INDIRA GANDHI INSTITUTE OF MEDICAL SCIENCES

SHEIKHPURA, PATNA – 800 014 (Bihar, India

STANDARD OPERATING PROCEDURE

FOR HOSPITAL INFECTION CONTROL

Compiled & Documented By	**Dr P K Sinha** **Dean Research & Medical Superintendent, IGIMS, Patna**
Approved By	**Dr N R Biswas, Director, IGIMS**

Hospital Hygiene and Infection Control

Objective

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

Epidemiology of Nosocomial Infections

- Nosocomial infections known also as hospital-acquired infections, hospital-associated infections, and hospital infections are infections that are not present in the patient at the time of admission to hospital but develop during the course of the stay in hospital. There are two forms:

- Endogenous infection, self-infection, or auto-infection. The causative
  agent of the infection is present in the patient at the time of admission to hospital but there are no signs of infection. The infection develops during the stay in hospital as a result of the patients altered resistance.

- Cross-contamination followed by cross-infection. During the stay in hospital the patient comes into contact with new infective agents, becomes contaminated, and subsequently develops an infection.

While there is no clinically significant difference between the endogenous self-infection and the exogenous cross-infection, the distinction is important from the standpoint of epidemiology and prevention.

Healthy people are naturally contaminated. Faeces contain about 1013 bacteria per gram, and the number of microorganisms on skin varies between 100 and 10000 per cm2. Many species of microorganisms live on mucous membranes where they form a normal ßora. None of these tissues, however, is infected. Microorganisms that penetrate the skin or the mucous membrane barrier reach subcutaneous tissue, muscles, bones, and body cavities (e.g. peritoneal cavity, pleural cavity, bladder), which are normally sterile (i.e. contain no detectable organisms). If a
general or local reaction to this contamination develops, with clinical symptoms, there is an infection.

The transition from contamination to infection

Whether or not a tissue will develop an infection after contamination depends upon the interaction between the contaminating organisms and the host.

Healthy individuals have a normal general resistance to infection. Patients with underlying disease, newborn babies, and the elderly have less resistance and will probably develop an infection after contamination. Health-care workers are thus less likely to become infected than patients.

Local resistance of the tissue to infection also plays an important role: the skin and the mucous membranes act as barriers in contact with the environment. Infection may follow when these barriers are breached. Local resistance may also be overcome by the long-term presence of an irritant, such as a cannula or catheter; the likelihood of infection increases daily in a patient with an indwelling catheter.

The most important determinants of infection, however, are the nature and number of the contaminating organisms. Microorganisms range from the completely innocuous to the extremely pathogenic: the former will never cause an infection, even in immune compromised individuals, while the latter will cause an infection in any case of contamination.

When only a few organisms are present on or in a tissue, an infection will not necessarily develop. However, when a critical number is exceeded, it is very likely that the tissue will become infected. For every type of microorganism, the minimal infective dose can be determined; this is the lowest number of bacteria, viruses, or fungi that cause the Þrst clinical signs of infection in a healthy individual. For most causative agents of nosocomial infections, the minimal infective dose is relatively high. For Klebsiella and Serratia spp. and other Enterobacteriaceae, for example, it is more than 100 000, but for hepatitis B virus it is less than 10.

The sources of infection

In a health-care facility, the sources of infection, and of the preceding contamination, may be the personnel, the patients, or the inanimate environment.
The hospital environment can be contaminated with pathogens. Salmonella or Shigella spp., Escherichia coli O157:H7, or other pathogens may be present in the food and cause an outbreak of disease just as they can in a community outside the hospital. If the water distribution system breaks down, waterborne infections may develop. In more sophisticated premises the water cooling system of air conditioning equipment may become contaminated with Legionella pneumophilia, causing Legionnaires Õ disease in susceptible patients. Pharmaceuticals may become contaminated during production or preparation; an outbreak of infection with, for example, Pseudomonas aeruginosa, Burkholderia cepacia, or Serratia marcescens, may occur as a consequence. In all these examples, it may be possible to isolate the same causative agent in several patients, which would suggest a common source. All possible measures should be taken to prevent the recurrence of such incidents. The source of an outbreak of nosocomial infection may also be a health worker who is infected or colonized (a carrier). The symptoms of frank infection will make the potential of transmission apparent to the health worker and/or to managerial staff, and infected personnel are usually dismissed from patient care duties. A symptomless carrier, however, is contaminated or colonized by potentially pathogenic organisms but does not develop any infection. A typical example is Staphylococcus aureus, which may be carried in the nasal passages of 30Ð60% of personnel. Faecal carriage of enteropathogens such as Salmonella spp. also occurs frequently, but the prevalence varies according to the region. Other conventional pathogens that can be found in symptomless carriers include Streptococcus pyogenes, Corynebacterium diphtheriae, Neisseria meningitidis, hepatitis B virus, and cytomegalovirus. Contamination of patients by carriers can give rise to an outbreak of disease. Careful investigation and isolation of the same organisms from a cluster of patients should reveal the cause of the outbreak.

Classification of pathogenic germs

Conventional pathogens

Cause disease in healthy individuals in the absence of specific immunity.
Examples:
Staphylococcus aureus, Streptococcus pyogenes, Salmonella spp., Shigella spp., Corynebacterium diphtheriae, Mycobacterium tuberculosis, Bordetella pertussis, hepatitis A and B viruses, rubella virus, rotaviruses, human immunodeficiency virus (HIV).

Conditional pathogens

Cause disease, other than trivial local infections, only in persons with reduced resistance to infection (including newborn infants) or when implanted directly into tissue or a normally sterile body area.
Examples:
Streptococcus agalactiae, Enterococcus spp., Clostridium tetani, Escherichia coli, Klebsiella spp., Serratia marcescens, Acinetobacter baumanii, Pseudomonas aeruginosa, Candida spp.

Opportunistic pathogens

Cause generalized disease, but only in patients with profoundly diminished resistance to infection.
Examples:
atypical mycobacteria, Nocardia asteroides, Pneumocystis carinii.

Source: Parker (1978).

The source of most hospital epidemics is infected patients, i.e. patients contaminated with pathogenic microorganisms. These microorganisms are often released into the environment in very high numbers, exceeding the minimal infective dose, and contaminate other patients who subsequently develop hospital-acquired infections.

The routes of transmission

Microorganisms can be transmitted from their source to a new host through direct or indirect contact, in the air, or by vectors. Vector-borne transmission is typical of countries in which insects,arthropods, and other parasites are widespread. These become contaminated by contact with excreta or secretions from an infected patient and transmit the infective organisms mechanically to other patients. Airborne transmission occurs only with microorganisms that are dispersed into the air and that are characterized by a low minimal infective dose. Only a few bacteria and viruses are present in expired air, and these are dispersed in large numbers only as a result of sneezing or coughing. Direct contact between patients does not usually occur in health-care facilities, but an infected health-care worker can touch a patient and directly transmit a large number of microorganisms to the new host. The most frequent route of transmission, however, is indirect contact. The infected patient touchesÑand contaminatesÑan object, an instrument, or a surface. Subsequent contact between that item and another patient is likely to contaminate the second individual who may then develop an infection. During general care and/or medical treatment, the hands of health-care workers often come into close contact with patients. The hands of the clinical personnel are thus the most frequent vehicles for nosocomial

infections. Transmission by this route is much more common than vectorborne or airborne transmission or other forms of direct or indirect contact.

The prevention of Nosocomial infection

Principles

Two basic principles govern the main measures that should be taken in order to prevent the spread of nosocomial infections in health-care facilities:

- Separate the infection source from the rest of the hospital;
- Cut off any route of transmission.

The separation of the source has to be interpreted in a broad sense. It includes not only the isolation of infected patients but also all Òaseptic techniques on the measures that are intended to act as a barrier between infected or potentially contaminated tissue and the environment, including other patients and personnel. In recent years, increasing attention has been paid to the protection of the personnel, in particular against the transmission of bloodborne infections, e.g. AIDS and viral hepatitis B and C. Preventive measures are known as ÒuniversalÓ or ÒstandardÓ precautions. It is impossible to avoid all contact with infected tissue or potentially contaminated body ßuids, excreta, and secretions. Even when they are not touched with the bare hands, they may come in contact with instruments, containers, linen, etc. All objects that come in contact with patients should be considered as potentially contaminated. If an object is disposable, it should be discarded as waste. If it is reusable, transmission of infective agents must be prevented by cleaning, disinfection, or sterilization. Despite the continuing concern of hospital managers and all attempts at improvement, many health-care establishments are unable to achieve adequate levels of prevention, particularly in developing countries. An international survey of the prevalence of hospital-acquired infections was conducted in 14 countries in different regions of the world between 1983 and 1985. The results of this survey, which covered 47 hospitals of size ranging from 227 to 1502 beds (mean 614) showed a wide range of nosocomial infections, with prevalence varying from 3% to 21% (mean 8.4%) in individual hospitals. This work emphasizes the importance of the public health problem.

