a “dot” and dries clear and so is invisible. It is easily removed with wiping, as during routine environmental cleaning. After cleaning, the area can be viewed with a black light. If there is no visible dot, the surface has been sufficiently disinfected or cleaned. If the dot is still visible after cleaning, the cleaning was not adequate. This technique can be used to provide feedback to the cleaning staff on how well the environmental surfaces are being disinfected.

These new technologies are not widely available at health care facilities in many low- and middle-income countries. Environmental cleaning by trained health care facility cleaning staff using soap and disinfectants remains the primary means for disinfecting health care environments in such settings.

Summary

Globally, there has been an increased interest in the role the environment plays in the transmission of infection. This has prompted an increased emphasis on monitoring the effectiveness of environmental cleaning in health care facilities. Thorough environmental cleaning in health care facilities by physically removing dirt and debris with soap and water and microorganisms with disinfectants remains the most effective method for cleaning the health care environment. To be effective, the cleaning staff must be well-trained on the appropriate cleaning methods, including the effective use of cleaning and disinfection products. Cleaning staff must also know the facility's policies and procedures on proper cleaning methods, and be closely supervised to ensure that the proper procedures are being followed correctly.

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Chapter 3. Managing Food and Water Services for the Prevention of Health Care-Associated Infections

Key Topics

- Prevention of health care-associated foodborne diarrhea
- Preparation of infant formula
- Prevention of health care-associated waterborne diarrhea

Key Terms

- **Clean water** is natural or chemically treated and filtered water that is safe to drink and use for other purposes (e.g., handwashing and general medical use) because it meets national public health standards and/or the World Health Organization (WHO) guidelines for drinking-water quality.
- **Contact time** is the length of time a cleaning product must remain wet on the surface being cleaned for the disinfectant to kill the targeted microorganisms. Time of contact varies depending on the type of cleaning product and the targeted microorganism (e.g., bacteria, viruses, mycobacteria, spores). For use in health care facilities, the contact time for the organism that is most difficult to kill is routinely adopted.
- **Detergent** (term is used interchangeably with soap) is a cleaning product (e.g., bar, liquid, leaflet, or powder) that lowers surface tension of water, thereby helping to remove dirt and debris. Plain soaps do not claim to be antimicrobial on their label and require friction (i.e., scrubbing) to mechanically remove microorganisms. Antiseptic (antimicrobial) soaps do kill or inhibit growth of some microorganisms but not all.
- **Disinfectant** is a chemical that destroys or inactivates microorganisms on inanimate (non-living) objects. Disinfectants are classified as low-, intermediate-, or high-level depending on their ability to kill or inactivate *some* (low- or intermediate-level) or *all* (high-level) microorganisms. While disinfectants may kill all microorganisms, they do not kill all spores. Commonly used disinfectants for low-, intermediate-level cleaning include phenols, chlorine or chlorine-containing compounds, and quaternary ammonium compounds (QUAT) and hydrogen peroxides (H_2O_2). These classes of disinfectants are often used to clean frequently touched surfaces in health care facilities.
- **Environmental cleaning,** in health care facilities, refers to the general cleaning of surfaces and equipment to reduce the number of microorganisms present and providing a clean and pleasant atmosphere.
- **Foodborne or waterborne illness** is any disease of an infectious or toxic nature caused by ingestion of food or water.
- **Health care-associated diarrhea** is diarrhea that begins on or after the third calendar day of hospitalization (the day of hospital admission is Day 1).
- **Sanitizer** is a chemical that reduces the number of bacterial contaminants on inanimate objects to safe levels, based on public health requirements (e.g., a chemical that kills 99.999% of the specific bacteria in 30 seconds under test conditions). They are used in food service but not for cleaning surfaces in health care facilities.

Background

Food prepared by a health care facility or brought to the facility by the families of patients can become a source of infection for patients. While the role of foodservice is to provide safe, nutritious food and beverages for patients (and sometimes health care workers [HCWs] and visitors), outbreaks of diarrhea have been associated with contaminated food and water provided by health care facilities. Foodservice staff play an important role in the prevention and control of infections in health care facilities. Foodservice staff should follow food management practices recommended by local and national authorities related to receiving, producing, storing, and serving food and water to ensure a safe food chain. Adherence to these recommended practices helps prevent failures that can lead to food- and waterborne illness in a health care facility. (APIC 2014)

Health care facilities in various settings provide different levels of foodservices to patients. Aspects of this section may be more or less relevant to each facility (e.g., food safety principles, maintenance of the food preparation area, storage of prepared foods, and preparation of infant formula and enteric feeds).

Common Organisms

Contamination of food can be caused by a wide variety of organisms, including bacteria (*Salmonella*, *Shigella*, *Escherichia coli, Staphylococcus aureus*, *Yersinia* species, vibrio [cholera], *Candida albicans*, *Cryptosporidium*) and viruses (norovirus, rotavirus, and other enteroviruses) (for more information, see Module 10, Chapter 6, Preventing Health Care-Associated Infectious Diarrhea). These organisms are often spread through the fecal-oral transmission route.

Foodservices: Preventing Foodborne Diarrhea

Serving food to a large number of ill and immunocompromised people (vulnerable to infection), over an extended period of time (mealtimes may span several hours and be delayed by patient care), and transporting food considerable distances (not just from kitchen to table/bedside but from one building to another) can increase the risk of foodborne illness. Other risks include preparation of large quantities of infant formula, nasogastric (enteral) feedings, and special diets, which require additional handling. Also, sometimes relatives bring food for patients from outside the hospital that may not have been prepared and handled according to food safety principles.

Importance of Hand Hygiene

Organisms causing diarrhea are often transferred to susceptible people via the hands of HCWs or patients who picked up the organism from direct contact with feces or indirectly from articles that are contaminated with the organisms (usually not visible). To reduce the risk of exposure and cross-contamination, patients and staff should follow the recommendations for hand hygiene. Washing hands with soap and water or using alcohol-based handrub for hand hygiene is the single most important intervention for preventing diarrhea among patients in a health care facility (see Module 2, Hand Hygiene, for further details).

Note: Hand hygiene for staff and patients is the single most important practice to prevent outbreaks of health care-associated diarrhea.

Situations in Which Foodborne Illnesses Occur

For foodborne infection to occur:

- Sufficient numbers of infectious organisms or toxins must be introduced into a food item.

- Preparation and storage processes and practices must allow organisms to persist and/or increase.
- Food must be eaten by people susceptible to the illness.

Role of Infection Prevention and Control in the Foodservice Department

The staff of the infection prevention and control (IPC) department should work closely with the in-charge or supervisor of the foodservice department to ensure that food provided to patients is safe. This includes:

- Developing policies, procedures, and guidelines for safe operation
- Providing education and training for staff
- Monitoring work areas and work practices at regular intervals to ensure that safety standards are being followed (see Appendix 3-A, Foodservice Audit Checklist)
- Determining correct cleaning, sanitation, and disinfection agents and practices (see Chapter 2, Environmental Cleaning, in this module)
- Assisting with compliance with local health regulations
- (APIC 2014)

Proper food handling practices will help prevent outbreaks of foodborne illnesses. These practices include:

- Complying with guidelines for proper handwashing and glove use to handle food
- Purchasing raw materials from reliable or certified sources to avoid potentially contaminated raw materials
- Preventing contamination of raw materials during transport, storage, and preparation
- Keeping raw ingredients separated from prepared food
- Keeping work areas clean
- Ensuring correct cooking practices and procedures
- Using prepared food within the safe time period after preparation
- Preventing contamination of prepared foods during transport and storage
- Storing food properly, including maintaining the recommended temperature at which to hold food after it is cooked and before serving
- Following hygienic practices for storing food
- Using proper procedures to clean kitchen equipment as soon as possible after use
- Ensuring that employees infected with a disease, including gastrointestinal infections, are not allowed to work in the kitchen
- (APIC 2014)

For a detailed checklist that can be used to audit foodservices, see Appendix 3-A. Foodservice Audit Checklist.

Exclusion of Foodservice Personnel from Work

Staff with gastrointestinal illnesses, jaundice, skin lesions, coughs, and colds should be excluded from duties in the foodservice area at the onset of an illness. They should receive medical care and should

return to work only when cleared by the employee health department or designated medical staff in consultation with the IPC team. See Module 4, Infection Prevention and Control Aspects of Occupational Health in Health Care Settings.

Routine screening of the foodservice personnel is not recommended unless indicated by signs and symptoms or in an outbreak situation. (WHO 2008)

Cleaning and Disinfection of Food Preparation Equipment and Surfaces

Both heat and chemicals can be used to disinfect food preparation equipment and surfaces in a health care facility kitchen (see Appendix 3-B). Chemical disinfectants are affected by exposure time, temperature, pH, and water hardness. Heat, whether dry or moist, requires a minimum temperature and exposure time to properly disinfect equipment.

World Health Organization Food Safety Guidelines

Proper food handling is necessary for the prevention of foodborne illness. Food handlers (including the relatives of patients who are providing meals) should be trained and monitored to follow the World Health Organization's Food Safety Guidelines:

1. **Keep clean**.

   Contaminants found in soil, water, animals, and people can be carried on hands, wiping cloths, equipment, and utensils and can be transferred from these items to food:

   - Wash hands before handling food.
   - Wash hands frequently during food preparation.
   - Wash hands after going to the toilet.
   - Thoroughly wash and sanitize all surfaces and equipment used for food preparation immediately after use. Clean food preparation surfaces should be cleaned with sanitizers or disinfectants (see Appendix 3-B).
   - Protect the kitchen and food from insects, pests, and animals.

2. **Keep raw and cooked food separate**.

   Raw foods and their juices may contain dangerous microorganisms that can be transferred to other food during preparation and storage:

   - Separate raw meat, poultry, and seafood from other foods.
   - Use separate equipment and utensils, including knives and cutting boards, for raw foods.
   - Store prepared food in containers with sealed lids and position prepared food to avoid contact with raw food, such as drippings from raw foods onto prepared food.

3. **Cook thoroughly**.

   Proper cooking can kill almost all dangerous organisms; a temperature of 70°C (158°F) will reduce or kill harmful bacteria in 30 seconds. Foods that require special attention include minced or ground meats, large pieces of meat, rolled roasts, and whole poultry. Harmful bacteria can be found on the inside as well as on the surface of these foods:

   - Cook food thoroughly, especially meat, poultry, eggs, and seafood.
   - Bring foods like soups and stews to boiling and cook meats until juices run clear, not pink.

- Reheat food thoroughly.

4. **Keep food at safe temperatures**.

   Contaminants can multiply quickly in food stored at room temperature. The danger zone is 5–60°C (41–140°F). To help prevent foodborne illness, hold food at temperatures below 5°C (41°F) or above 60°C (140°F):

   - Do not leave cooked food at room temperature for more than 2 hours.
   - Refrigerate promptly all cooked and perishable food (below 5°C [41°F]).
   - Keep cooked food hot (> 60°C [140°F]) before serving.
   - Do not store food for longer than 3 days in the refrigerator.
   - Do not thaw frozen food at room temperature; thaw in a refrigerator or immersed in water.

5. **Use safe water and safe raw ingredients**.

   Germs may be present in raw ingredients, including in water and ice, and may grow in food during storage and preparation, causing food-related illness when eaten:

   - Use safe water or treat water to make it safe.
   - Select fresh, undamaged, best-quality foods.
   - Choose foods processed for safety such as pasteurized milk and cheese.
   - Wash fruits and vegetables thoroughly with clean water.
   - Do not use old (expired) food, food stored for more than 2 hours at the danger zone, or food stored for more than 3 days in the refrigerator.

Preparation of Infant Formula

While breastfeeding is always preferred and encouraged, in some circumstances it is not possible and hospitalized infants require infant formula as a substitute. Powdered infant formula is not a sterile product and may become contaminated with microorganisms that can cause severe illnesses and even death in infants. The contamination may occur during manufacturing or preparation. The safety of infant formula also relies on preparation with clean water. Correct preparation and handling of formula can reduce the risk of illness. Any product that goes through a lot of handling, including long and inappropriate storage procedures, has a higher risk of contamination. (WHO 2007) (See Appendix 3-C. Checklist for Auditing the Preparation of Infant Formula.)

General Recommendations

- Clean up before preparation:
  - Wash hands.
  - Clean and sterilize all equipment for preparing and feeding infant formula.
  - Clean work surfaces.
- Prepare safely:
  - Boil appropriate amounts of clean water.
  - Allow water to cool, but not below 70°C (158°F); check temperature with a sterile thermometer.
  - Pour an exact amount of boiled, cooled water into a cleaned and sterilized feeding cup or bottle.

- Add the exact amount of formula following the manufacturer's instructions, shake the bottle to mix thoroughly, if using a feeding cup, and mix thoroughly with a cleaned and sterilized spoon.
- Cool the formula quickly to ensure that it is not too hot (preferably to room temperature) before feeding the baby by placing the bottle or cup in cold water, keeping the top of the bottle or cup above the level of the cold water.
- Check the temperature before feeding the infant to avoid scalding.

- Use up quickly or store safely:
  - Discard any prepared formula that has not been used after 2 hours and any formula in a bottle that has not been consumed. Prepared formula can be stored in a refrigerator for up to 24 hours at temperatures no higher than 5°C (41°F).
  - Do not prepare and store formula in large volumes because large volumes are slow to cool and can promote the growth of harmful bacteria.
  - Prepared formula should not be removed from the refrigerator and warmed until immediately before use.
  - Do not warm formula for more than 15 minutes to prevent the growth of harmful bacteria.

Adapted from: CDC 2016.