Isolation of infected patients and standard precautions

The first essential measure in preventing the spread of nosocomial infections is isolation of infected patients. The term isolation covers a broad domain of measures. The strictest form of isolation is applied in case of very infectious diseases (e.g. haemorrhagic fever, diphtheria); less stringent precautions can be taken in case of diseases such as tuberculosis, other respiratory infections, and infectious diarrhoea. Isolation of any degree is expensive, labour-intensive, and usually inconvenient or uncomfortable for both patients and health-care personnel; its implementation should therefore be adapted to the severity of the disease and to the causative agent. Disease-specific precautions should include details of all the measures (private room, wearing of masks or gowns, etc.) to be taken in the case of a specific disease caused by a defined organism. The so-called standard precautions, summarized in Box 14.2, essentially
protect health-care workers from bloodborne infections caused by human immunodeficiency virus and hepatitis B and C viruses.

Cleaning

One of the most basic measures for the maintenance of hygiene, and one that is particularly important in the hospital environment, is cleaning. The principal aim of cleaning is to remove visible dirt. It is essentially a mechanical process: the dirt is dissolved by water, diluted until it is no longer visible, and rinsed off. Soaps and detergents act as solubility promoting agents. The microbiological effect of cleaning is also essentially mechanical: bacteria and other microorganisms are suspended in the cleaning fuid and removed from the surface. The efficacy of the cleaning process depends completely on this mechanical action, since neither soap nor detergents possess any antimicrobial activity. Thorough cleaning will remove more than 90% of microorganisms. However, careless and superficial cleaning is much less effective; it is even possible that it has a negative effect, by dispersing the microorganisms over a greater surface and increasing the chance that they may contaminate other objects. Cleaning has therefore to be carried out in a standardized manner or, better, by automated means that will guarantee an adequate level of cleanliness.

Diluting and removing the dirt also removes the breeding-ground or culture medium for bacteria and fungi. Most non-sporulating bacteria and viruses survive only when they are protected by dirt or a film of organic matter; otherwise they dry out and die. Non-sporulating bacteria are unlikely to survive on clean surfaces.

The effectiveness of disinfection and sterilization is increased by prior or simultaneous cleaning.

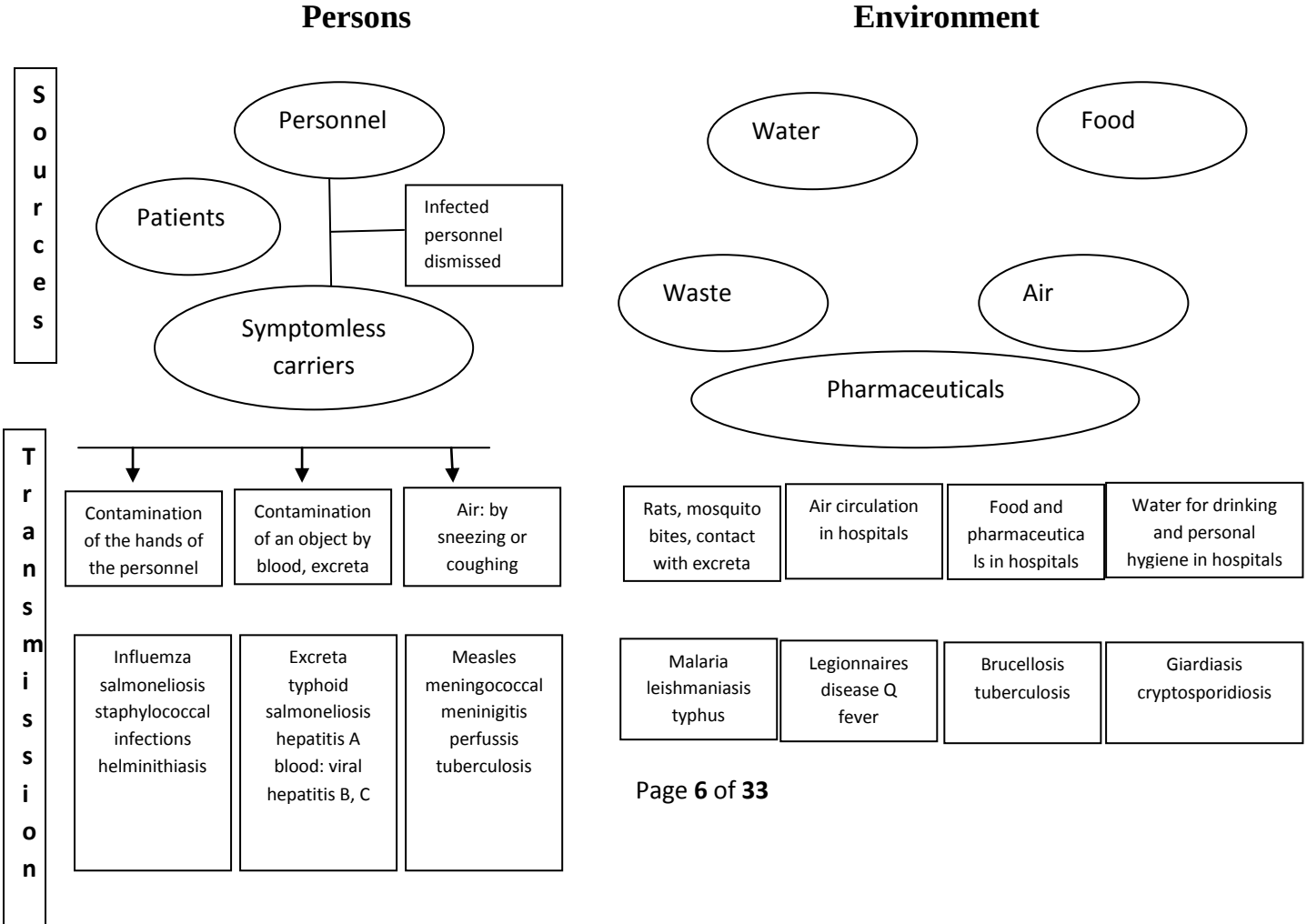
Sterilization

Self-evidently, an object should be sterile, i.e. free of microorganisms, after sterilization. However, sterilization is never absolute; by definition,

Safe management of wastes from health-care activities

The Spread Of Nosocomial Infection

Many of the listed diseases can spread by more than one route. The figure shows only a few of the many diseases that may be transmitted within a hospital setting.



DISPOSAL OF SHARPS AND NEEDLES IN THE PUNCTURE-PROOF CONTAINERS

CENTRAL STERILE SUPPLY DEPARTMENT

Objectives

- Making sterilized articles available in the hospital at the required time and place.
- Ensuring that all items receive the same degree of cleaning and sterilization.
- Ultimately contributing in the reduction of hospital infections which might occur due to usage of contaminated devices.
- Maintaining records of effectiveness of cleaning, disinfection and sterilization processes.

Workflow

The division of the CSSD should be into four areas:

- Decontamination area
- Clean packaging area
- Sterilizer area
- Sterile storage area

Physical barriers should separate the decontamination areas from other areas to contain contamination. A unidirectional work flow should be maintained for optimum functioning.
A manual must be maintained.

Transport and reception of non-sterile items

- Used, dirty goods are to be received in the dirty area of the department.
- Personnel handling contaminated items should wear gloves, gowns and masks.
- Dedicated trolleys (preferably covered) should be used for transportation of articles to the department.
- The items must also be sent from the OR‟s via dedicated elevators, especially designed for this purpose.

Cleaning of devices and items

- In the decontamination area, all reusable contaminated supplies are sorted and decontaminated.
- The CSSD workers in the decontamination area should wear household-cleaning- type rubber or plastic gloves when handling contaminated instruments and items.
- Face mask, eye protection such as eye shields/goggles, appropriate gowns should be worn when exposure to blood or body fluid may occur.
- Sharps should never be retrieved from trays with gloved hands. Forceps may be used for this purpose.
- At least six air changes per hour and a negative pressure is recommended in the decontamination area.
- The ceilings and walls should be constructed of a non-shedding material and the floors should be able to withstand the chemicals and disinfectants used in cleaning.
- Daily cleaning and maintenance of the facility is needed.
- The instruments may be manually cleaned (scrubbed using detergents and appropriate brushes) or cleaned using automated washers or disinfectors.
- All instruments with dried secretions should be first soaked in detergent water to loosen up the debris. Ensure the instrument is free of any debris or proteinacious deposits as this affects the efficiency of the sterilization process.
- After washing, each device should be inspected for cleanliness, functionality, breakage or defects and then appropriately assembled.
- All items should be properly dried after washing should be properly dried and moisture-free as moisture impairs many sterilization processes. Drying may be done manually or using automated dryers.

Assembling and packaging

- Packaging area is used for inspecting, assembling and packaging of clean, non-sterile articles.
- Wrapping of the articles before sterilization should be done in such a manner that tenting and gapping should be avoided.
- Workers should wear gloves, gowns and masks while packing.
- The packaging procedure and material should be validated for the type of sterilization.
- Double wrapping may be done sequentially or non-sequentially.
- Each pack should be marked with the name and contents of the pack, the initials of the person who packed it and the date and initials of the person who carried out the sterilization.

Sterilization

- The sterilizer should be loaded in accordance to the manufacturers‟ recommendations.
- Ensure that all the physical and chemical parameters are checked before and during the sterilization cycle.
- Maintain complete records of each sterilization cycle.
- Following sterilization, all sterile items should be moved aseptically to the sterile area for the storage of items.
- The sterile area should be a limited access area with controlled temperatures 75 F and relative humidity (30-60%).
- A record of the date of sterilization, physical parameters of sterilization cycle and microbiological tests reports should be maintained for each batch.
- All sterile items should be kept in the sterile area till they are supplied to the clinical areas.
- Positive pressure and minimum of ten air changes per hour is recommended in the sterilizer equipment room.

Issuing sterile items

- Clean packaged, sterile goods are sent to the respective clinical areas from the sterile area of the CSSD.
- The personnel delivering the goods should wear caps, gowns, masks and gloves while transporting the items to the clinical areas and should use clean covered dedicated trolleys.
- The trolleys should be clean, covered and preferably lined with a clean cloth.
- The articles can be transported to the OR‟s via dedicated elevators directly into the OR‟s.

Validation and communication

- Procedures being carried out in the CSSD should be continuously validated.
- This should include all activities including wrapping methods, sterilization methods and sterilization conditions (all physical and chemical parameters).
- The in-charge should ensure proper maintenance of all the equipment according to the manufacturer‟s recommendations. Any failure or defect of the physical/chemical/biological indicators should be reported to the administration, maintenance, infection control and other appropriate clinical units or personnel.
- All outdated sterile units should be removed at regular intervals.

STERILIZATION PROCEDURES

Steam under pressure (Autoclaves)

- **Essential parameters:** Steam (dry, saturated), time, temperature and pressure.
- **Time to sterilize:** usual cycles: 121 ^{0}C x 30 minutes, 132 ^{0}C x 4 minutes.

Precautions:

- Follow the manufacturer‟s instructions.
- Arrange items in a way that allows the steam to circulate freely.

- Keep the loads at the sterilizing temperature for the recommended holding time.
- Exercise care during opening (potential for steam injuries).

Uses:

- It is the most efficient and reliable method of sterilization (wide margin of safety).
- Use for sterilization of all critical and semi-critical items that are heat and moisture resistant (surgical instruments, surgical drapes, some respiratory and anesthetic equipments, microbiological waste and sharps).

Monitoring of steam sterilization process:

Residual air detection for vacuum sterilizers (Bowie- Dick test): Test daily.

Procedure:

- A commercially available Bowie- Dick type test sheet should be placed in the centre of the pack.
- The test pack should be placed horizontally in the front, bottom section of sterilizer rack, near the door and over the drain in an otherwise empty chamber and run at 134 ^{0}C x 3.5 minutes.
- Residual air in the chamber will interfere with steam contact (the entrapped air will cause a spot to appear on the test sheet due to inability of steam to reach the chemical indicator).
- If the sterilizer fails the test, do not use until remedied.

a) *Mechanical monitoring*: Each cycle

b) *Chemical monitoring*: Each cycle

c) *Biological monitoring*: *Geobacillus sterothermopilus* spores 10^{5}.

- Use at least weekly (preferably daily) and with each load of implantable devices.
- Loads containing implantable devices should ideally be quarantined until the results of biological indicators are available.

Hot air sterilizer

- **Essential parameters:** Temperature and time

  Precautions:

- Follow the manufacturer‟s instructions.
- Arrange items in such a way that, the hot air circulates freely.
- Keep the load at sterilizing temperature for the recommended holding time
- Exercise care during opening (potential for thermal injuries).
- Take out the sterile items with sterile pick-ups, after they have reached room temperature.

  Uses: Should be used only for heat tolerant materials that may be damaged by/ impermeable to moist heat. Examples: powders, petroleum products, sharp instruments, glass wares.

Time to sterilize: 170 ^{0}C x 60 minutes/ 160 ^{0} C x 120 minutes/ 150 ^{0} C x 150 minutes.

Monitoring of cycle processes:
a) *Mechanical: Each cycle*

b) *Chemical: Each cycle*

c) *Biological monitor*:

- ***B atrophaeus* spores (106): Use at least weekly (preferably daily) and with each load of implantable devices.**
- **Loads containing implantable devices should ideally be quarantined until the results of biological indicators are available.**

Low temperature sterilization

1. Ethylene Oxide (EtO)

Ethylene oxide is gaseous, low temperature sterilant.
Essential parameters: Gas concentration (450-1200 mg/L), temperature (37-63^{0}C), relative humidity (40-80%), vacuum, pressure and exposure time (1-6 hours; aeration requires an additional 8-12 hours).

Precautions

- EtO gas must penetrate the entire load
- Must be handled according to strict guidelines
- Manufacturer‟s instructions must be followed for packaging, sterilizing, validation and aeration.
- Items must undergo aeration to remove residual EtO
- Most occupational exposures to EtO are covered by OSHA standards. OSHA has established a PEL of 1 ppm airborne EtO in work place.
- Ensure regular environmental monitoring, employee information, training and medical examination. Warning signs must be posted near EtO plants. Only authorized persons should enter the area.
- Effectiveness altered by lumen length, lumen diameter, inorganic and organic contamination.

Time to sterilize: 12-24 hours
Uses

- Appropriate for sterilization of heat and moisture labile critical and semi-critical items.
- Sterilization of devices containing electronic components.

Monitoring of process
a. ***Mechanical: Each cycle*** (time, temperature, pressure). The essential components of gas concentration and humidity cannot be monitored.

b. Chemical: Each cycle

c. Biological monitor:

- *B atrophaeus* spores (10^6): Use at least weekly (preferably daily) and with each load of implantable devices. Loads containing implantable devices should ideally be quarantined until the results of biological indicators are available.

2. Hydrogen peroxide (H_2O_2) Gas plasma

Principle

- Gas plasmas are referred to as the fourth state of matter.
- They are generated by exciting a chemical precursor (H_2O_2) under a deep vacuum in an enclosed chamber using radiofrequency/ microwave energy.
- This produces highly reactive and biocidal charged particles, many of which are free radicals.
- The free radicals react and inactivate essential cellular components (enzymes, nucleic acids) of microbes.

Precautions

- Items should be totally dried before loading.
- H_2O_2 may be toxic at levels greater than 1 ppm TWA (time weighted average)

Time to sterilize: 47-75 minutes
Monitoring of procedure:

- ***Physical and Chemical monitoring***: is inbuilt with each cycle (it records the concentration of active ingredients).
- ***Biological monitor:*** Spores of *G stearothermophilus* (read at 48 hours): The system has its own monitor in plastic vials, which should be incorporated at least weekly (preferably daily).