Water Services: Preventing Waterborne Diarrhea

Background

Effective functioning of health care facilities depends on a number of different requirements, including safe and sufficient water. Factors that increase the risk of waterborne illnesses in hospitals include the need to provide water to a large number of ill and immunocompromised patients, HCWs, and visitors for drinking, bathing, and hand hygiene, as well for important hospital functions such as environmental cleaning, foodservices, and the laundry.

A contaminated water supply provides one of the most effective pathways for mass transmission of pathogens to a large population. However, in resource-limited areas, many health care facilities find providing clean water challenging. Working with key persons in the facility and community to provide and maintain safe water for patient and health care use is an important part of IPC. (Adams et al. 2008; WHO 2012)

Common Organisms

Common pathogens known to be transmitted through drinking water include typhoid, cholera, hepatitis A, *Shigella* spp., and *E. coli* O157. These can lead to severe and sometimes life-threatening disease. Others are typically associated with less severe outcomes, such as self-limiting diarrheal diseases like norovirus and *Cryptosporidium.* (WHO 2006b)

Situations in Which Waterborne Infections Occur

For waterborne infection to occur:

- Sufficient numbers of infectious organisms must be present in or introduced into water.
- Water preparation, storage, and delivery processes and methods must allow organisms to persist and/or increase.

- Contaminated water must be consumed by susceptible people or the organisms from contaminated water must be introduced into the mouth (such as by hands through the fecal-oral route).

Waterborne pathogens can also cause infections when released from the water into the air or allowed to grow in water associated with cleaning or using medical equipment. Contaminated water is a major source of:

- Respiratory tract infection, when inhaled or aspirated (non-tuberculosis mycobacteria, legionella)
- Wound, skin, and mucous membrane infections
- Infection of invasive medical devices such as intravascular catheters and urinary catheters

World Health Organization Safe Water Guidelines

The World Health Organization established guidelines for safe water supplies at health care facilities in low- and middle-income settings (WHO 2006b). Each guideline is accompanied by a set of indicators that can be used as goals when assessing existing situations, planning and constructing a new health care facility, or improving existing facilities. (Methods for treating water to make it safe are described in Appendix 3-D.)

1. **Water quality**: Water for drinking, cooking, personal hygiene, medical activities, cleaning, and laundry is safe for the purpose intended:
    - Water has zero *E. coli* per 100 mL.
    - Water is filtered and treated with disinfectants to ensure adequate concentration (e.g., chlorine 2 parts per million [ppm]) at point of use to eliminate disease-causing microorganisms.
    - There are no tastes, odors, or colors that would discourage consumption of the drinking water.
2. **Water quantity**: Sufficient water is available at all times for drinking, food preparation, personal hygiene, medical activities, cleaning, and laundry:
    - Minimum water requirements in a health care facility (on average):
        - 5 liters of water per outpatient
        - 40–60 liters/patient/day per admission
        - 100 liters/procedure in operating theaters and maternity units
3. **Water facilities and access to water**: Sufficient water-collection points and water-use facilities are available in a health care facility to allow convenient access to, and use of, water for medical activities, drinking, personal hygiene, food preparation, laundry, and cleaning:
    - There are enough water points with soap to facilitate handwashing compliance.
    - There are at least two handwashing basins in wards with more than 20 beds.
    - There is at least one shower for every 40 users in inpatient areas.
    - There are enough water points in the kitchen, laundry, and other areas.
4. **Excreta disposal**: Adequate, accessible, and appropriate toilets are provided for patients, staff, and caregivers:
    - There is at least one toilet per 20 inpatients.
    - There are separate toilets for males and females.
    - Toilets are built according to local resources, cultures, and practices.

5. **Wastewater disposal**: Wastewater is disposed of rapidly and safely:
    - Wastewater is disposed of rapidly from the point of use.
    - Wastewater drainage systems are away from the fresh water supply system.

Adapted from: Adams et al. 2008.

Minimum Essential Temporary Measures for Water Safety at Health Care Facilities

In some situations, it can be challenging to fully comply with these guidelines. In these situations, minimum essential measures for water safety should be implemented, including:

- Provide safe drinking water from a protected groundwater source (spring, well, or borehole) or from a treated supply and keep it safe until it is consumed or used (the water storage container should be cleaned regularly). (Methods for treating water to make it safe are described in Appendix 3-D.)
- Provide water for HCWs to wash their hands after going to the toilet, before handling food, and before and after performing health care. This may be done using simple and economical equipment, such as a pitcher of water, a basin, and soap, or wood ash in some settings.
- Provide basic sanitation facilities that enable patients, staff, and other caregivers to go to the toilet without contaminating the health care facility or resources, such as water supplies. This may entail measures as basic as providing simple pit latrines with reasonable privacy.
- Provide information about, and implement, hygiene promotion so that patients, staff, and other caregivers are informed about essential behaviors for limiting disease transmission in health care facilities and at home.
- These short-term measures should be implemented immediately and maintained until the water-service guidelines can be put into place. These are temporary measures and WHO's guidelines should remain the goal.

Summary

Unsafe water and contamination of food served in a health care facility can cause outbreaks of diarrheal disease and other water- and foodborne illnesses among patients and providers. Health care facilities should have written guidelines on managing water and foodservices in their facilities. HCWs managing water and foodservices should strictly follow the recommendations and practices discussed in this chapter to prevent water- and foodborne disease outbreaks in their facilities.

Appendix 3-A. Foodservice Audit Checklist

The following checklist contains suggested guidelines for health care facility foodservices. It can be used as an audit tool for monitoring work practices at a health care facility.

No.	Task	Y/N/NA	Comment
PURCHASING AND RECEIVING FOOD			
1.	Purchase fresh food from reputable vendors.		
2.	Purchase the required quantity of fresh food every day. Avoid buying frozen food if possible.		
3.	Purchase food in commercially packed, unopened containers.		
4.	Inspect food for expiry date and damaged packages upon arrival at the facility before using.		
5.	Raw and unpacked food items should be thoroughly cleaned before storing and using.		
6.	Staff are aware of food that certain populations should not eat.		
STORING FOOD			
7.	Storage areas, carts, and containers used to transport food are regularly cleaned (e.g., daily or after each use).		
8.	There is a plan to rotate stock (first in, first out) and check expiration dates regularly.		
9.	There is a dedicated place for storing raw food materials.		
10.	Shelving in the storage area allows for cleaning under the bottom shelf; allow 15 cm (6 inches) from the floor and away from walls.		
11.	Storage area is protected from insects and rodents.		
12.	Food is stored at correct temperatures in a refrigerator: • Fruit and vegetables at 4–7°C (40–45°F) • Dairy products, eggs, and meat at 0–4°C (32–40°F)		
13.	Refrigerators and deep freezers are monitored using a thermometer and a log book.		
14.	Raw foods from animal sources (i.e., meat and eggs) are separated from other foods during storage.		

No.	Task	Y/N/NA	Comment
15.	There is a dedicated place for storing food before it is served.		
16.	Food is served soon after it is prepared, while it is fresh.		
17.	Patients are encouraged to keep their own food with them, not stored in the facility kitchen, and to eat fresh food.		
18.	Cleaning products and equipment are stored separately, away from area for storing raw and cooked food items.		
PREPARING FOOD			
19.	Food preparation staff have good personal hygiene and do not have open cuts, sores, or boils.		
20.	Staff with respiratory, skin, or gastrointestinal illness are not allowed to work in foodservice area until cleared by facility clinician and IPC team.		
21.	Staff have been trained in correct hand hygiene and respiratory etiquette and can describe or demonstrate this.		
22.	Staff comply with hand hygiene practices: • Before and after touching food • Before putting on gloves and after removing gloves (if worn) • Before and after cleaning a food preparation area • After clearing used dishes/utensils • After contact with uncleansed equipment or work surfaces • After contact with waste • After contact with soiled clothing and rags • After using the bathroom • After using cleaners or chemicals • After touching the hair or face • Anytime hands are visibly soiled		
23.	Staff comply with respiratory and cough etiquette by covering their nose while coughing or sneezing and performing hand hygiene after coughing and sneezing.		
24.	Direct hand and arm contact with food is avoided where possible by use of implements (e.g., tongs, spatulas, spoons, forks, etc.), wrappers, or clean, disposable gloves.		
25.	Staff cover hair while working with food and no jewelry is worn.		
26.	Utensils, containers, and cutting boards are cleaned between use with different types of foods.		

No.	Task	Y/N/NA	Comment
27.	Cutting boards are made from non-absorbent material and separate boards are used for meat, raw fruits and vegetables, and cooked foods.		
28.	Meat is thawed at refrigerator temperature or covered with running water 21°C (70°F) for no more than 4 hours.		
29.	Meats are not thawed and refrozen.		
30.	Food is always prepared fresh.		
31.	Foods that are cooked and refrigerated are reheated rapidly to 70°C (158°F) or higher before being served, or are rapidly brought to boil for at least 1 minute.		
32.	A thermometer placed in the thickest part of the food is used to determine correct cooking temperatures. Thermometer is sanitized after each use. If thermometer is not available, meats and poultry are cooked until juices run clear and meat is not pink; seafood and eggs are cooked through completely and are served piping hot.		
33.	Raw fruits and vegetables are washed before use.		
34.	Only authorized persons are allowed access to kitchens.		
CLEANING AND SANITIZING FOOD PREPARATION EQUIPMENT AND AREAS			
35.	Staff are trained in cleaning and sanitization of food preparation equipment and areas.		
36.	Utensils, containers and cutting boards, and work surfaces are cleansed thoroughly as soon as possible after each period of use by: • Rinsing with clean, potable water • Washing in hot water with detergent • Sanitizing (see Appendix 3-B on heat and chemical sanitizers)		
37.	Surfaces and equipment are free from chips and cracks and those in which chips and cracks are identified are not used.		
38.	Cleaning cloths, towels, and equipment are kept clean and changed daily. Sponges are not used. Sanitizing solution for cleaning cloths: 5 mL household bleach in 750 mL water—use for utensils surfaces and wiping clothes.		

No.	Task	Y/N/NA	Comment
HOLDING AND SERVING PREPARED FOOD **Harmful bacteria introduced during processing and handling can grow in the food. At 5–60°C (41–140°F) temperatures, all harmful bacteria grow rapidly.**			
39.	Cooked food is not left at room temperature for more than 2 hours.		
40.	Foods are not precooked and held for final cooking.		
41.	Protect cooked food from pests.		
MANAGING WASTE			
42.	Keep waste covered and empty waste containers frequently.		
43.	Kitchen waste is disposed of as regular waste without further treatment.		

Sources: Adams et al. 2008; APIC 2014; WHO 2006a; WHO 2006b.

Appendix 3-B. Heat and Chemical Disinfection

Table B-1. Examples of Time and Temperature Requirements for Chemical Disinfectants

Chemical Sanitizer	Minimum Concentration	Minimum Temperature	Minimum Contact Time
Chlorine	(0.0025%) 25 parts per million (ppm)	50°C/122°F	10 seconds
Chlorine	(0.005–0.01%) 50 ppm–100 ppm	24–46°C/75–115°F	30 seconds
Chlorine	(0.01%) 100 ppm	13°C/55°F	10 seconds
Iodine	(0.00125–0.0025%) 12.5–25 ppm	24–49°C/75–120°F	30 seconds
Quaternary Ammonium	180–200 ppm	24°C/75°F (minimum)	30 seconds

Adapted from: APIC 2014; FDA 2013.

Table B-2. Examples of Time and Temperature Requirements to Disinfect Equipment with Heat

Medium	Temperature	Minimum Contact Time
Steam	95°C/203°F	5 minutes
Water	77°C/170°F	5–20 minutes
Dry heat	83°C/181°F	20 minutes

Adapted from: APIC 2014; FDA 2013.

Appendix 3-C. Checklist for Auditing the Preparation of Infant Formula

Standard	Reason	Met (√)	Comments
Areas are designated for mixing formula.	Foods that require a lot of handling or mixing have a high risk of contamination.		
Areas designated for mixing formula and tube feedings are very clean (there is a cleaning schedule and procedure).	Poor hygiene has been reported as the probable cause of some *E. sakazakii* outbreaks. Harmful bacteria can be carried on hands and can also be present on surfaces. Washing hands and cleaning and disinfecting surfaces reduce the risk of feeds becoming contaminated during preparation.		

Standard	Reason	Met (√)	Comments
Preparation of powdered infant formula or tube feeds: • There is a documented procedure. • Staff have been trained in preparation of infant formula or tube feeds and can demonstrate correctly. • Staff perform hand hygiene before preparing feeds. • All equipment used for feeding infants and for preparing feeds has been thoroughly cleaned and sterilized before use. • Feeds are prepared fresh each time and used immediately in an individual feeding cup or bottle. • Feeds are prepared in small quantities separately for each individual child. • Feeds not consumed within 2 hours are stored in temperature-monitored refrigerator (at 5°C/41°F) for not longer than 24 hours. • Feeds for which transportation will take more than 30 minutes are refrigerated before transportation, transported under refrigerated (or cool) conditions, and reheated at the destination. • Feeds are re-warmed for no more than 15 minutes. • Re-warmed feed that has not been consumed within 2 hours is discarded. • Preparations are tested regularly to be sure correct technique is used (e.g., monthly).	• Harmful bacteria can be carried on hands. • Outbreaks of *E. sakazakii*, which is widespread in the environment and has been shown to attach and grow from biofilms on surfaces commonly used in infant feeding equipment (e.g., latex, silicon, and stainless steel), have been attributed to equipment used for preparing feeds. • Use the prepared formula food within 2 hours. Use water heated at ≥ 70°C/158°F temperature.		
If refrigeration is not available, prepared formula should be used within 2 hours. If refrigerated, formula should be discarded after 24 hours.			