Uses:

- Sterilization of devices which are heat and moisture sensitive (plastic, electronic devices, corrosion sensitive metals).
- Examples: Arthroscope & its instruments, micro instruments, vascular instruments, spine sets, pneumatic drills, dermatomes, micro and mini drill, implants, urethroscope & its instruments, laproscope & its instruments, thorocoscope & its instruments, laprotomy set, nephrectomy set , microvascular instruments, dental implants, craniotomy sets, tracheostomy set, image intensifying cover, retractors, bone nibblers, ophthalmic instruments.

CLEANING , STERILIZATION AND DISINFECTION

Important definitions:

Sterilization is defined as the process where all the living microorganisms, including bacterial spores are killed. Sterilization can be achieved by physical, chemical and physiochemical means.

Disinfection is the process of elimination of most pathogenic microorganisms (excluding bacterial spores) on inanimate objects. Disinfection can be achieved by physical or chemical methods. Chemicals used in disinfection are called disinfectants. Sterilization is an absolute condition while disinfection is not. The two are not synonymous.

Decontamination is the process of removal of contaminating pathogenic microorganisms from the articles by a process of sterilization or disinfection. It is the use of physical or chemical means to remove, inactivate, or destroy living organisms on a surface so that the organisms are no longer infectious.

Sanitization is the process of chemical or mechanical cleansing, applicable in public health systems. Usually used by the food industry. It reduces microbes on eating utensils to safe, acceptable levels for public health.

Asepsis is the employment of techniques (such as usage of gloves, air filters, UV rays etc) to achieve microbe-free environment.

Disinfection and sterilization are essential for ensuring that medical and surgical instruments do not transmit infectious pathogens to patients.

Patient Contact	Examples	Device Classification	Minimum Inactivation Level
Intact skin		Non-Critical	Cleaning and/or Low/Intermediate Level Disinfection
Mucous membranes or non-intact skin		Semi-Critical	High Level Disinfection
Sterile areas of the body, including blood contact		Critical	Sterilization

The approach to disinfection or sterilization is based on the classification which categorizes instruments or items into critical, semi-critical or non critical based on the intended use and the potential for risk of transmission of infection if the instrument was microbiologically contaminated before use. Table below shows the Spaulding‟s classification of medical devices.

Item/Device	**Definition/Intended** Use	**Risk of infection**	**Reprocessing required**	**Example**
Critical	Medical device which is intended to enter a normally sterile tissue or vasculature	High	Sterilization	Cardiac catheter Surgical -instrument Implants Needle
Semi critical	Devices that are intended to come in contact with mucous membrane or non-	High/Intermediate	Sterilization desirable HLD acceptable	Respiratory therapy equipment. Some endoscopes Manometry probes

	intact skin			Diaphragm fitting Rings.
Non critical	Devices that come in contact with intact skin.	Low	Intermediate or LLD	BP cuff, stethoscope

Sterilizing Practices

- Ensuring sterilization depends not only on the effectiveness of the sterilization process but also on the pre-cleaning, disassembling and packaging of the device, loading the sterilizer, monitoring of sterilization, sterilant quality and quantity, assessing the appropriateness of the cycle for the load contents, and other aspects of device reprocessing.
- The cleaning, disinfection and sterilization of medical and surgical equipments should preferably be done at a central processing area by trained personnel.
- Must comply with the manufacturer‟s recommendations. The daily operation of the sterilization must be documented by personnel performing the process.

1. ***Cleaning.***

- All items **MUST** be cleaned using water with detergents or enzymatic cleaners before processing.
- Pre-cleaning in patient-care areas may be needed on items that are heavily soiled with feces, sputum, blood, or other material.

2. ***Packaging***

- Once items are cleaned, dried, and inspected, those requiring sterilization must be wrapped or placed in rigid containers and should be arranged in instrument trays/baskets.
- Surgical items may be kept in rigid containers, peel-open pouches, roll stock or reels and sterilization wraps (woven or nonwoven).
- The packaging material must allow penetration of the sterilant, provide protection against contamination during handling, provide an effective barrier to microbial penetration, and maintain the sterility of the processed item after sterilization.

3. ***Loading***

- All items to be sterilized should be arranged so that all surfaces will be directly exposed to the sterilizing agent.
- Allow for proper sterilant circulation; perforated trays should be placed so that the tray is parallel to the shelf; non-perforated containers should be placed on their edge (e.g., basins); small items should be loosely placed in wire baskets and peel packs should be placed on edge in perforated or mesh bottom racks or baskets.

4. ***Storage***

- Wrapped surgical trays remain sterile for varying periods depending on the type of material used to wrap the trays.
- Safe storage times for sterile packs vary with the porosity of the wrapper and storage conditions (e.g. open versus closed cabinets).
- Items that have been sterilized should not be used after the expiration date or if the sterilized package is wet, torn, or punctured.

Following the sterilization process, medical and surgical devices must be handled using aseptic technique in order to prevent contamination.

- Sterile supplies should be stored far enough from the floor (8 to 10 inches), the ceiling (5 inches unless near a sprinkler head [18 inches from sprinkler head]), and the outside walls (2 inches) to allow for adequate air circulation, ease of cleaning, and compliance with local fire codes.
- Medical and surgical supplies should not be stored under sinks or in other locations where they can become wet.
- Sterile items that become wet are considered contaminated because moisture brings with it microorganisms from the air and surfaces.
- Closed or covered cabinets are ideal but open shelving may be used for storage.
- Any package that has fallen or been dropped on the floor must be inspected for damage to the packaging and contents (if the items are breakable).

5. ***Monitoring***

The sterilization procedure must be regularly monitored to evaluate the sterilizing conditions and microbiologic status of the processed items. Monitoring is done by mechanical, chemical and biological means.

Mechanical indicators: include the daily assessment of cycle time, temperature and pressure (maintain a record/ print-outs of temperature chart and pressure).

Chemical indicators*:*

- Should be used in conjunction with biological indicators, but should not replace them.
- Chemical indicators are affixed on the outside of each pack to show that the package has been processed through a sterilization cycle, but they do not prove that sterilization has been achieved.
- Preferably, a chemical indicator should also be placed on the inside of each pack to verify sterilant penetration.
- Chemical indicators usually are either heat-or chemical-sensitive inks that change color when one or more sterilization parameters (e.g., steam-time, temperature, and/or saturated steam; ETO-time, temperature, relative humidity and/or ETO concentration) are present.
- If the internal and/or external indicator suggests inadequate processing, the item should not be used.

Biological indicators

- These are ideal monitors of sterilization process, because they measure the sterilization process directly by using the most resistant microorganisms (i.e., *Bacillus* spores),
- The manufacturer‟s instructions should be followed for use of all commercially prepared biologic monitoring system.

Apart from routine testing, biological indicators are also required to be used in the following situation: Installation of a new sterilizer, after relocation of an existing sterilizer, after a sterilizer malfunction, after major repairs to a sterilizer that are outside the scope of routine or preventive maintenance and after repairs to the steam generator/delivery system.

- The CDC recommends that "objects, other than implantable objects, do not need to be recalled because of a single positive spore test unless the steam sterilizer or the sterilization procedure is defective." If the mechanical and chemical indicators suggest that the sterilizer was functioning properly, a single positive spore test probably does not indicate sterilizer malfunction but the spore test should be repeated immediately. If the spore tests remain positive, use of the sterilizer should be discontinued until it is serviced. For EtO and H_2O_2 gas plasma, a single positive spore test may be considered significant. All loads should be retrieved for re-processing.
- The details of the biological indicators for sterilization are given below: Biological Indicators of sterilization procedures.

Spore Strain	***Bacillus atrophaeus***	***Geobacillus stearothermophilus***
Monitors	Ethylene oxide, dry heat	Steam, Hydrogen peroxide gas plasma, liquid peracetic acid
Number of spores	10^6 spores	10^6 spores/10^5 spores
Method of use	Place strip in centre of one or more packs of chamber; transfer strips into a recommended broth	Place strip in centre of one or more packs of chamber; transfer strips into a recommended broth.
Incubation	35-37 ^{0} C x 14 days. Examine for turbidity. Incubate an unexposed spore strip simultaneously	55-56^{0}C for upto 14 days anaerobically. Incubate an unexposed strip simultaneously.

Cleaning of hospital surfaces

The frequency of cleaning and disinfecting the environmental surfaces may vary according to the type of patient care area (high risk/ post-operative/ ICUs, OTs), the type of surfaces, the amount of people‟s movement and soiling.

The following protocol may be followed:

- The staff must be properly trained on the practices of cleaning & decontamination of hospital surfaces.
- Appropriate personal prophylactic equipments (PPE; gloves, masks, and boots) must be worn at all times and a proper log of all cleaning procedures must be maintained.
- The house keeping surfaces (floors/ table- tops/ counters) should be cleaned on a regular basis, when visibly soiled and when spills occur.
- Cleaning may be done with detergent and hot water or an EPA registered hospital disinfectant for housekeeping surfaces.
- Use of a low/ intermediate level disinfectant is advocated in specific high risk areas or when there is suspected spills of blood/ body substances/ MDR organisms).
- Do not use disinfectants in offices.
- High level disinfectants must not be used for environmental surfaces in any area of the hospital.
- Prepare fresh detergent/disinfectant solutions every day, according to manufacturer‟s instructions and replace with fresh solution frequently.
- Hospitals may select one EPA- registered disinfectant for all the wards, considering its activity, cost, safety and material compatibility.
- Follow the manufacturer‟s instructions for use of disinfectants, its storage and disposal.
- Diluted disinfectants may become contaminated with resistant pathogen, therefore, avoid application of contaminated cleaning solution from spray bottles/equipments which generate aerosols.
- Discard the remaining solutions after day‟s use and dry the containers.
- The methods of cleaning non- porous floors include vacuum cleaning, wet mopping, dry dusting with electrostatic material and spray buffing.
- Avoid dry mopping with brooms, which generate dust aerosols.
- Ensure thorough physical wiping and scrubbing which is as effective as the use of disinfectant in reducing the bio-burden.
- Wet dust horizontal surfaces daily with a clean cloth moistened with an EPA registered hospital disinfectant (or detergent).
- Minimize contamination of cleaning solution and cleaning tools.
- For wet mopping, use a two bucket system. When a single bucket is used, change the solutions more frequently. Discard used cleaning solutions in the sluice. Clean the buckets with detergent and warm water and store inverted to assist drying.

Worn and damaged cleaning equipment should be replaced. Preferably use disposable mop heads, if cost permits; otherwise, change mop heads after cleaning spills and at the beginning of the day. Decontaminate mop head and cleaning cloths regularly to prevent contamination. This may be done by laundering (heat disinfection) with detergent and drying at $80^{o}C$ for 2 hours daily or immersing the cloth in hypochlorite solution (4000 ppm) for 2 minutes. Alternatively, dust attracting mops (microfiber material) may be used, especially for critical care areas.

- Clean the walls, blinds and window curtains when they are visibly contaminated or soiled. Curtains in the vicinity of a disperser of epidemic MRSA strain may be changed if the area is to be re occupied by a susceptible person within 24 hours.
- Clean and disinfect high touch surfaces more frequently than minimal touch surfaces.

- Appropriate barrier protective coverings may be used for difficult to clean high touch non critical equipment surfaces that are likely to become contaminated with blood or body fluids (e.g. computer key boards).
- Surfaces should be left dry after cleaning.
- Disinfectant fogging is not recommended for routine patient care areas.

MANAGEMENT OF SPILLS OF BLOOD AND BODY SUBSTANCES

All blood and body fluid spills in health set ups must be managed according to the recommendations of OSHA, WHO and CDC.

- All equipment and surfaces contaminated with blood and other potentially infectious material OPIM must be decontaminated with an appropriate disinfectant.
- PPE gloves, face masks, fluid resistant gowns must be used for cleaning blood spills. For large spills, protective shoe covers/ boots must be worn.
- Small spills should be cleaned and disinfected using an intermediate level germicide having a tuberculocidal claim. In 1997, OSHA amended the policy to include, EPA registered disinfectants whose label includes inactivation claims for HBV and HIV provided that such surfaces have not become contaminated with agent s or volumes of or concentration of agents for which a higher level of disinfection is recommended. These agents are tested in EPA‟S list D & E. EPA encourages the use of registered products because the agency reviews them for safety and performance when the product is used according to label instructions. For blood borne pathogens other than HBV or HIV, OSHA recommends the use of EPA registered tuberculocidal disinfectants.
- For decontamination of small spills < 10 ml , if sodium hypochlorite solution is selected, use a 1:100 dilution a 1:100 dilution of 5.25-6.15% sodium hypochlorite provide, 525-615 ppm of available chlorine . If spills involve large amounts eg >10ml of blood or OPIM, or involves a culture spill in the laboratory, a 1:10 dilution of hypochlorite solution for first application before cleaning reduce the risk of infection during cleaning. After the first application, remove the visible organic matter with absorbent material eg disposable paper towels discarded into leak-proof, labeled container , then terminal disinfection with 1:100 sodium hypochlorite may be done.

Sharps containing spillage

Nominate a member of staff to keep the public well clear of the area.

- If possible exclude the public from the area until the hazard has been removed.
- Do not touch any needles or syringes.
- Call a suitably trained member of staff to deal with the spillage.
- Put on strong, protective gloves, overalls, stout shoes, and, if necessary goggles which are located the unit
- Use a pair of tongs or forceps to return the used equipment to a sharps container. These items are located in the unit
- Clear away the equipment as quickly and safely as possible.
- Check the area thoroughly for loose sharps.
- Return sharps container to its storage place.
- Clean the affected area thoroughly with a disinfectant.

- Remove gloves, overalls and shoes and return to their storage place.

Loose sharps

- **NEVER** attempt to re-sheath a needle – this is the most common cause of needle stick injuries.
- If a needle or syringe is left on the counter or accidentally dropped, do not touch it or attempt to move it.
- Keep the public well away from the area.
- The pharmacist or trained member of staff should deal with the needle.
- Put on a pair of strong protective gloves which are located in the unit
- Use a pair of forceps or tongs to place the loose sharps into the sharps container. These items are located in the unit
- Clean the affected area thoroughly with a disinfectant.

Spillage kit

- Biohazard infectious yellow disposable bag
- Disposable single use sterile gloves
- Face mask
- Disposable gown
- Disposable goggles
- Paper towels
- Hypochlorite powder/ Sodium dichloro isocyanurate (Na DCC) granules
- Clean up scoop and scraper
- SPILLAGE SLIDES (2)

Cleaning of special care areas

Housekeeping areas in high risk wards need special attention for routine cleaning.

- Wet dust horizontal surfaces daily with clean cloths moistened with freshly prepared detergent or EPA-registered hospital disinfectant.
- Avoid use of cleaning equipments that produce mist or aerosols or produce dispersion of dust.
- Preferably perform vacuum cleaning.
- Equip vacuums with HEPA filters, especially for the exhaust.
- Ensure regular cleaning and maintenance of equipment to ensure efficient particle removal.
- Keep the doors closed when near -by areas are being cleaned.
- Filters in cleaning equipment/air handling unit should be cleaned and replaced as per the manufacturer‟s recommendation.

Cleaning of bedding, mattresses and pillows

- Keep the mattress and pillow covers dry. Discard them if they become wet, damaged or stained, especially in burns/ other high risk wards.

- Cover the mattress with protective water- proof plastic material, which should be replaced if torn.
- Sheets should be changed at least twice weekly, if soiled, wrinkled, stained or contaminated with potentially infectious material.
- Mattress and pillows with plastic covers should be wiped over with a neutral detergent and dried. Avoid excessive wetting during cleaning. If disinfection is required, use a chlorine releasing agent and rinse well.
- Mattresses without plastic covers should be steam cleaned if they have been contaminated with body fluids. If this is not possible, contamination should be removed by manual washing, ensuring personnel and environmental protection.
- Avoid the practice of sticking needles into mattresses.
- Wash pillows and bed sheets in a hot water laundry cycle.

Disinfection in hemodialysis unit

- The hemodialysis system includes the hemodialysis machine, water supply & treatment system and distribution system.
- Hemodialysis systems usually are disinfected by chlorine based disinfectant, heat pasteurization, ozone, or per acetic acid.
- The non- critical surfaces in hemodialysis systems include the dialysis bed/ chair, counter tops, external surface of dialysis machines and equipments (scissors, hemostats, clamps, BP cuffs, stethoscopes). These should be disinfected with an EPA registered low level disinfectant.