Adapted from: APIC 2014; Forsythe, 2005; Gürtler et al. 2005; WHO 2007.

Appendix 3-D. Measures for Providing Safe Drinking Water

Health care facilities can use point-of-use water treatment techniques to improve water quality and reduce the risk of waterborne diseases. However, not all simple technologies are highly effective in reducing all classes of waterborne pathogens (bacteria, viruses, and protozoa). For example, chlorine is ineffective for inactivating oocysts of the waterborne protozoan *Cryptosporidium parvum,* and some filtration methods, such as ceramic and cloth or fiber filters, are ineffective in removing enteric viruses. Therefore, careful consideration should be used when choosing among these technologies.

Water Treatment Technique	Description of Water Treatment Process
Solar disinfection	There are a number of technologies that use solar irradiation to disinfect water: • Dark and opaque containers that use solar radiation to inactivate microbes by relying on heat from sunlight. • Clear plastic containers penetrated by ultraviolet (UV) radiation from sunlight rely on the combined action of UV radiation, oxidative activity associated with dissolved oxygen, and heat (e.g., the SODIS [solar disinfection] system). • Combinations of these solar radiation effects, such as UV-penetrable plastic bags (e.g., the "solar puddle") and panels.
UV light technologies using lamps	UV light radiation from UV lamps is used to inactivate waterborne pathogens. For small-scale water treatment, most employ low-pressure mercury arc lamps producing monochromatic UV radiation at a germicidal wavelength of 254 nanometers. These may have limited application in low- and middle-income countries because of the need for a reliable supply of electricity and cost and maintenance requirements.
Thermal (heat) technologies	Thermal technologies use heat produced by burning fuel to destroy microbes in water. Water is heated until the temperature rises to a rolling boil (100°C [212°F]), then it is removed from the heat and allowed to cool naturally. It should be protected from post-treatment contamination by storing in clean, sanitized containers with tight-fitting lids.
Membrane, porous ceramic, or composite filters	These are filters with defined pore sizes that rely on physical straining through a single porous surface or multiple surfaces to physically remove and retain microbes by size exclusion. Most household filter technologies operate by gravity flow or by water pressure provided from a piped supply. Examples include carbon block filters, porous ceramics containing colloidal silver, reactive membranes, polymeric membranes, and fiber/cloth filters. Some of these filters may also employ chemical antimicrobial or bacteriostatic surfaces or chemical modifications that adsorbed microbes. Cloth filters, such as a sari or other similar cloth in four layers, have been widely used for reducing *Vibrio cholerae* in water.

Water Treatment Technique	Description of Water Treatment Process
Granular media filtration	These include filters containing sand or diatomaceous earth or others using discrete particles as packed beds or layers of surfaces through which water is passed. These filters retain microbes by a combination of physical and chemical processes, including physical straining, sedimentation, and adsorption. Some may also employ chemically active antimicrobial or bacteriostatic surfaces or other chemical modifications. Some granular media filters are biologically active because they develop layers of microbes on the surface of or within the filter granules. This biologically active layer retains microbes and often leads to their inactivation and biodegradation.
Coagulation, precipitation, and/or sedimentation	Coagulation or precipitation uses a natural or chemical coagulant or precipitant to congeal or separate suspended particles, including microbes. These methods may be used along with cloth or fiber media for a straining step to remove the floc (the large coagulated or precipitated particles that form in the water). Sedimentation allows suspended particles, including microbes, to settle out so they can be removed from the water. This method often employs a series of three pots or other water storage vessels in a series, in which water is settled and then carefully transferred daily. By the third vessel, the water has been sequentially settled and stored for a total of at least 2 days to reduce microbes.
Chemical disinfection	Disinfection of small-scale drinking-water supplies in low- and middle-income countries is done primarily with free chlorine, commonly available as chlorine bleach, because it is inexpensive, effective, widely available, used globally, and easy to dose. However, chemical disinfection of drinking water includes any chlorine-based technology, as well as ozone, some other oxidants, and some strong acids and bases. Except for ozone, proper dosing of these disinfectants provides the additional benefit of leaving a residual in the water that provides some protection against post-treatment contamination during storage.
Combination (multi-barrier) treatment approaches	Any of the above technologies can be used together, either at the same time or one after the other, such as coagulation/disinfection, media filtration/chemical disinfection, or media filtration/membrane filtration. Some combination systems are commercial products in the form of granules, powders, or tablets containing a chemical coagulant, such as an iron or aluminum salt, and a disinfectant, such as chlorine. When added to water, these chemicals coagulate and flocculate impurities to promote rapid and efficient sedimentation and to deliver the chemical disinfectant to inactivate microbes. These combined coagulant/flocculent/disinfectant products are added to specified volumes of water, allowed to react, usually with brief mixing to promote coagulation/flocculation, then allowed to remain unmixed for the floc to settle. The clarified water is then decanted, usually through a cloth or other fine-mesh medium to strain out remaining particles. The recovered water should be allowed to sit for a short period, typically several tens of minutes, to allow for additional chemical disinfection before use.

Adapted from: WHO 2006b.

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Chapter 4. Processing Reusable Health Care Textiles

Key Topics

- The importance of safe handling and processing of soiled textiles
- Use of personal protective equipment (PPE) during textile processing
- Collecting and transporting soiled textiles
- Sorting and washing soiled textiles
- Drying, storing, transporting, and distributing clean textiles

Key Terms

- **Contact time** is the length of time a cleaning product must remain in contact with the surface being cleaned for the disinfectant to kill the targeted microorganisms. Time of contact varies depending on the type of cleaning product and the targeted microorganism (e.g., bacteria, viruses, mycobacteria, spores). For use in health care facilities, the contact time for the organism that is most difficult to kill is routinely adopted.
- **Detergent** (term is used interchangeably with soap) is a cleaning product (e.g., bar, liquid, leaflet, or powder) that lowers surface tension of water, thereby helping to remove dirt and debris. Plain soaps do not claim to be antimicrobial on their labels and require friction (i.e., scrubbing) to mechanically remove microorganisms. Antiseptic (antimicrobial) soaps kill or inhibit growth of most microorganisms.
- **Disinfectant** is a chemical that destroys or inactivates microorganisms on inanimate (non-living) objects. Disinfectants are classified as low-, intermediate-, or high-level depending on their ability to kill or inactivate *some* (low- or intermediate-level) or *all* (high-level) microorganisms. While disinfectants may kill all microorganisms, they do not kill all spores. Commonly used disinfectants for low-, intermediate-level cleaning include phenols, chlorine or chlorine-containing compounds, and quaternary ammonium compounds (QUAT) and hydrogen peroxides (H_2O_2). These classes of disinfectants are often used to clean frequently touched surfaces in health care facilities.
- **Health care textiles** are made from woven textile materials, either natural or synthetic fibers or a mix of fibers, and material prepared from non-woven fibers. These textiles can be either single-use or reusable items and used to make uniforms, PPE, surgical drapes, bed sheets, and other items. They are generally referred to as textiles in health care facilities.
- **Hygienically clean** laundry has been processed to remove pathogens so that the textiles pose no threat of illness to humans. (ANSI/AAMI 2008)
- **Occupational injuries or infections** are injuries or infections acquired by health care workers (HCWs) while performing their normal duties.
- **Soap**—term is used interchangeably with detergent; see the definition of detergent.
- **Sorting** is the process of inspecting and removing foreign items, including dangerous objects (e.g., sharps or broken glass), from soiled textiles before washing. Sorting also includes separating soiled textiles into appropriate wash loads by classification such as color, type of fabric, soil type or soil load, and/or type of use (e.g., diapers/nappies, sheets, or patient gowns) for each laundry formula used.
- **Sterilization** is the process used to render an item free from viable microorganisms, including spores.

Background

The demand for reusable textiles grows as health care facilities expand; both in terms of services required and increases in usage. In low- and middle-income settings, facility staff are often responsible for handling and processing soiled textiles and other reusable items. Sending textiles outside the facility for laundry services is not a common practice. Regardless of the location where textiles are processed, guidelines for safely processing textiles are the same.

Although soiled textiles contain large numbers of microorganisms, the overall risk of disease transmission from soiled textiles is low if they are handled, transported, and laundered in a manner that avoids transfer of microorganisms to patients, HCWs, including cleaning and laundry staff, and the environment. Bacteria, viruses, and fungi are all found in textiles used in health care facilities. (Fijan and Turk 2012; Sehulster et al. 2015)

The main cause of work-related infections among HCWs who handle textiles is improper handling (e.g., shaking soiled textiles, not using gloves, or not performing hand hygiene during or after handling soiled textiles). Most of the risk to HCWs is related to injuries from sharps hidden in the textiles. If the HCWs wear proper PPE, perform hand hygiene, and follow guidelines for removing foreign objects from soiled textiles, there is minimal risk of infection during textile processing. (Sehulster et al. 2015; Fijan and Turk 2012)

However, all HCWs who work in the laundry should be vaccinated against the hepatitis B virus. In addition, an exposure control plan should be put in place to protect HCWs (i.e., a plan on how to properly treat an individual who has been exposed to potentially contaminated, infectious, or dangerous substances). (See the section on Post-Exposure Management for HIV and Hepatitis B and C in Module 4, Chapter 3, Sharps Injuries and Management of Exposure to Bloodborne Pathogens, and Chapter 2, Infection Prevention and Control Aspects of Occupational Health in Health Care Settings.)

To protect patients and HCWs, all soiled reusable textiles should be processed following the recommended infection prevention and control (IPC) guidelines for collecting, sorting, laundering, and storing textiles.

Overview of Processing Textiles

Processing textiles:

STEP 1: Collect soiled textiles.

STEP 2: Transport soiled textiles.

STEP 3: Sort soiled textiles.

STEP 4: Launder reusable textiles (i.e., wash, dry, iron, and fold or pack).

STEP 5: Store clean textiles.

STEP 6: Distribute clean textiles.

Safely processing textiles from multiple sources is a complex process. To reduce the risk of contamination, procedures should be in place to safely handle, process, and store textiles. The principles are listed in Box 4-1.

HCWs handling the textiles should be properly trained on the processing procedures and should protect themselves by applying Standard Precautions (see Module 1, Chapter 2, Standard and Transmission-Based

Precautions), including wearing the appropriate PPE for laundering textiles (see the Use of Personal Protective Equipment during Processing of Textiles section in this chapter and Module 3, Chapter 1, Personal Protective Equipment).

Box 4-1. Processing Textiles Principles

- Wear heavy-duty utility gloves and other PPE when collecting, handling, transporting, sorting, and washing soiled textiles (see the section on PPE in this chapter and Module 3, Chapter 1, on PPE).
- Use PPE for Standard Precautions, carefully scrape off solid body fluids (e.g., stool or vomit) using a firm, flat object and dispose in toilet or sluice before item is placed in collection container.
- Use leak-proof containers for all textiles or at least those grossly contaminated with blood or body fluids to protect staff from exposure to blood and body fluids.
- Do not sort textiles in patient care areas.
- Confine the soiled textiles to designated areas until transported to the laundry. Using the principles of Standard Precautions, handle all discarded textiles as soiled, including items on which there is no visible contamination.
- Launder all textiles present during procedures, regardless of whether or not they are visibly dirty or were used in the procedure, such as sterile towel drapes contained in an opened surgical pack that were not used during the procedure must be laundered before they can be sterilized and reused. (See Module 6, Chapter 4, Sterilization of Reusable Surgical Instruments and Medical Devices).
- Transport textiles in covered containers or closed bags.
- Handle soiled textiles with minimum agitation to avoid contamination of air, surfaces, and individuals.
- Handle soiled textiles as little as possible and with minimum contact to avoid accidents, injuries, and the spread of microorganisms.
- Sort textiles in the laundry area carefully before washing.
- Follow special guidelines for textiles used in isolation areas for patients with highly infectious diseases (e.g., viral hemorrhagic fever). Consult the ministry of health or World Health Organization (WHO) guidelines.

Sources: OSHA; Sehulster et al. 2015.

Use of Personal Protective Equipment during Processing of Textiles

Recommended PPE for HCWs performing tasks associated with processing textiles are listed in Table 4-1. (See Chapter 2, Environmental Cleaning, in this module for instructions on cleaning PPE; see Module 3, Chapter 2, Use of Personal Protective Equipment during Outbreaks of Viral Hemorrhagic Fever, for details on PPE required for highly infectious diseases.)

Table 4-1. Recommended PPE for Processing Textiles

Activity	Type of PPE
• Collecting soiled textiles • Transporting soiled textiles	• Thick utility or heavy-duty household gloves • Closed-toe shoes to minimize the risk of accidental injury from sharp objects or contact with blood or body fluids
• Sorting soiled textiles • Hand washing soiled textiles • Loading washers • Handling disinfectant cleaning solutions	• Thick utility or heavy-duty household gloves • Protective eyewear and mask or face shield • Fluid-resistant gowns or plastic or rubber aprons • Closed-toe shoes

Source: OSHA; Sehulster et al. 2015.

Collecting, Handling, Transporting, and Sorting Soiled Textiles

Design, Ventilation, and Space Requirements for Processing Textiles

- Processing areas for textiles should be physically separated from the patient care and food preparation areas.
- Laundry areas should have hand hygiene facilities.
- Processing areas for soiled textiles must be physically separated (e.g., divided by walls) from areas used for folding and storing clean textiles. If separate rooms are not possible, a physical barrier between the clean and soiled textile areas should be constructed.
- Processing areas area considered “soiled areas” and should be adequately ventilated.
  - For facilities with natural ventilation, airflow should be away from other areas and air should be exhausted out of the building.
  - For facilities with mechanical ventilation, negative pressure and 10 air exchanges per hour with air exhausted directly outdoors are recommend.
- (APIC 2014; Sehulster et al. 2015)

Collecting, Handling, and Transporting Textiles

- After invasive medical or surgical procedures or when changing textiles in patient rooms, the following precautions and procedures should be applied in each situation (CDC 2011; Sehulster et al. 2015). There are special guidelines for textiles used in isolation areas for patients with highly infectious diseases (e.g., viral hemorrhagic fever). Consult ministry of health or WHO guidelines.

Collecting

- Collect and remove soiled textiles from patient rooms after each procedure, daily, or as needed.
- Use Standard Precautions, including PPE (see above), when collecting used textiles.
- Do not sort textiles in patient care areas.
- Collect used textiles at the point of use.
  - Use leak-proof containers for all textiles; cloth bags are adequate for patient care textiles not soaked with blood or body fluids.
- Roll items that are heavily contaminated with blood or body fluids carefully into the center of the item and place in a leak-proof bag or a container with a lid if leak-proof bags are not available.
  - Do not sort or rinse textiles heavily contaminated with blood and body fluids in patient care areas.
- Label clearly or use color-code containers for collecting and transporting used textiles.
- Wash and dry containers routinely before subsequent use. (See the Environmental Cleaning chapter in this module for guidance on disinfectants.)

Note: If utility gloves are not available, put on two pairs of non-sterile gloves (double gloving). This provides **some** protection for HCWs responsible for collecting, transporting, and sorting soiled textiles and other items.

Handling

- Handle soiled textiles as little as possible. To avoid the spread of microorganisms in the environment and among HCWs and patients, do not shake soiled textiles.
- It is not necessary to *routinely* double bag or use additional precautions for textiles used by patients in isolation. Two bags may be indicated if the textile cannot be placed in the bag without contaminating the outside of the bag.

Transporting

- Transport collected soiled textiles to the processing area in closed bags, containers with lids, or covered carts.
- Transport soiled textiles and clean textiles separately. If there are separate carts, trolleys, or containers available for soiled and clean textiles, they should be labeled accordingly. If soiled and clean textiles are transported in the same cart or container:
  - Clean the containers and trolleys or carts thoroughly after transporting soiled textiles using disinfectant cleaning solution (see the Environmental Cleaning chapter in this module for guidance on disinfectants); or
  - Keep soiled textiles in separate areas of the same cart where clean textiles are located and cover both.

Sorting Soiled Textiles

Careful sorting of textiles is extremely important for the safety of HCWs. Sorting must be carefully performed because soiled textiles (e.g., large drapes and towel drapes) from the operating theater (OT) and other procedure areas may contain sharps (e.g., scalpels, sharp-tipped scissors, hypodermic and

suture needles, and sharp-tipped towel clips). In addition, bedding from patients' rooms may contain soiled dressings (e.g., blood-stained or wet with other body fluids).

Sorting laundry also allows for customization of washing processes for various categories of textiles or soil level. It also increases efficiency during inspection, folding, ironing, etc. Soiled textiles may also contain non-infectious items (e.g., coins and keys). These items pose no risk and should be returned directly to the patient.

- Do not sort or pre-rinse soiled textiles in patient care areas; they should be sorted in the laundry area.
- Sort soiled textiles into appropriate wash loads by classification such as color, type of fabric, soil type or soil load, and/or type of item (e.g., whites items, cloth nappies/diapers, cotton/wool items, mop heads, surgical drapes, etc.).

(HLAC 2006; Sehulster et al. 2015)

Laundering Textiles

Washing and Drying

All textiles (e.g., bed sheets, surgical drapes, and gowns) used in the direct care of a patient must be thoroughly washed and dried before reuse. Laundering removes pathogens from textiles, making them hygienically clean[1] and ready for use. Laundered textiles are not sterile and are not required to be, including for neonatal intensive care units. (Sehulster et al. 2015)

Laundering standards in hospitals should address key, specific standards, for example, water quality and temperature, amount of agitation needed, and chemical properties needed to properly clean surgical attire. Effective laundering is dependent on the following factors, which, when used together, have a greater effect than when used separately:

- Duration of cleaning
- Mechanical action (i.e., agitation)
- Chemicals used in the process
- Temperature of water and air in the machine dryer

If one of these factors is decreased (e.g., temperature), then other factors (e.g., chemicals, mechanical action, or time) must be increased to result in the same level of cleanliness.

Laundering cycles consist of flush, main wash, disinfecting (bleaching), rinsing, and souring (addition of a mild acid agent).

Decontamination of textiles by presoaking with soap, water, and chlorine solution prior to washing is not necessary unless the item is heavily soiled or will be hand washed. Repeated soaking of textiles in chlorine solution, even dilute solution, can cause fabric to deteriorate more quickly.

Note: The storage time for soiled textiles before washing is a practical issue related to available storage space and aesthetics, **not** an infection prevention concern.

[1] Hygienically clean laundry has been processed to remove pathogens so that the textiles pose no threat of illness to humans. (ANSI/AAMI 2008)

Using Cold Water

Using cold water saves energy. Cool water cycles rely heavily on the action of bleach to kill microbes. Temperatures of 22–25°C (71–77°F) for washing textiles is satisfactory for removing microbes if the water cycle, type of soap or detergent, strength of chlorine solution, and other additives are used in proper concentrations. WHO recommends soaking textiles in 0.05%–0.5% chlorine solution for 15–30 minutes and then washing with soap and water to remove the bleach. (AORN 2013; Fijan and Turk 2012; Sehulster et al. 2015; SEARO/WHO 2004)

Washing textiles by hand

To properly hand wash textiles:

STEP 1: Wear PPE while washing textiles by hand.

STEP 2: Separate heavily soiled textiles from non-soiled textiles and wash separately.

STEP 3: Wash the entire item in water with soap to remove all dirt and debris, even if not visible.

STEP 4: Soak in clean water with chlorine solution (0.005–0.015% or 50–150 parts per million [ppm][2]) for 30 minutes. Add sour (a mild acid agent) to prevent yellowing of the textile.

STEP 5: Wash again with soap and water to remove bleach.

STEP 6: Check the item for cleanliness. Rewash if it is still dirty or stained.

STEP 7: Rinse the item with clean water.

(Sehulster et al. 2015; SEARO/WHO 2004)

Note: Workers should not carry wet, soiled textiles close to their bodies even if they are wearing plastic or rubber aprons: carry textiles in a plastic tub or bucket.

Machine washing

Heavy-duty washers or dryers are recommended for larger health care facilities (e.g., hospitals). To properly machine wash textiles:

STEP 1: Wear PPE while handling and loading machines.

STEP 2: Separate heavily soiled textiles from non-soiled textiles and wash separately.

STEP 3: Follow manufacturers' instructions to adjust temperature settings, cycle time, type of soap, and other washing agents to be added.

STEP 4: For hot-water washing at 70–80°C (158–176°F), use soap for ≥ 25 minutes to aid in loosening soil. Add bleach and sour if stain removal is required. If not using hot water, soaking textiles in 0.05%–0.5% chlorine solution for 15–30 minutes and then wash with soap and water to remove the bleach.

STEP 5: When the wash cycle is complete, check the item for cleanliness. Rewash if it is dirty or stained. (Heavily soiled textiles may require two wash cycles.)

(CDC 2011; SEARO/WHO 2004)

[2] To make 10 liters of 0.005% or 50 ppm bleach solution, add 15 mL of 3.5% chlorine to 10 liters of water. To make 10 liters of 0.015% or 150 ppm bleach solution, add 45 mL of 3.5% chlorine to 10 liters of water. For guidance on preparing sodium hypochlorite solution, see Table 2-3 in Chapter 2, Environmental Cleaning, in this module.

Drying, inspecting, and folding textiles

To dry, inspect, and fold hand- and machine-washed textiles:

STEP 1: Completely air- or machine-dry cleaned textile before further processing. A cycle in the dryer has been associated with elimination of pathogenic bacteria. For air-drying, direct sunlight is preferred. Keep the fabric off the ground, away from dust and moisture.

STEP 2: After textiles are totally dry, check for holes and threadbare (worn) areas. If these are present, the item must be discarded or repaired before reuse or storage:

- For holes, punctures, or tears or large areas to be repaired, the item should be patched with the same quality material by stitching or heat sealing; otherwise, the item should not be used for direct patient care or surgical procedures. Worn textiles can be cut into pieces and used as cleaning cloths.
- For surgical drapes, the percentage of exposed surface allowed to be patched depends on the sterilization method used to process the item and the number of layers of fabric from which the drape is made. For example, a drape should have no more than five patches per area 30 centimeters (12 inches) square, or no more than 20% of the drape covered with patches. Patches should be avoided, if possible, because they increase the thickness of the item and decrease steam penetrability when sterilization is required.

STEP 3: Air-dried textiles should be ironed. Ironing has been associated with the elimination of pathogenic bacteria and is essential to prevent parasites in some regions.

STEP 4: Clean, dry textiles should be folded. If sterile textiles are required (e.g., in the OT), prepare and sterilize wrapped packs as discussed in Module 6, Chapter 4, Sterilization of Reusable Surgical Instruments and Medical Devices. In neonatal intensive care units, hygienically laundered textiles can safely be used; it is not necessary to use sterilized textiles.

(AORN 2013; Bearman et al. 2014; Sehulster et al. 2015; SEARO/WHO 2004; Tietjen et al. 2003)

Storing, Transporting, and Distributing Hygienically Clean Textiles

Storing Hygienically Clean Textiles

Procedures for proper storing of hygienically clean textiles:

- Store clean textiles in clean, closed storage areas.
- Store clean textiles in an area free of pests, dust, and lint and at room temperatures of 20–25.6°C (68–78°F).
- Use physical barriers to separate folding and storage rooms from soiled areas.
- Ensure that storage shelves are:
  - 2.5 to 5 cm (1 to 2 inches) from the wall
  - Bottom shelf: 15 to 20 cm (6 to 8 inches) from the floor
  - Top shelf: 30 to 45 cm (12 to 18 inches) below the ceiling
- Keep shelves clean and textiles covered, which can be achieved by:
  - Covering clean textiles on a clean cart
  - Wrapping bundles of clean textiles in plastic or other suitable material and closing securely
- Restrict access to the laundry storage room to authorized staff.

- Store hygienically clean surgical attire as close to the point of use as possible to avoid any microbial contamination.
- Handle stored textiles as little as possible.
- (APIC 2014; Sehulster et al. 2015)

Transporting Clean Textiles

Procedures for proper transporting of clean textiles:

- Hygienically clean and soiled textiles should be transported separately. If separate trolleys or containers are used for clean and soiled textiles, they should be labeled accordingly.
- If clean and soiled textiles must be transported in the same cart, the following are options in order of preference:
  - Thoroughly clean the containers and trolley with disinfectant cleaning solution (e.g., 0.5% hypochlorite solution) before transporting hygienically clean textiles;

    or
  - Keep hygienically clean textiles in separate areas of the same trolley where soiled textiles are located and cover both.
- Wrap or cover hygienically clean textiles during transport to avoid contamination.

Distributing Hygienically Clean Textiles

It is important to protect hygienically clean textiles from environmental contaminants (e.g., dust and dirt) until they are distributed for use. Outbreaks associated with textiles have resulted from contamination of clean textiles; several outbreaks of *Bacillus cereus* in hospital settings were linked to contaminated textiles. (Balm et al. 2012; Duffy et al. 2014; Hosein et al. 2013; Sasahara et al. 2011)

To avoid contamination of textiles in health care facilities:

- Do not leave extra textiles in patients' rooms.
- Handle clean textiles as little as possible.
- Avoid shaking clean textiles where dust and lint can be released into the room.
- Do not conduct routine microbiologic sampling of clean textiles.
- Clean soiled mattresses and pillows using the following guidelines before putting clean textiles on them:
  - Clean plastic-covered mattresses and pillows by wiping down with detergent. Mattresses without plastic covers that have any blood or body fluids should have the stains removed by either steam cleaning or manual washing. HCWs should wear PPE during this cleaning process.

  (Sehulster et al. 2015; SEARO/WHO 2004)

Summary

Facility staff are often responsible for handling and processing reusable textiles at the facility. Although soiled textiles may contain large numbers of microorganisms, the overall risk of disease transmission is low if textiles are handled, transported, and laundered in a manner that avoids transfer of microorganisms to patients, HCWs, and the environment. Health care outbreaks can occur because of contaminated textiles and HCWs can experience injuries and exposures if these recommendations are not followed.

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Chapter 5. Waste Management in Health Care Facilities

Key Topics

- Categories of health care waste
- Reduction of health care waste
- Segregation of waste at point of generation
- Management of the health care waste process
- Waste treatment and disposal methods

Key Terms

- **Combustible wastes** are those that can be burned or will easily catch on fire, and include paper, cardboard, and used dressings and gauze as well as some liquids and gases.
- **Cytotoxic waste** contains by-products of drugs that kill dividing cells, used for treatment of certain cancers. It also includes waste materials that can damage human genes (e.g., DNA) and may cause cancers or congenital deformities in babies. This waste can include any items exposed to these drugs including sharps, personal protective equipment (PPE), and body fluids.
- **Disposal** is the final step in health care waste management and entails intentional treatment of waste to render it harmless followed-by burial, deposit, discharge, dumping, placement, or release of waste material into the air or water or onto/into land. It is undertaken without the intention of retrieval/reuse.
- **Encapsulation** is a process used when other options for safe disposal are not available. It involves surrounding hazardous waste with an immobilizing agent within sealed, solid waste containers to reduce the likelihood of future environmental, scavenger, or human contact with waste.
- **General waste** does not pose any particular biological, chemical, radioactive, or physical hazard (e.g., paper boxes, newspapers and magazines, polyethylene bottles, polyester bags, wood, other papers, metals [e.g., aluminum cans and containers], high-density polyethylene [e.g., milk containers, saline bottles], glass, and construction/demolition materials).
- **Hazardous waste** is waste that can pose a health risk to health care workers (HCWs), patients, and other people who are exposed to it. It includes both chemical/radioactive and infectious health care waste, for example, sharps, pathological waste, pharmaceutical waste, and cytotoxic, chemical, and radioactive waste.
- **Health care wastewater** is any water that has been adversely affected in quality during the provision of health care services. It is mainly liquid waste containing some solids produced by staff and patients (i.e., human excrement) or during health care-related processes, or cooking, cleaning, and laundering at the health care facility. This type of wastewater poses risks similar to those of domestic wastewater, which is considered infectious. However, health care facilities (depending on the services offered) also generate wastewater that poses a higher risk, containing chemicals, pharmaceuticals, contagious microorganisms, and radioactive substances.
- **Incineration** is one method of waste disposal and involves controlled burning of solid, liquid, or gaseous combustible wastes that results in inorganic, non-combustible residue.