Cleaning of medical equipment

Thorough cleaning, preferably done at the point of use must precede any disinfection or sterilization process. Cleaning alone (physical scrubbing with detergents and surfactants followed by rinsing with water) effectively removes a large number of microorganisms from contaminated equipments and surfaces. For effective cleaning:

- The staff must be properly trained and required to wear PPE appropriate to be task.

- The manufacturers of equipment should provide instructions regarding its cleaning and disinfection, with specific information regarding germicide and water compatibility.

- Utmost care should be taken to prevent drying/baking of soiled material on the surface. Therefore, immediately after use, surgical equipments/soiled devices must be disassembled, rinsed or soaked in water with / without detergent to prevent drying of blood and to facilitate removal of soil and blood.

- Cleaning can be done manually or by automated methods. Manual cleaning is done by scrubbing/rubbing with friction using a brush and employing water under pressure. Care should be taken to remove all visible soil and to reach all channels and bores of the instruments. Items composed of more than one removable part should be disassembled and cleaned.

- The automated methods currently available include ultrasonic cleaners, washer decontaminators, washer disinfectors and washer sterilizers. These equipments must be

used according to the manufacturer's instructions. Special precautions should be taken in loading these automated systems: hinged instruments should be opened fully to allow adequate contact with the detergent solution, stacking of instruments should be avoided and instruments should be disassembled as much as possible.

- Delicate and intricate objects and heat- or moisture-sensitive articles may require careful cleaning by hand.

- Cleaning should be usually done using a detergent or soap and water. A neutral/near neutral pH detergent solution is commonly used because such solutions generally have the best material compatibility and good soil removal. Enzymes (usually proteases) are sometimes added to assist in removing organic material. Enzymatic cleaners must be used in accordance with manufacturer's instructions.

Disinfection of HBV, HCV, HIV or TB contaminated devices

Equipment, devices and surfaces should be managed in the same way regardless of the whether the patient is known to be infected with HBV, HCV, HIV or *M. tuberculosis*. Sterilization or high level disinfection with EPA registered chemicals should be done.

Reprocessing Single-Use or Disposable Items

Items or devices that cannot be cleaned and sterilized or disinfected without altering their physical integrity and function should not be reprocessed. Reprocessing procedures that result in residual toxicity or compromise the overall safety or effectiveness of the items or devices should be avoided.

Sterilization and Disinfection

Sterilization: can be achieved by either physical or chemical methods.

- Pre-cleaning to remove all the organic soil must be done for all instruments undergoing sterilization.
- Equipment which can withstand heat and moisture must be sterilized by autoclaving.

Chemical/ Liquid sterilization:

- Consider the use of chemical sterilization only if single use is not cost effective and other sterilization methods (mentioned in CSSD protocols) can not be used.
- The choice of disinfectants should be primarily based on material compatibility, time, use- conditions and cost. Strictly follow the manufacturer‟s instructions of use.
- The FDA has approved a few high level disinfectants which can be used for chemical sterilization if the exposure time is prolonged. These chemicals must be used strictly according to the manufacturer‟s instructions regarding use-concentration, contact time, temperature, product compatibility and shelf life.
- A disadvantage of chemical sterilization is that items can not be packed and therefore, must be used immediately. The disinfectants also need to be rinsed off thoroughly to prevent toxicity.
- There are no reliable biological indicators for monitoring chemical sterilization.

Disinfection

- Disinfection is used to destroy organisms present on delicate or heat sensitive instruments which cannot be sterilized or when single use items are not available.
- The level of disinfection varies with the intended use and level of risk of infection associated with its use.

Disinfection can be achieved by thermal (pasteurization) or chemical means.

Thermal disinfection (Pasteurization)

- If an in instrument is able to withstand heat and moisture and is not required to be sterile, thermal disinfection is appropriate.
- Semi-critical items suitable for pasteurization include equipment for respiratory therapy and anesthesia.
- The items to be pasteurized must be thoroughly cleaned with detergent and water prior to disinfection.
- They must be totally immersed in water during the pasteurization cycle. After pasteurization, special care must be taken to dry (residual water tends to collect) and prevent re- contamination of the equipment during storage and transport.

Chemical disinfection:

Numerous disinfectants are used alone, or in combination for disinfection. Commercial formulations of these germicides are unique products, which must be registered with EPA or cleared by FDA.

In general, the activity of a disinfectant depends on the temperature, contact time, pH, presence of organic or inorganic matter and number and resistance of the bio-burden on a surface, therefore, while using the product, the users must comply with the manufacturer‟s label instructions of use-concentration, contact time, temperature, product compatibility, specific purpose of germicide, exposure hazard and methods of disposal.

- HCW must exercise due precautions and use appropriate PPE while using disinfectants.
- Use only instrument grade disinfectants for equipments and instruments.
- Household/ hospital grade chemicals should be reserved for non critical surfaces.
- Pre-cleaning of instruments must be done to ensure appropriate disinfectant activity.
- An increase in pH improves the activity of some disinfectants (glutaraldehyde, quaternary ammonium compounds) but decreases the activity of others (phenols, hypochlorite, iodine). Many disinfectants require dilution prior to use.
- It is mandatory to follow the manufacturer‟s instructions exactly as per label regarding use, its dilution and mixing (higher dilution will reduce activity and high concentration can damage instruments or cause toxic effects to the users).
- Use diluted preparations only till recommended shelf life. During use, the minimum effective concentration (MEC) must be regularly monitored depending on the frequency of use.

ALCOHOLS:

Available compounds: Ethyl alcohol, Isopropyl alcohol (IPA), N-propanol

Optimal Concentration: 60-90 % in water (v/v); 100 % concentration not effective.

Uses: **Intermediate/ low level disinfectant**

- Alcohols/ alcohol impregnated wipes are used for disinfection of small, smooth, clean surfaces (eg trolley tops).
- Disinfection of rubbers stoppers of medication vials, thermometers, stethoscopes, scissors, manual ventilation bags, manikins, ultrasound instrument, and external surface of ventilators, electrical / electronic equipments, which can not be immersed in disinfectants and medication preparation areas.
- Skin antiseptic
- Comment: No product cleared by FDA for HLD/sterilization.

GLUTARALDEHYDE

Concentration: 2-3.2%; generally used as a 2 % activated alkaline solution at room temperature

- **Method of use:** Aqueous solutions are acidic and not sporicidal. They are activated by alkalinizing to pH 7.5-8.5 for sporicidal effect. Activity depends on pH, temperature, use concentration, presence of inorganic ions and age of solution.
- **Shelf life**: Shelf life of the activated chemical is approximately 14 days. Solutions may become diluted on repeated use, especially in automated endoscope reprocessors, if wet instruments are immersed.
- **Quality control (Q/C)** procedures: Chemical test strips/ liquid chemicals should be used at recommended frequency to ensure use concentration of > 1-1.5% (Minimum effective concentration; MEC) while high level disinfecting semi-critical items. If solutions are used daily, test MEC daily.

Do not use test strips to extend use life beyond expiration date.

Disposal: Neutralize with sodium bisulfate.

Uses: Liquid chemical sterilant/ High level disinfectant

- Low temperature disinfection/ sterilization of medical equipments like endoscopes, spirometry tubings, dialyzers, transducers, anesthetic & respiratory equipments, hemodialysis proportioning and dialysate delivery systems etc.
- Should not be used for cleaning non-critical surfaces (toxic & expensive).

Measures to minimize exposure:

- Cover the immersion baths with tight lids
- Use only in areas with adequate provisions for exhaustion of toxic vapors (ducted exhaust hood/ ductless fume hoods with vapor absorbents).
- Ensure appropriate ventilation (7-15 air changes/ hour)
- Use of appropriate PPE (gloves, fluid resistant gowns, face masks, goggles)
- Use of appropriate automated machines.

Modified formulations (have reuse life of 28-30 days**):**

- Activated dialdehyde solutions containg 2.4-3.5% glutaraldehyde

- Glutaraldehyde phenate
- Potentiated acid glutaraldehyde
- Phenol + 2 % glutaraldehyde
- Stabilized alkaline glutaraldehyde

However, alkaline glutaraldehyde are superior microbicidals, sporicidal and have better anticorrosive properties

ORTHO-PTHALADEHYDE

Available compounds: 0.55% 1,2- benezene dicarboxaldehyde
Disposal: Must be disposed off in accordance with state regulations. If disposed through sanitary sewers, glycine (25 gms/ gallon) can be used to neutralize OPA.
Uses: Chemical sterilant/ High level disinfectant

- Low temperature disinfection/ sterilization of medical equipments.
- Probably more useful for washer disinfectors where glutaraldehyde resistant strains have emerged.

Precautions: Handle the chemical with care. Use appropriate PPE (gloves, fluid resistant gowns, face masks, eye protection). Store in containers with tight fitting lids.

FORMALDEHYDE
Available compounds: 37 % formaldehyde by weight (formalin)
Uses:

- Preservative of tissues and anatomic specimens
- Preparation of some viral vaccines
- Embalming agent
- Occasionally used to disinfect disposable hemodialyzers reused on the same patient & used to disinfect internal fluid pathways. The equipment must be thoroughly rinsed and tested for residual formaldehyde after disinfection.
- Decontamination of laminar flow biologic safety cabinets

PARAFORMALDEHYDE
A solid polymer of formaldehyde, may be vaporized by heat for decontamination of biological safety cabinets.

HYDROGEN PEROXIDE (H_2O_2)
Available compound: Commercially available 3-25 % H_2O_2 formulations, 7.5 % H_2O_2 with 0.85% phosphoric acid (to maintain a low pH) is marketed as a sterilant.

- A new, rapid acting, 13.4% H_2O_2 formulation (not FDA cleared) has demonstrated sporicidal, myco bactericidal, fungicidal and virucidal efficacy.

Uses: Chemical sterilant/ High level disinfectant

- FDA approved commercial products containing H_2O_2 alone or in combination with peracetic acid is used for disinfection/ sterilization of semi-critical/ critical medical or dental equipments.
- Commercially available 3-7.5% H_2O_2 is used for disinfecting, ventilators, fabrics, endoscopes, foot care equipment. Vaporized H_2O_2 is also used for gas plasma sterilization.

Precautions: Check the MEC (6-7.5%) regularly to ensure effective disinfection

PERACETIC ACID/ PEROXYACETIC ACID (PAA)
Available compounds: Effective at low (<0.3%) concentrations
Uses: Chemical sterilant/ High level disinfectant (See table 7 for FDA approved products)

- Low temperature sterilant for endoscopes, dental equipments.
- In combination with H_2O_2, it is used for disinfection of hemodialyzer.

0.2 % PAA is approved by FDA for use with an automated endoscope reprocessor (AER) at elevated temperature.
Precautions: Proper training and appropriate channel connectors must be used with AERs.
CHLORINE RELEASING AGENTS
Available compounds:
1. Hypochlorites (most commonly used): available as a liquid (sodium hypochlorite, NaOCl) or solid (calcium hypochlorite) formulation.
2. Chlorine dioxide
3. Sodium dichloroisocyanurate (NaDCC)
4.Monochloramine
5. Chloramine T

CARE OF PATIENTS ON VENTILATOR AND PREVENTION OF VAP

Intubation procedure:

- Preoxygenate with 100% oxygen to provide apneic or distressed patient with reserve while attempting to intubate.
    - Do not allow more than 30 seconds to any intubation attempt.
    - If intubation is unsuccessful, ventilate with 100% oxygen for 3-5 minutes before a reattempt.

Volume and pressure ventilation

- Volume ventilation: Volume is constant and pressure will vary with patient‟s lung compliance.

- Pressure ventilation: Pressure is constant and volume will vary with patient‟s lung compliance.

Initial settings:
- Select your mode of ventilation
- Set sensitivity at Flow trigger mode
- Set Tidal Volume
- Set Rate
- Set Inspiratory Flow (if necessary)
- Set PEEP
- Set Pressure Limit

Humidification

Post initial settings:
- Obtain an ABG (arterial blood gas) about 30 minutes after you set your patient up on the ventilator.
- Goal:

Keep patient‟s acid/base balance within normal range:

- pH 7.35 – 7.45
- PCO 2 35-45 mmHg
- PO2 80-100 mmHg

STANDARD PRECAUTIONS

Assume that every person is potentially infected or colonized with an organism that could be transmitted in the healthcare setting and apply the following infection control practices during the delivery of health care.

Hand hygiene

- Hand hygiene has been cited frequently as the single most important practice to reduce the transmission of infectious agents in healthcare settings and is an essential element of Standard Precautions.
- The term "hand hygiene" includes both hand washing with either plain or antiseptic-containing soap and water, and use of alcohol-based products (gels, rinses, foams) that do not require the use of water.
- In the absence of visible soiling of hands, approved alcohol-based products for hand disinfection are preferred over antimicrobial or plain soap and water because of their superior microbiocidal activity, reduced drying of the skin, and convenience .
- Improved hand hygiene practices have been associated with a sustained decrease in the incidence of MRSA and VRE infections primarily in the ICU

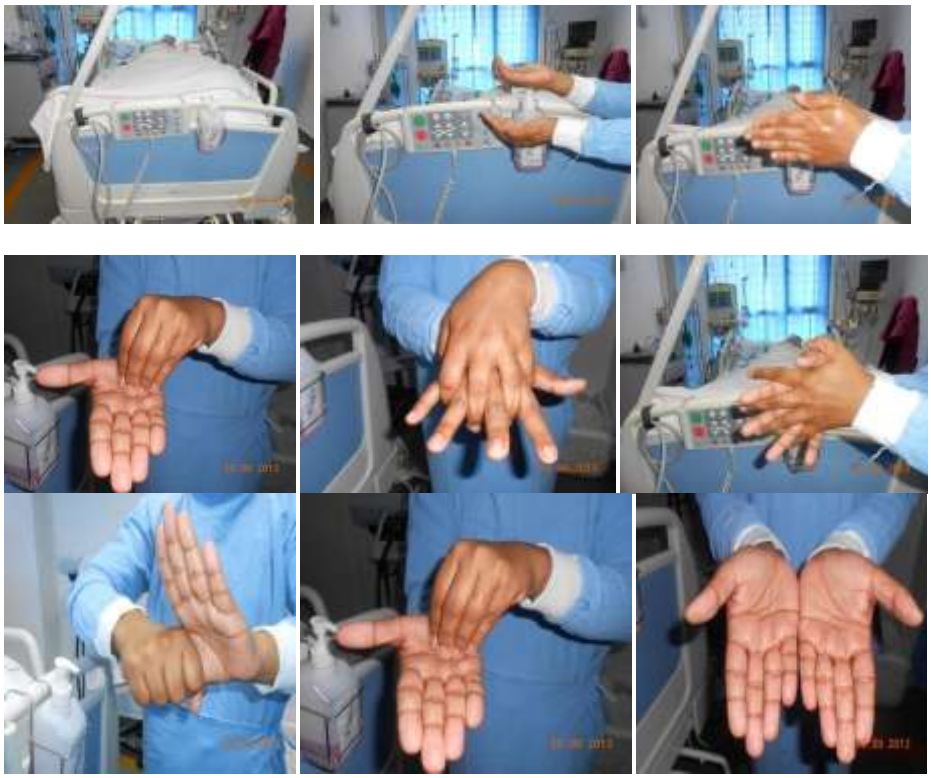
Hand hygiene must be performed

- During the delivery of healthcare, avoid unnecessary touching of surfaces in close proximity to the patient to prevent both contamination of clean hands from environmental surfaces and transmission of pathogens from contaminated hands to surfaces.

- When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids, wash hands with either a non antimicrobial soap and water or an antimicrobial soap and water.

- If hands are not visibly soiled, or after removing visible material with non antimicrobial soap and water, decontaminate hands. The preferred method of hand decontamination is with an alcohol-based hand rub. Alternatively, hands may be washed with an antimicrobial soap and water. Frequent use of alcohol-based hand rub immediately following hand washing with non antimicrobial soap may increase the frequency of dermatitis.

STEPS FOR PERFORMING HAND HYGIENE USING HAND RUBS/ HAND WASH
(Each step should be repeated for both the hands)



Wash hands:

- Before having direct contact with patients

- After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings.
- After contact with a patient‟s intact skin e.g., when taking a pulse or blood pressure or lifting a patient).
- If hands will be moving from a contaminated-body site to a clean-body site during patient care.
- After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient.
- After removing gloves: Wash hands with non-antimicrobial soap and water or with antimicrobial soap and water if contact with spores (e.g., *C. difficile* or *Bacillus anthracis*) is likely to have occurred. The physical action of washing and rinsing hands

INFECTION-CONTROL AND VENTILATION REQUIREMENTS FOR OPERATING ROOMS

Air change rate:

- An air change is defined as occurring when a volume of air equivalent to the volume of the room has been supplied to or removed from that room. (which ever airflow is greater).