- **Infectious waste** is waste that is potentially contaminated with blood, body fluids, or pathogenic organisms, including, but not limited to, laboratory cultures, microbiological stocks, excreta, and items soiled with blood or body fluids.
- **Municipal waste** is general waste that is generated mainly by households, commercial activities, and street-sweeping. Ideally, it is collected by municipalities (e.g., local villages or cities) but in some locations this service is not available.
- **Residence time** is the time that it takes between the entry of a waste substance into a furnace or incinerator and the exit of exhaust gases or burn-out residue from the furnace or incinerator.
- **Sanitary landfill** is an engineering method used for disposing of solid waste on land in a manner that protects the environment (e.g., by spreading the waste in thin layers, compacting it to the smallest practical volume, and then covering it with soil at the end of each working day).
- **Sewerage** is the system for the collection and transport of human excrement and accompanying water used in toilet systems (sewage). The system includes conduits (channels) and pipes (sewers), and pumping stations.
- **Sharps waste** includes used or unused sharps (e.g., hypodermic, intravenous, or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glass).
- **Standard Precautions** are a set of infection control practices used for every patient encounter to reduce the risk of transmission of bloodborne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control practices to be used, at a minimum, in preventing the spread of infectious agents to all individuals in the health care facility.
- **Waste management** includes all activities, administrative and operational (including transportation activities), involved in the handling of waste: generation, collection, transport, storage, and disposal of waste.
- **Waste segregation** is the systematic separation of health care waste into designated categories according to the type of composition and hazards, to enhance the safety and efficiency of waste handling and disposal.

Background

Health care waste, produced in the course of delivering health care, is potentially hazardous, and effective management is critical to infection prevention and control in health care. A health care facility is responsible for managing public health and protecting the environment with regard to the waste produced. However, the waste management process (generation, collection, transport, storage, and disposal) entails considerable complexity, involving clinical and non-clinical staff across a facility, and often depends on outside agencies.

Managing waste remains particularly challenging for facilities in limited-resource settings. Lack of organization, financial resources, training, segregation, equipment, locations for storage, access to PPE, municipal support, and safe disposal locations have been identified as among the challenges (Awodele et al. 2016; Caniato et al. 2016). In 2002, the World Health Organization (WHO) completed an assessment of biomedical waste disposal in 22 low- and middle-income countries and found that up to 64% of these countries' health care facilities did not use recommended waste disposal methods (WHO 1999). Public interest in waste management practices of health care facilities and the impact on climate and the environment continues to grow. Knowledge of the potential for harm from health care waste continues to be relevant to governments and communities. (WHO 2014)

Risks from health care waste include exposure to pathogenic organisms, harmful chemicals, toxins, or radioactive substances, and injury from sharp items. Anyone who comes into contact with waste, both in the community and within the facility (HCWs, patients, visitors, laundry workers, cleaners, porters, etc.) may be at risk. Exposure to toxic agents contained in health care waste can cause skin, respiratory tract, and neurological conditions. Recommendations for reducing the risk from injury and infection are described in this chapter.

Infectious health care waste includes waste that has the potential for causing infection. HCWs can be infected when they are exposed to waste through a skin puncture, broken skin, splashes into the mouth or eyes, inhalation, or ingestion. Infectious conditions potentially transmitted from health care waste include gastrointestinal conditions (i.e., diarrhea and vomiting), respiratory conditions, skin and eye infections, meningitis, bloodborne virus infections (e.g., HIV, hepatitis B and C), and hemorrhagic fever—including Ebola Virus Disease.

Standard Precautions protect HCWs from the risks of handling infectious waste at each point throughout the waste management process. All waste should be handled using Standard Precautions (see Module 1, Chapter 2, Standard and Transmission-Based Precautions) and waste that includes any items potentially contaminated with blood and body fluids should be managed as infectious waste.

Applying infection prevention and control recommendations to all aspects of waste handling (generation, collection, transport, storage, and disposal) minimizes the risks to human health and the environment.

Categories of Health Care Wastes

Categorizing the waste produced in health care facilities is a useful method of understand the handling and disposal requirements for each type of waste.

Approximately 75–90% of the general waste produced by health care facilities is non-contaminated and poses no risk of infection for those who handle it. Similar in nature to municipal waste, all or most general waste can be discarded in dumps or landfills or burned in incinerators. (WHO 2014)

Infectious waste from health care facilities must be handled and disposed of properly because they may carry microorganisms that have the potential to infect individuals who come in contact with them.

There are other types of waste generated in health care facilities that do not contain infectious agents but are considered hazardous because of the potential harm they can cause to the environment. Table 5-1 details various categories of waste generated by health care facilities, as defined by WHO.

Table 5-1. Categories of Waste Generated by Health Care Facilities

Waste Category	Descriptions and Examples
Non-Hazardous Health Care Waste	
General waste	Waste that does not pose any particular biological, chemical, radioactive, or physical hazard (e.g., paper boxes, newspapers and magazines, polyethylene bottles, polyester bags, wood, other papers, metals [e.g., aluminum cans and containers], high-density polyethylene [e.g., milk containers, saline bottles], glass, and construction/demolition materials).
Hazardous Health Care Waste	
Sharps waste	Used or unused sharps (e.g., hypodermic, intravenous, or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glass).
Infectious waste	Infectious waste is waste that is potentially contaminated with blood, body fluids, or pathogenic organisms, including, but not limited to, laboratory cultures, microbiological stocks, excreta, and items soiled with blood or body fluids.
Pathological waste	Waste that contains human tissues or fluids, organs, body parts, fetuses, and unused blood products.
Pharmaceutical waste	Pharmaceuticals that are expired or no longer needed and items contaminated by or containing pharmaceuticals.
Cytotoxic waste	Cytotoxic waste contains by-products of drugs that kill dividing cells, which are used for treatment of certain cancers. It also includes waste materials that can damage human genes (e.g., DNA) and may cause cancers or congenital deformities among babies. This waste can include sharps, PPE, and body fluid exposed to the drugs.
Chemical waste	Waste containing chemical substances (e.g., laboratory reagents, film developer); disinfectants that are expired or no longer needed; solvents; and waste with a high content of heavy metals (e.g., batteries, broken thermometers, and blood pressure gauges).
Radioactive waste	Waste containing radioactive substances (e.g., unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; and sealed sources—containers in which radioactive substances are stored and sealed).

Adapted from: World Health Organization (WHO). 2013. *Safe Management of Wastes from Health-Care Activities,* 2nd ed. page 4. WHO: Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1.

Sources of Health Care Wastes

The types and amount of health care waste generated in a health care facility depend upon the size of the facility as well as the range of services provided. The larger the facility (e.g., university hospital, regional hospital) and the more services provided (e.g., tertiary health care facility with a trauma center, cancer treatment department), the more waste is produced and the greater variety of waste generated. Table 5-2 provides examples of health care waste from different sources in health care facilities.

Table 5-2. Health Care Wastes from Different Sources in a Health Care Facility

Location	Sharps	Infectious and Pathological Waste	Chemical, Pharmaceutical, and Cytotoxic Waste	Non-Hazardous or General Waste
Major Sources				
Medical ward	Hypodermic needles, IV set needles, broken vials, and ampoules	Dressings, bandages, gauze and cotton contaminated with blood or body fluids; gloves and masks contaminated with blood or body fluids	Broken thermometers, blood pressure gauges, spilled drugs, and spent disinfectants	Packaging, food scraps, paper, flowers, empty saline bottles, non-bloody diapers, non-bloody intravenous tubing and bags
Operating theater	Needles, intravenous sets, scalpels, blades, and saws	Blood and other body fluids, suction canisters, gowns, gloves, masks, gauze and other waste contaminated with blood and body fluids, tissues, organs, fetuses, body parts	Used disinfectants and waste anesthetic gases	Packaging, uncontaminated gowns, gloves, masks, hats, and shoe covers
Laboratory	Needles, broken glass, petri dishes, slides and cover slips, and broken pipettes	Blood and body fluids, microbiological cultures and stocks, tissue, infected animal carcasses, tubes and containers contaminated with blood or body fluids	Fixatives, formalin, xylene, toluene, methanol, methylene chloride and other solvents, and broken lab thermometers	Packaging, paper, and plastic containers
Pharmacy store			Expired drugs, spilled drugs	Packaging materials and empty containers
Radiology			Silver, fixing and developing solutions, acetic acid, and glutaraldehyde	Packaging materials
Chemotherapy	Needles and syringes		Bulk chemotherapeutic waste, vials, gloves and other material contaminated with	Packaging materials

Location	Sharps	Infectious and Pathological Waste	Chemical, Pharmaceutical, and Cytotoxic Waste	Non-Hazardous or General Waste
Major Sources				
			cytotoxic agents, and contaminated excreta and urine	
Vaccination campaigns	Needles and syringes		Bulk vaccine waste, vials, and gloves	Packaging materials
Environmental services	Broken glass		Disinfectants, cleaners, spilled mercury, and pesticides	Packaging, flowers, newspapers, magazines, cardboard, plastic, glass containers, yard and plant waste
Engineering			Cleaning solvents, oils, lubricants, thinners, asbestos, broken mercury devices, and batteries	Packaging, construction or demolition waste, wood, and metal
Food services				Leftovers, food scraps, plastic and paper packaging, and containers
Minor Sources				
Physician office (Outpatient department)	Needles and syringes, broken ampoules, and vials	Cotton, gauze, dressings, gloves, masks, and other materials contaminated with blood and other body fluids	Broken thermometers and blood pressure gauges, expired drugs, and used disinfectants	Packaging, papers, newspapers, magazines, uncontaminated gloves, and masks

Source: World Health Organization (WHO). 2014. *Safe Management of Wastes from Health-Care Activities,* 2nd ed., page 12. WHO: Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1.

Management of Health Care Waste

Reduction of Health Care Waste

The preferred strategies for reducing health care waste are to minimize waste generation by preventing waste production, reducing waste production, reusing and recycling waste, and recovering useful substances from waste. The least preferable strategy is treating and disposing of health care waste.

Health care facilities can take several steps to minimize waste, including monitoring the consumption of hazardous substances and chemicals. Purchasing supplies with minimal packaging and using reusable medical devices, where feasible, are other ways to minimize health care waste. In addition, recycling waste when technologies are available will help minimize waste.

Chemical waste minimization options include:

- Using less toxic, environmentally friendly chemicals
- Using minimum concentrations when possible
- Ensuring good inventory control
- Designing proper storage areas
- Developing spill prevention and clean-up procedures

(WHO 2014)

Segregation of Waste at Point of Generation

While general waste is the least expensive and easiest to dispose of, infectious and hazardous waste, which makes up 15% of waste, is more expensive and risky to handle. When general waste is mixed with infectious or hazardous waste, the cross-contamination is introduced and all the resulting waste must be treated as infectious and hazardous.

Mixed waste occurs when wastes are not properly separated at the point of generation or are mixed during any part of the waste management process. Segregation at the point of waste generation will reduce the amount of waste that the facility must treat as infectious or hazardous and is a key strategy for improving waste management at health care facilities.

Note: Training HCWs and having conveniently placed sharps containers close to where sharps are used will help eliminate problems with improper disposal.

Use the following guidelines when disposing of infectious and general waste at the point of generation in all types of health care facilities:

- The HCW who generates the waste should segregate it where it is generated (e.g., before leaving a patient's room, examination room, operating theater, or laboratory).
- The waste should be separated into the local or WHO categories (based on its potential hazard and final disposal method). See Table 5-3.
- Separating wastes by hand after generation puts HCWs at risk and should not be allowed.
- Deposit infectious waste in a labeled or color-coded, leak-proof, puncture-resistant container. See Table 5-3.
- Use leak-proof (plastic or galvanized metal) containers with tight-fitting covers for contaminated and hazardous wastes to protect patients and HCWs.
- Where available and feasible, use sturdy plastic bags/bin liners inside of the waste collection containers to assist with waste collection and transport. Do not re-use plastic bags or bin liners.
- Use puncture-resistant sharps containers for all disposable sharps (e.g., sharps that will not be reused).

Methods to encourage waste segregation include:

- Employ a "Three-Bin System" to segregate waste into separate bins for general, non-hazardous wastes, infectious waste, and sharps (see Table 5-3).
- Use standardized, colored plastic bags (if available) or colored waste containers or standardized, clearly labeled containers to alert HCWs to the contents of the containers.
- Place waste containers and sharps containers at or close to the point of waste generation so waste and sharps can be placed directly into the container.
- Use tools such as a kidney dish or bowl to separate waste and transport it safely from the point of waste generation to waste containers when waste containers and sharps containers cannot be placed close to the point of waste generation (see Module 4, Chapter 3, Sharps Injuries and Management of Exposure to Bloodborne Pathogens).

Note: The sharps container should be placed at the point of use so that HCWs do not have to carry sharp items.

- Train HCWs on the importance, categories, and methods of waste segregation.
- Use workplace reminders (posters, signs) to remind staff how to segregate waste.
- Talk with HCWs, in each area of the facility, about the barriers to segregation in their departments since these will vary widely according to the types of tasks performed and the workflow.

  (WHO 2014)

Note: it is important to train all HCWs, including clinicians and cleaning staff, and patients to keep infectious and non-infectious waste separate.

Table 5-3. WHO Recommended Segregation Scheme

Type of Waste	Color of Container and Markings	Type of Container
Highly infectious waste	Yellow, marked "highly infectious" with biohazard symbol	Strong, leak-proof plastic bag or container capable of being autoclaved
Other infectious waste, (includes all pathological waste)	Yellow with biohazard symbol	Leak-proof plastic bag or container
Sharps	Yellow, marked "SHARPS" with biohazard symbol	Puncture-proof container
Chemical and pharmaceutical waste	Brown, labeled with appropriate hazard symbol	Plastic bag or rigid container
Radioactive waste	Labeled with radiation symbol	Lead box
General health care waste	Black	Plastic bag or container

Source: World Health Organization (WHO). 2014. *Safe Management of Wastes from Health-Care Activities,* 2nd ed., page 79. WHO: Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1.

In addition, use symbols to indicate the different categories of infectious and hazardous waste (see Figure 5-1).

Figure 5-1. Hazardous Waste Symbols for Health Care Facilities

Biohazard

Radiation

Chemical Corrosive

Highly Flammable Chemical

Toxic Chemical

Explosive Chemical

After segregation in patient care areas, separation during collection, transport, and storage of waste must be maintained to obtain any benefit. All HCWs, including cleaners, porters, and those collecting, transporting, storing, and disposing of the waste, must be educated about the importance of segregation.

Collection and Transportation of Waste in Health Care Facilities

To manage waste in health care facilities and ensure timely and safe disposal, waste collection and transportation systems should be developed using the following criteria:

- Waste collection routes should be carefully planned and drawn out, taking into consideration the principle of collecting from least to most infectious waste (e.g., the laboratory would be last on a collection route).

Note: Waste bags and sharps containers should NOT be filled more than three-quarters full.

- Waste collection timetables for each route should be carefully planned according to the waste generation patterns of the various departments. For example, operating theaters, labor and delivery areas, laboratories, and outpatient clinics may generate more waste at different times than other areas and require more frequent collection schedules.
- Collect waste on a regular basis such as daily or sooner if needed according to the rate it is generated and the size of the waste containers. Waste bags and sharps containers should NOT be filled more than three-quarters full.
- Staff should be trained to understand risks and safety procedures for handling waste:
  - Do not mix infectious/hazardous and general waste during collection or transport.
  - Collect and transport infectious waste to disposal sites in leak-proof, covered, contaminated-waste containers.

Note:

- Never use hands to compress waste into containers.
- Hold plastic bags at the top.
- Keep bags from touching or brushing against the body while lifting or during transport.

- Do not use equipment (e.g., wheelbarrow, trolley/cart) that is used to hold and transport wastes for any other purpose in the health care facility.
- Use PPE when handling wastes.

Steps for collection and transport of solid infectious wastes:

STEP 1: Wear heavy-duty or utility gloves and closed-toe shoes when handling and transporting all waste.

STEP 2: Collect waste containers and transport to the storage area or treatment area for final disposal.

STEP 3: Clean infectious-waste containers each time they are emptied using soap/detergent and water, disinfect with a low- to intermediate-level disinfectant, and allow to dry before reuse. Clean non-contaminated-waste containers at least once a week or when visibly soiled.

STEP 4: Remove utility gloves and perform hand hygiene after handling wastes.

STEP 5: Wash and dry gloves (see Chapter 2, Environmental Cleaning, in this module).

When using plastic bags/bin liners:

- Tie bags securely to provide a barrier between the waste and the HCW.
- Label bags with the date and type of waste in them.
- Do not shake or squeeze bags in an attempt to reduce volume when sealing them.
- Carry sealed bags at the top (i.e., by their necks) to the transportation trolley/cart/bin.
- Do not lift or hold bags by the bottoms or sides.
- Carry bags away from the body.
- Ensure that bags are not broken, opened, or dropped.
- Do not throw bags.

When bags/bin liners are not available:

- Use waste containers with lids.
- Clearly identify the containers by appropriate color/labeling, for example, “pathological waste,” “infectious waste,” and “general municipal waste.”

(WHO 2014)

Steps for collection and transport of sharps containers:

STEP 1: Wear heavy-duty utility gloves closed-toe shoes.

STEP 2: Pick up the sharps container from the clinical area—ensure that the container is closed tightly so no sharps are spilled during transport.

STEP 3: Place the container in the designated part of the storage area when it is ready for disposal.

STEP 4: Remove utility gloves and perform hand hygiene after handling waste.

STEP 5: Wash and dry gloves (see Chapter 2, Environmental Cleaning, in this module).

Storage of Waste in Health Care Facilities

Waste storage areas in the health care facility should be kept clean, organized, protected from pests and the public (children or scavengers), and well-shaded to reduce heat buildup). Recommendations for waste storage areas include:

- An easy-to-clean, hard floor with good drainage
- Separate areas for infectious and general waste
- Separate cabinets to store pharmaceutical and other toxic wastes
- A good water supply with a sink for hand hygiene
- Regular cleaning
- Identification (signs) as a "waste storage area"
- Lockable door/gate.

Disposal of Health Care Waste

Recommended Waste Disposal Methods

Countries committed to minimizing the level of dangerous, cancer-causing chemicals (e.g., dioxin and furans) in groundwater can adopt recommended approaches for waste treatment/dips. However, meeting current guidelines may be challenging for facility in resource-limited settings. Waste minimization to limit the volume of hazardous waste produced and waste segregation to minimize the proportion of the total waste that is infectious/hazardous are key waste management measures in all settings. Choosing the best currently available waste disposal method and working towards safer waste disposal to protect the community and the environment is essential. Table 5-4 summarizes options for waste treatment that health care facilities can choose based on available resources and the volume and types of waste generated. (WHO 2014)

Table 5-4. Methods for Treating Health Care Waste

Method	Brief Description
Non-Burn Methods	
Non-Infectious Waste	
Thermal processes	Use of heat to destroy microorganism in the waste
Chemical processes	Disinfectants (e.g., chlorine dioxide, sodium hypochlorite, peracetic acid, lime solution, ozone gas, dry inorganic compounds) used to treat waste
Irradiation technologies	Irradiation from electron beams, cobalt-60, or ultraviolet sources to destroy microorganisms
Biological processes	Use of natural living organisms to degrade organic matter (e.g., composting of kitchen wastes)
Mechanical processes	Grinding, mixing, and compacting to reduce waste volume and to supplement other health care waste processes (e.g., after waste disinfection)

Method	Brief Description
Infectious Waste	
Autoclaving	Use of high-pressure steam to kill microorganisms in infectious waste and sterilize medical instruments
Integrated, steam-based treatment	A continuous flow system that uses mechanical processes before, during, and/or after steam-based processes (similar to autoclaving) that transfers heat to the waste, making the waste unrecognizable
Microwave technologies	Steam-based system that uses moist heat and steam generated by microwave energy
Dry-heat treatment	Dry-heat system that heats waste by conduction, natural or forced convection, or thermal radiation
Chemical treatment	Chemical disinfection for treating liquid waste (e.g., blood and body fluids); solid waste should be shredded or mixed before it is chemically disinfected
Burn Technologies	
Incineration	High-temperature, dry oxidation (1,200°C [2,192°F) process that reduces organic and combustible waste to inorganic and incombustible material using combustion, pyrolysis, or gasification
Other Methods	
Encapsulation	Filling containers (e.g., high-density polyethylene or metallic drums) with three-quarters waste and then one-quarter medium substance (e.g., plastic foam, bituminous sand, cement mortar, or clay material) and sealing container to be disposed of in landfill site
Inertization	Mixing of waste (e.g., pharmaceutical and high-metal content ashes) with cement and other substances before disposal to reduce the risk of toxic substances leaching into surface and groundwater
Land disposal	Removal of health care waste materials after minimization or treatment to land sites (e.g., controlled landfills) for final disposal
Municipal and other external disposal sites	Landfill or waste site operated in a controlled manner for municipal waste, whether treated or untreated waste, based on municipal guidelines

Adapted from: WHO 2014.

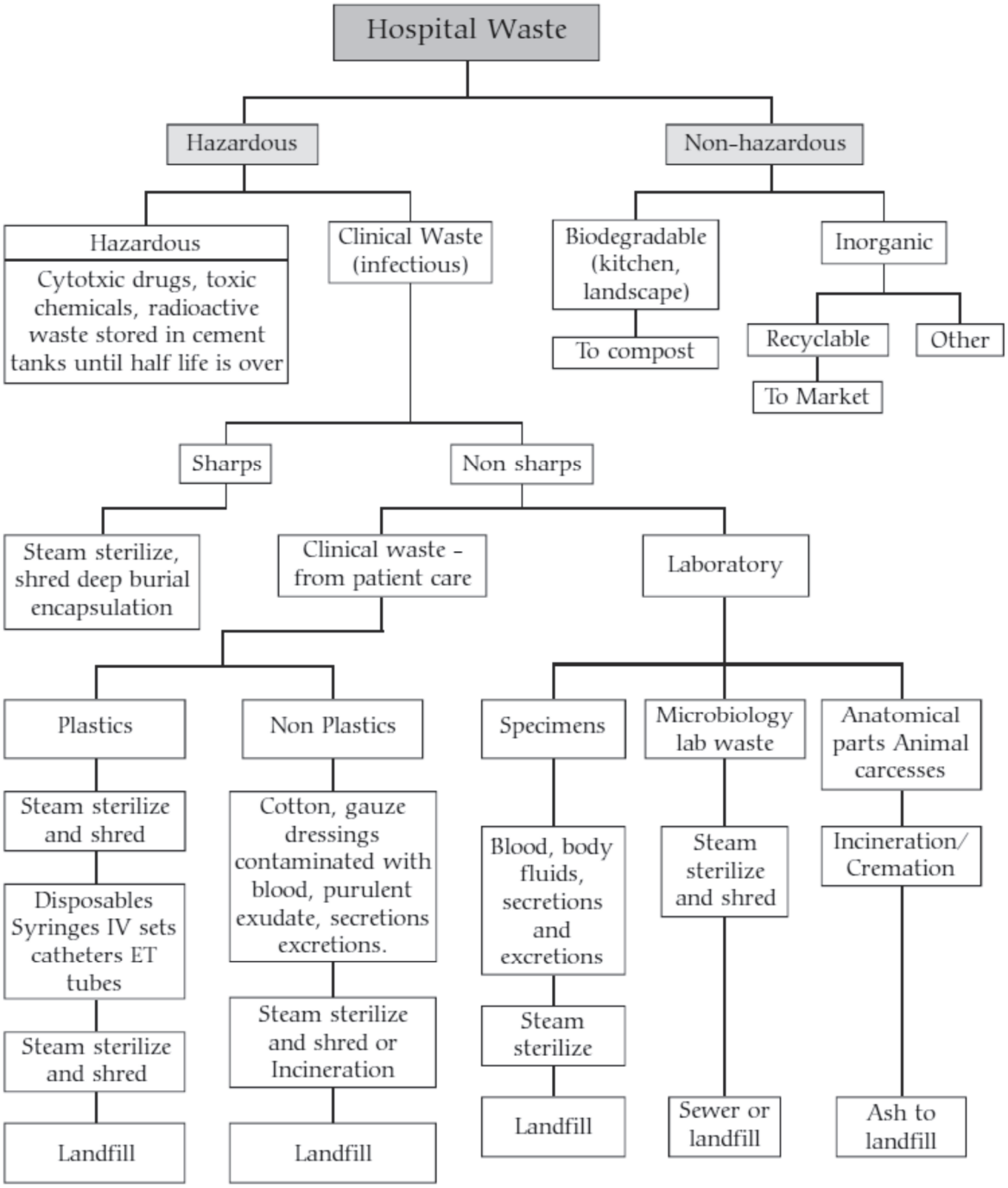
The following waste treatment methods are not recommended and should be avoided:

- Open piles of waste, because they:
  - Are a risk to those who scavenge and unknowingly reuse contaminated items
  - Allow persons to accidentally step on sharp items and injure themselves
  - Produce foul odors
  - Attract insects and animals
  - Can scatter in the wind and rain

- Open burning, because:
  - It is dangerous.
  - Temperatures reached are not adequate to treat health care waste.
  - It is unsightly.
  - The smoke is a pollutant.
  - The wind can scatter the waste.

Specific steps are required for disposing of different categories of waste. Infectious and hazardous waste should be treated prior to final disposal. Figure 5-2 shows the acceptable methods of waste disposal. See Appendix 5-A. Methods of Waste Disposal for Low-Resource Settings for details.

Figure 5-2. Practical Classification of Hospital Wastes and Methods of Disposal



Source: WHO. *Practical Guidelines for Infection Control for Health Care Facilities*, page 25. URL: http://www.wpro.who.int/publications/docs/practical_guidelines_infection_control.pdf. WHO/South East Asia Regional Office 2004. All rights reserved.

Disposal of solid infectious waste

Solid infectious waste consist of those items defined in national guidelines. Items such as surgical specimens and those soaked with blood or body fluids are included. The method of disposed for these

items depend upon the type of material from which they are constructed. See the sections on incineration, autoclaving, or burying in Appendix 5-A, Methods of Waste Disposal for Low-Resource Settings.

Disposable sharps

Sharps (e.g., hypodermic needles, suture needles, razors, and scalpel blades—see national guidelines for specific items) require special handling because they are the items most likely to injure the HCWs who use them as well as people in the community if these items go to the municipal landfill without proper treatment methods.

Treatment and disposal methods for sharps include:

- By autoclave, followed by shredding (mechanical), and then disposal in a landfill or sharps pit
- By incineration (sharp objects may not be completely destroyed by incineration, but it does make them less likely to be reused or repurposed and less risky to handle) and disposal in an ash pit
- By shredding (mechanical) and disposal in a sharps pit (there is a risk of exposure to staff handling non-decontaminated sharps)
- If other treatment options are not available, small quantities of sharps waste can be encapsulated and disposed of in a landfill.

Disposal of liquid infectious waste

Liquid infectious waste includes liquid culture media, blood, body fluids, and human excreta. Products that can be added to liquid waste to solidify it for safer handling may be available.

Steps for proper handling of liquid infectious waste in volumes greater than 20 mL:

STEP 1: Put on PPE (utility gloves, face protection, long-sleeved, fluid-resistant gown, and plastic apron, protective shoes) (see Module 3, Chapter 1, Personal Protective Equipment) when handling liquid wastes.

STEP 2: Determine if wastes require pre-treatment before disposal. Blood and other infectious agents from laboratory work should be sterilized by steam sterilization at the earliest stage (i.e., inside the health care facility) prior to disposal, if possible (see the Recommended Waste Treatment Methods section in this chapter).

STEP 3: Carefully pour liquid wastes down a utility sink drain or into a flushable toilet and thoroughly rinse with water to remove residual wastes. Clean and disinfect the surfaces (e.g., toilet or sink) to remove residual wastes using 1.0% chlorine solution, and **avoid splashing the chlorine solution**. If a sewerage system does not exist, dispose of liquids using incineration or burial and not into open drains.

STEP 4: Wash the container that held the waste with detergent and water, disinfect using intermediate- or low-level disinfectant, and dry completely before storing and using. (See Chapter 2, Environmental Cleaning, in this module and Module 8, Chapter 1, Clinical Laboratory Biosafety.)

STEP 5: Remove PPE.

STEP 6: Perform hand hygiene.

(WHO 2014)

Disposal of liquid waste from highly infectious diseases

During outbreaks of cholera and viral hemorrhagic fever such as Ebola Virus Disease, health care facility sewage must be treated and disinfected. *Vibrio cholerae,* the causative agent of cholera, and Ebola virus are easily killed and do not require use of strong disinfectants. Chlorine solutions are not effective in disinfecting liquids with high organic content, such as blood and stool. Therefore, in situations such as a cholera and outbreaks of viral hemorrhagic fever, feces and vomit should be mixed with lime milk (calcium oxide) dry powder in a ratio of 1:2 for a minimum of 6 hours of contact before disposing. Urine can be mixed with a 1:1 ratio with 2 hours of minimum contact before disposing. (WHO 2014)

Disposal of pathological waste

Pathological waste consists of tissues, organs, body parts, placentas, blood, body fluids, and other waste from surgery and autopsy. It also includes human fetuses. It is sometimes referred to as anatomical waste. Containers with pathological waste should be appropriately labeled using recommended labeling for infectious waste.

Traditional options for disposal of pathological wastes:

- Burying in cemeteries or special burial sites
- Burning in crematoria or specially designed incinerators
- Placenta pit

Steps for using a placenta pit

Construct a placenta pit and dispose of placentas in the pit (see Figure A-4 in Appendix 5-A. Methods of Waste Disposal for Low-Resource Settings for details.)

- Open the cover of the pit and dispose of placentas and other organic waste into the pit as soon as possible without adding any disinfection to allow appropriate biodegradation to kill microorganisms and other cells.
- Keep the opening of the pit covered with a heavy lid or a concrete slab.
- Close the pit once it is filled up to 0.5 meter below the underneath slab. Keep it closed for 2 years.

The contents of the pit can be safely removed and disposed of in a sanitary landfill and the pit can be used again.

If a placenta pit is not available, for example, in areas with high water table, the option is to incinerate or bury the pathological waste in a burial pit. Never leave pathological waste out in the open.

Other Hazardous Wastes

Chemical waste

Chemical waste includes residues of chemicals in their packaging, outdated or decomposed chemicals, or chemicals that are no longer required. Small quantities of chemical waste are generally collected in containers with infectious waste and can be incinerated, encapsulated, or buried. Large quantities of chemical waste should not be collected with infectious waste. Since there is no safe and inexpensive method for the disposal of chemical waste, the following options are recommended:

Note: Different types of chemical waste should never be mixed. Chemical waste should not be disposed of in a sewer system.

- Return the chemical waste to the original supplier. This is the best option for the disposal of specific chemical waste.
- Incinerate at a high temperature.

Because these chemical waste disposal methods can be expensive and may be impractical, it is important to keep chemical waste to a minimum. (See the Reduction of Health Care Waste section in this chapter.)

Chemical containers

For plastic containers that held toxic substances such as glutaraldehyde (e.g., Cidex) or formaldehyde, rinse three times (dispose of rinse water as chemical waste) with water and dispose of by burning, encapsulating, or burying. Do not reuse these containers for other purposes.

Wear proper PPE to protect eyes and skin from splashes and rinse glass containers thoroughly with water. Glass containers may be washed with soap, rinsed, and reused.

Pharmaceutical waste

Small quantities of non-hazardous pharmaceutical (drugs or medicines) waste are usually incinerated, encapsulated, or safely buried. Examples of non-hazardous pharmaceutical waste include vitamins, salts and amino acids (ampoules and fluids), solid or semi-solid tablets, granules, powders, creams, gels, lotions and suppositories, and aerosols (e.g., sprays and inhalers). All controlled substances, cytotoxic/genotoxic drugs, anti-infective/antibiotic drugs, and disinfectants and antiseptics are considered hazardous waste (WHO 2014). It should be noted that temperatures reached in a single-chamber drum or brick incinerator may be insufficient to totally destroy pharmaceuticals and therefore they can remain hazardous.

Options for disposal of small quantities of pharmaceutical waste, such as outdated drugs (except cytotoxic drugs and antibiotics), include the following:

- Return of expired pharmaceuticals to the donor or manufacturer
- Encapsulation and burial in a sanitary landfill
- Chemical decomposition as per manufacturers' recommendations

For moderate quantities of relatively mild liquid (e.g., vitamin solutions, cough syrups, intravenous solutions, eye drops)—dilute in large amounts of water and discharge into a sewer. Antibiotics or cytotoxic drugs should not be discharged into municipal sewers or watercourses.

Large quantities of pharmaceutical waste may be disposed of by the following methods:

- Water-soluble, relatively mild pharmaceutical mixtures (e.g., vitamin solutions, cough syrups, intravenous solutions, eye drops) may be diluted in large amounts of water and then discharged into sanitation systems.
- Pharmaceutical waste can be returned to the original supplier if possible.
- Cytotoxic drugs and antibiotics may be incinerated; the residues (i.e., what is left over after the wastes have been incinerated) can go into a landfill. An incinerator that is capable of reaching a combustion temperature of at least 1,200°C (2,192°F) should be used. Temperatures below 1,200°C may release cytotoxic vapors.

- Residues from cytotoxic drugs or other cytotoxic waste should never be mixed with other pharmaceutical waste.
- Cytotoxic waste should never be discharged into natural water sources (rivers, lakes, etc.) or landfills.
- If the above options are not available, cytotoxic substances may be encapsulated.

Waste with a high content of heavy metals

Examples of wastes with heavy metal content include batteries that contain cadmium, thermometers, and blood pressure machines containing mercury. Mercury is a potent neurotoxin, especially during fetal and infant development. When released into water or air, mercury will enter the environment and contaminate lakes, rivers, and streams. To minimize the risk of mercury pollution, mercury-containing products (e.g., thermometers and blood pressure equipment) should be replaced with those that do not contain mercury.

Note: Do **not** touch mercury droplets with your hands unless wearing non-sterile or utility gloves.

Waste with high content of heavy metals should not be incinerated because of the toxic metallic vapors released in the air nor should it be buried without encapsulation (i.e., placed in a closed, tight container) because it may pollute groundwater. Usually, health care facilities have small amounts of this type of waste. Disposal options include:

- Recycling—the best disposal solution, if available.
- Encapsulation, if recycling is not feasible—encapsulated waste may be disposed of in a landfill.

Steps for disposal of mercury:

STEP 1: Put non-sterile gloves on both hands.

STEP 2: Collect all droplets of mercury with a spoon.

STEP 3: Place mercury in a small, plastic container with a tight-fitting lid and send it to the manufacturer. If this is not possible, encapsulate mercury before final disposal in a landfill.

The procedure for final disposal of mercury is very complex and requires expertise. Stabilization of mercury into an insoluble substance and use of an encapsulation approach are currently being recommended for disposal of mercury.

See Appendix 5-A, Methods of Waste Disposal for Low-Resource Settings for details.

Non-recyclable aerosol containers

Pressurized containers should never be burned or incinerated because of the risk of explosion. Before aerosol containers are buried, any residual pressure should be released.

In summary, avoid buying or using chemical products that create difficult or expensive disposal challenges, whenever possible. The ability of the health care facility to safely dispose of the product after it is finished should be one of the considerations during product selection.

Summary

Health care waste is potentially hazardous. Health care facilities are responsible for managing the waste they produce and appropriate management requires collective efforts of various HCWs. However, waste management is complex and managing waste is challenging for facilities in limited-resource settings. Guidelines for disposal of waste from health care facilities set out by WHO in 2014 may not be immediately attainable by many facilities. Waste minimization to limit the volume of hazardous waste produced and waste segregation to minimize the proportion of the total waste that is infectious or hazardous are key waste management measures in all settings. Choosing the best available waste disposal method and working towards safer waste disposal to protect the community and the environment is essential. Effective waste management will save resources, reduce costs, and prevent injuries and exposure to infectious disease.

Appendix 5-A. Methods of Waste Disposal for Low-Resource Settings

Autoclaves

Autoclaves use low-heat, high-pressure steam to treat infectious wastes. They can treat a wide range of health care wastes and consist of a metal vessel designed to withstand high pressures, with a sealed door and pipes and valves through which steam is brought in and removed (see Figure A-1). Removal of air from the vessel is essential to ensure penetration of steam into the waste. Since they must withstand repeated buildup and release of steam pressures, their construction materials, engineering design, fabrication, accuracy of pressure and temperature sensors, and testing must meet requirements to operate safely.

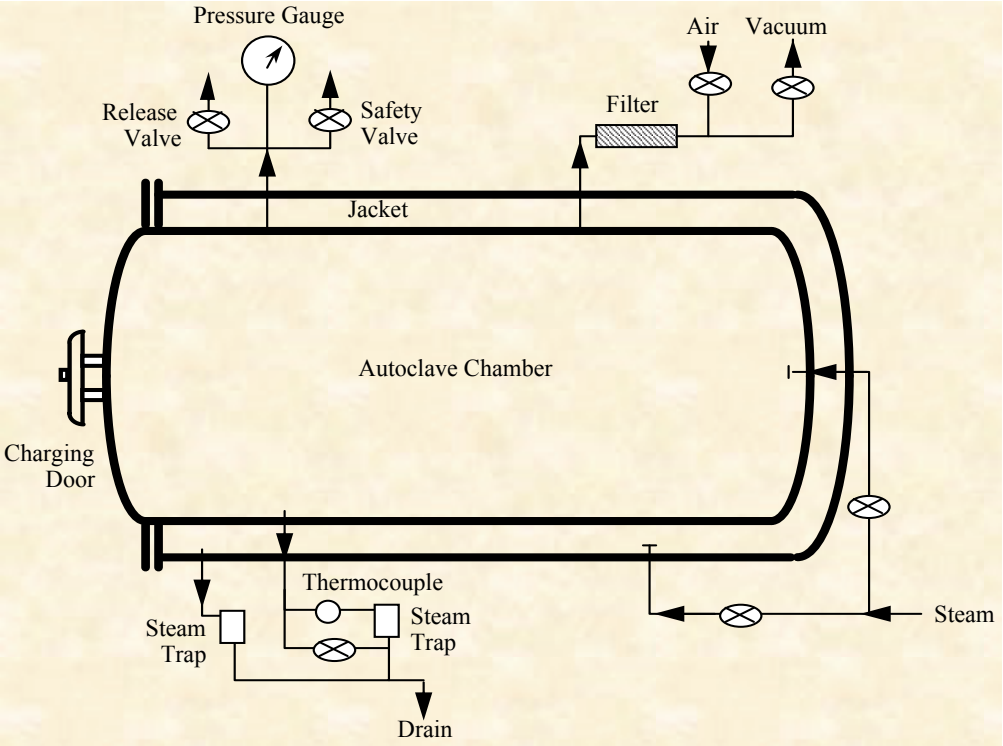
Autoclaves generate significantly fewer air pollutants than incinerators and other high-heat thermal processes. However, waste must be properly segregated to prevent hazardous chemicals from being autoclaved. Poorly segregated waste may emit low levels of alcohols, phenols, formaldehyde, and other organic compounds in the air and pose health risks to the autoclave operators and waste workers. Volatile and semi-volatile organic compounds, cytotoxic waste, mercury, other hazardous chemical waste, and radioactive waste should not be treated in an autoclave. Odors can also be a problem if ventilation is insufficient. The air that is removed must be treated to prevent the release of pathogenic aerosols; this is usually done with a high-efficiency particulate air (HEPA) filter or steam.

Treated waste from an autoclave will retain its physical appearance; shredders (though prone to breakdowns) may reduce the volume 60–80%. Glass, plastic, and metal waste can be recycled after it is sterilized.

The three common types of autoclaves are:

- Gravity-displacement autoclaves
- Pre-vacuum or high-vacuum autoclaves
- Pressure pulse autoclaves

Figure A-1. Diagram of an Autoclave



Source: United Nations Development Programme (UNDP) Global Environment Facility (GEF) Training: Module 15 Non-Incineration Treatment and Disposal. http://www.gefmedwaste.org/trainings-overview.

Incineration of Waste

Incinerators can range from extremely sophisticated, high-temperature models to very basic units that operate at much lower temperatures. Properly maintained and operated incinerators eliminate microorganisms from waste and reduce the waste completely to ashes. When selecting an incinerator, first analyze the needs of the health care facility and municipal or regional disposal requirements. Factors to consider include infrastructure of the area, local resources to support construction and operation, cost estimates, and environmental policies. (PATH 2010)

This section focuses on the selection, operation, and management of small-scale incinerators.

Design and types of incinerators

When performed properly, incineration is efficient and affordable. Important factors in an incinerator design with regard to oxygen supplies are:

- Air inlets must be the right size and in the correct location to allow for a good mixture of air (oxygen) with the waste gases.
- The chimney diameter and length (minimum of 4 meters [13.1 feet]) must be carefully designed (not too short and not too long) to control the air draft.
- The incinerator should be located away from objects such as buildings and trees.
- Ashes and other residues that build up and block the free passage of air (oxygen) must be removed routinely. (PATH 2010)

There are four basic types of incinerators that are commonly used for treating waste:

1. Double-chamber, high-temperature incinerators designed to burn infectious waste
2. Single-chamber, high-temperature incinerators that are less expensive and are used when double-chamber incinerators are not affordable
3. Rotary kilns that operate at high temperatures and are used for destroying toxic, organic constituents of hazardous waste and heat-resistant chemicals
4. Drum or brick (clay) incinerators that operate at lower temperatures and are less effective but can be made locally out of readily available materials

Note: Incinerators that meet specifications and are properly maintained and operated eliminate microorganisms from waste and reduce the waste to ash.

Precautions

If resources are limited, the following precautions should be taken when considering incineration:

- Provide an effective system for waste reduction and segregation (separate by type of waste).
- Use an engineer-designed incinerator with sufficient residence time and temperatures to minimize incomplete combustion of products and premature failures.
- Place incinerators away from health care buildings, residential areas, or where food is grown.
- Describe methods of operation clearly to achieve the desired combustion conditions and emissions.
- Plan periodic maintenance to replace or repair defective components.

(WHO 2014)

Certain chemicals and waste products are highly combustible and should not be incinerated (see Box A-1).

Box A-1. Types of Wastes That Should Not Be Incinerated

- Plastics at low temperatures
- Large amounts of reactive chemical waste
- Pressurized gas containers (e.g., aerosol cans)
- Silver salts and photographic or radiographic wastes
- Plastics containing polyvinyl chloride (e.g., blood bags, IV tubing, or disposable syringes)
- Waste with high mercury or cadmium content (e.g., broken thermometers, used batteries, and lead-lined wooden panels)
- Radioactive materials
- Pharmaceuticals thermally stable in conditions below 1,200°C (2,192°F) (e.g., 5-fluorouracil)

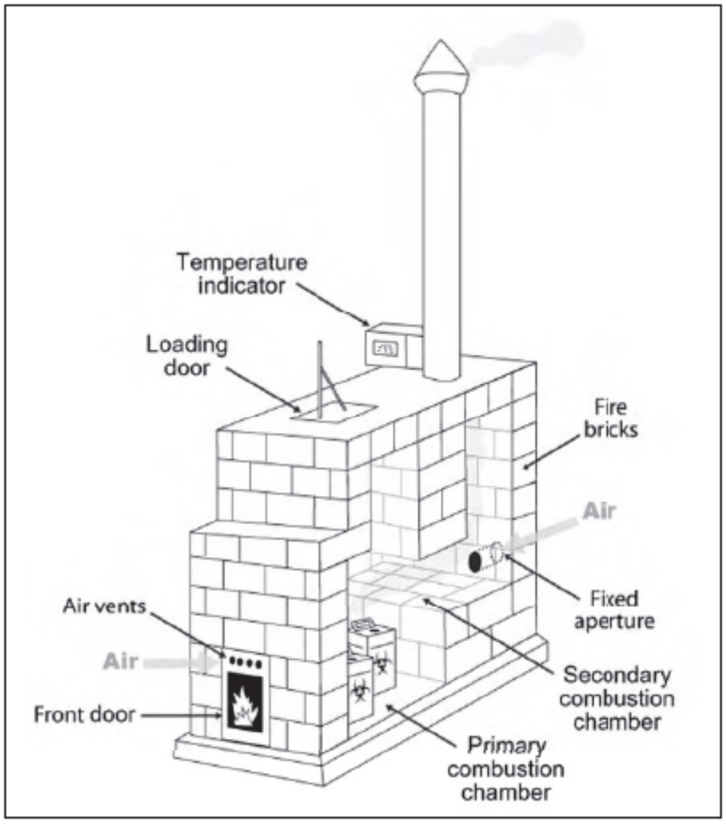
Source: WHO 2014.

Small-scale incinerator for waste disposals

Ideally, a small-scale incinerator[3] (see Figure A-2) should have the following characteristics:

- Has a minimum of two chambers
- Operates within a temperature range of 650–1,000°C (1,202–1,832°F)
- Has a minimum of 1-second smoke-residence time (i.e., amount of time that the gases take to travel through the incinerator)
- Is corrosion-resistant

Figure A-2. Standard Components of a Small-Scale Incinerator



Source: PATH 2010.

Encapsulation of Waste

Encapsulation is the process of mixing waste with cement or other substances before disposal. This process is used to reduce the risk of injury to people, reduce access to scavengers, and minimize the risk of toxic waste migrating into surface water or groundwater. Encapsulation is primarily designed for safe disposal of sharps but can also be used for disposal of solid residues from wastewater treatment, incinerator ash, or small quantities of heavy metals (e.g., mercury), chemicals, and cytotoxic pharmaceuticals when they cannot be returned to the manufacturer. Hard plastic boxes or metallic drums can be filled to three-quarters full and then topped with wet cement or clay. After hardening, the containers can be sealed and disposed of safely in a landfill. For waste containing small quantities of heavy metal, create a mixture of 65% waste material, 15% lime, 15% cement, and 5% water. This mixture is then

[3] Small-scale refers to incinerators with a capacity to destroy approximately 12 to 100 kilograms (26 to 212 lbs.) of waste per hour. (PATH 2010)

poured into a container (e.g., plastic or metal) and allowed to settle. Once it has completely dried, the container can be disposed of in a landfill. (WHO 2014)

Burying of Waste in Sanitary Landfills

In health care facilities with limited resources, short-term safe burial of wastes on or near the facility may be the only option available for waste disposal. Safe onsite burial is practical for only limited periods of time (1–2 years) and for relatively small quantities of waste. Burial can be used as a method of waste disposal only where the water table is more than 4 meters (13.1 feet) below the surface. During this interval, the health care facility should continue to look for better, permanent methods for waste disposal.

Note: Large quantities (over 1 kg [2.2 pounds]) of chemical (liquid) wastes should not be buried at the same time and burning of chemical waste should be spread over several days.

Limit health risks and environmental pollution from burying health care wastes by:

- Restricting access to the disposal site—build a fence around the site to keep animals and children away
- Lining the burial site with a material of low permeability (e.g., clay), if available
- Selecting a site at least 50 meters (164 feet) away from any water source to prevent contamination of the water table

The site should:

- Have proper drainage
- Be located downhill from any wells
- Be free of standing water
- Not be in an area prone to flooding

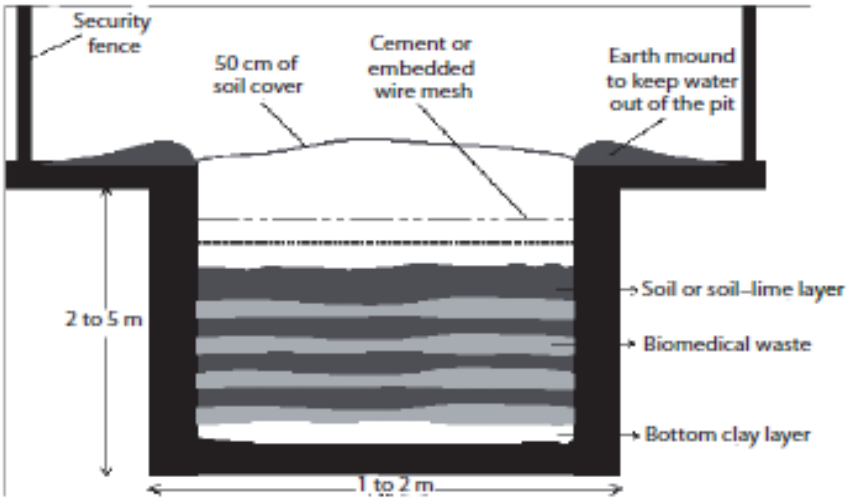
How to Make and Use a Small Burial Site for Waste Disposal

STEP 1: Find an appropriate location.

STEP 2: Dig a pit 1 meter (3.2 feet) square and 2 meters (6.5 feet) deep. The bottom of the pit should be 2 meters (6.5 feet) above the water table. Line the pit with clay or other low-permeable material.

STEP 3: Dispose of the infectious waste in the pit and cover the waste with 10–15 cm (4–6 inches) of dirt each day. The final layer of dirt should be 50–60 cm (20–24 inches) and compacted to prevent odors and attraction of insects, and to keep animals from digging up the buried waste. Depending on the volume of waste, this pit should last 30 to 60 days (see Figure A-3). (WHO 2014)

Figure A-3. Plan for a Small Burial Pit



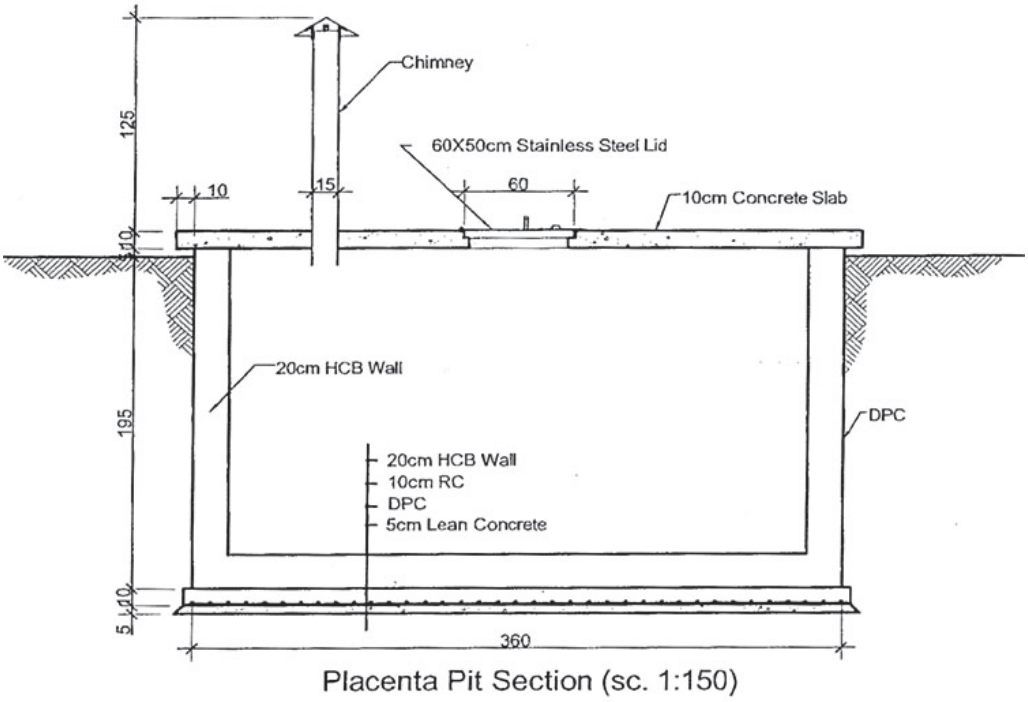
Source: WHO. 2014. Safe Management of Wastes from Health-Care Activities, 2nd ed. P 230. Geneva, Switzerland: WHO. http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1. All rights reserved.

Placenta Pit

In many cultures, burying placentas is an important custom. In low-resource settings, a placenta pit is an effective option for safe disposal. The site for a placenta pit should minimize public accessibility and the size will depend upon the number of daily childbirths in a facility. On average, one placenta and associated fluids require 5 liters (1.5 gallons) of pit capacity. Natural degradation and draining of liquid into the subsoil greatly reduce the volume of waste in the pit and facilitate the inactivation of pathogens. Small quantities of anatomical waste (e.g., body parts) may also be disposed of in placenta pits, if other treatment options are not available or if sociocultural or religious norms prohibit other forms of treatment.

The pit should be designed to prevent contents from contaminating the groundwater (see Figure A-4). The bottom of the pit should be at least 1.5 meters (5 feet) above the level of the groundwater. Placenta pits are not recommended in sites where the water table is near the surface or in flood-prone areas. (WHO 2014)

Figure A-4. Placenta Pit Plan



Source: WHO. Health Care Waste Management. Technology: Burial pit for organic waste. https://www.healthcare-waste.org/resources/technologies/

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