- The rate of air change is usually given in terms of air change per hour (ACH) and is derived from the volume of a room and the ventilation rate.

$$\text{Air change rate} = \frac{\text{Air supply rate}}{\text{Room volume}}$$

- Clean areas (operation room and preparation room): 20ACH/ hour
- Preparation room used for laying up sterile instrument : 37 ACH/ hour since the main route of entry of air borne contamination is via instruments
- If preparation rooms are used only as sterile pack stores: 11ACH/ hour.

Pressure differentials

- Pressure differentials are essential to prevent backflow of air from dirty to clean areas. The differentials are small and need to be measured by special electronic micro manometer or inclined fluid manometer. The desired pressure differentials vary from 9-30 Pascal
- Air leaving the final filter should contain no more than 0.5 CFU/m^3 of air. If air filters have been tested by particle penetration test, this test is not necessary.
- The filters should be checked to prevent passage of particles through it and the clean zone should resist particle ingress from outside.

AHU: The humidifier and cooling coil in AHU should be disinfected at least six monthly.

- Maintain positive-pressure ventilation with respect to corridors and adjacent areas.
- Do not use ultraviolet (UV) lights to prevent surgical-site infections.
- Keep operating room doors closed except for the passage of equipment, personnel, and patients.
- Strictly limit entry to essential personnel. Only people absolutely needed for an assigned work should be present. People present in theatre should curtail unnecessary movements in and out of theatres, which will greatly reduce bacterial count.
- Trolleys entering theatre should be designated for use in that theatre only and cleaned after each patient.

Precautionary procedures for infectious TB patients who also require emergency surgery

- Use an N95 respirator approved by the Hospital, without exhalation valves in the operating room.
- Incubate the patient in either the AII (airborne infection isolation) room or the operating room; if incubating the patient in the operating room, do not allow the doors to open until 99% of the airborne contaminants are removed.
- When anesthetizing a patient with confirmed or suspected TB, place a bacterial filter between the anesthesia circuit and patient's airway to prevent contamination of anesthesia equipment or discharge of tubercle bacilli into the ambient air.
- Extubate and allow the patient to recover in an AII room. If the patient has to be extubated in the operating room, allow adequate time for ACH to clean 99% of airborne particles from the air, because extubation is a cough- producing procedure.
- Whenever possible, patients with suspected tuberculosis should be taken as the last case.

Recommendations for pre operative surgical scrub

- An approved antiseptic agent should be used for hand washing.
- „Surgical scrub" hand wash should be for a minimum of 2 minutes.

Skin preparation & use of antiseptic agents:

- Alcohol solutions are more effective than and preferable to aqueous solutions for skin preparation .They should be allowed to dry thoroughly.

- **Chlorhexidine gluconate 0.5% w/w in spirit 70%.**

- **Povidone iodine 7.5%.**

- Multi-use bottles of antiseptics - if used:
  - Label with date first opened
  - Use within the „Use by Date" or discard once „use by date" reached
  - Never refill or „top up"; discard container and dispenser after use or when use by date has been reached

- **Sharps use and disposal**
  - Ensure removable blades can be easily detached using an appropriate device.
  - Use an appropriate size and type of „sharps" bin/box for the area and anticipated volume of usage
  - Do not place „sharps" bins/boxes in areas where there may be an obstacle to environmental cleaning.
  - Avoid overfilling: the sharps containers must be closed securely when three-quarters full.
  - Used needles must not be recapped.

PREVENTION OF VAP

- Avoid cross-contamination by FREQUENT HANDWASHING
- Decrease risk of aspiration (cuff occlusion of trachea, positioning, use of small-bore NG tubes)
- SUCTION only when clinically indicated, using STERILE TECHNIQUE
- Maintain closed system setup on ventilator circuitry and avoid pooling of condensation in the tubings.
- Ensure adequate nutrition
- Neutralization of gastric contents with antacids and H2 blockers

Plan of care for the ventilated patient

- Patient Goals:

- Patient will have effective breathing pattern.

- Patient will have adequate gas exchange.

- Patient"s nutritional status will be maintained to meet body needs

- Patient will not develop a pulmonary infection.

- Patient will not develop problems related to immobility.
- Patient and/or family will indicate understanding of the purpose for mechanical ventilation.

Role of a nurse:

- Observe changes in respiratory rate and depth; observe for SOB and use of accessory muscles. An increase in the work of breathing will add to fatigue; may indicate patient fighting ventilator.
- Observe for tube misplacement- note and post cm. Marking at lip/teeth/nares after x-ray confirmation and q. 2 h. Indicates correct position to provide adequate ventilation.
- Prevent accidental extubation by taping tube securely, checking q.2h. restraining/sedating as needed. Avoid trauma from accidental extubation, prevent inadequate ventilation and potential respiratory arrest.
- Inspect thorax for symmetry of movement. Determines adequacy of breathing pattern; asymmetry may indicate hemothorax or pneumothorax.
- Measure tidal volume and vital capacity. Indicates volume of air moving in and out of lungs.
- Asses for pain. Pain may prevent patient from coughing and deep breathing.
- Monitor chest x-rays Shows extent and location of fluid or infiltrates in lungs.
- Maintain ventilator settings as ordered. Ventilator provides adequate ventilator pattern for the patient.
- Elevate head of bed 60-90 degrees. This position moves the abdominal contents away from the diaphragm, which facilitates its contraction.
- Impaired gas exchange **r/t** alveolar-capillary membrane changes Monitor ABG‟s. Determines acid-base balance and need for oxygen.
- Assess LOC, listlessness, and irritability. These signs may indicate hypoxia.
- Observe skin color and capillary refill. Determine adequacy of blood flow needed to carry oxygen to tissues.
- Monitor CBC. Indicates the oxygen carrying capacity available.
- Administer oxygen as ordered. Decreases work of breathing and supplies supplemental oxygen.
- Observe for tube obstruction; suction **prn**; ensure adequate humidification. May result in inadequate ventilation or mucous plug.
- Reposition patient q. 1-2 h. Repositioning helps all lobes of the lung to be adequately perfused and ventilated.
- Provide nutrition as ordered, e.g. TPN, lipids or enteral feedings. Calories, minerals, vitamins, and protein are needed for energy and tissue repair. Obtain nutrition consult.
- Provides guidance and continued surveillance.
- Potential for pulmonary infection **r/t** compromised tissue integrity.
- Secure airway and support ventilator tubing.
- Prevent mucosal damage.
- Provide good oral care q. 4 h.; suction when need indicated using sterile technique; hand washing with antimicrobial for 30 seconds before and after patient contact. Measures aimed at prevention of nosocomial infections.
- Ensure ventilator tubing changed q. 7 days, in-line suction changed q. 24 h.; ambu bags changes between patients and whenever become soiled.

- Assess for GI problems. Preventative measures include relieving anxiety, antacids or H2 receptor antagonist therapy, adequate sleep cycles, adequate communication system. Most serious is stress ulcer. May develop constipation.
- Observe skin integrity for pressure ulcers; preventative measures include turning patient at least q2 h.; use pressure relief mattress or turning bed if indicated; follow prevention of pressure ulcers plan of care;
- Patient is at high risk for developing pressure ulcers due to immobility and decreased tissue perfusion.
- Maintain muscle strength with active/active-assistive/passive ROM and prevent contractures with use of span-aids or splints.
- Patient is at risk for developing contractures due to immobility, use of paralytics and ventilator related deficiencies.
- Encourage patient to relax and breath with the ventilator; explain alarms; teach importance of deep breathing; provide alternate method of communication; keep call bell within reach;
- Reduce anxiety, gain cooperation and participation in plan of care
- Anxious Patient
    - Can be due to a malfunction of the ventilator
    - Patient may need to be suctioned
    - Frequently the patient needs medication for anxiety or sedation to help them relax
        - Attempt to fix the problem
        - Call your DOCTOR
- Anytime you have concerns, alarms, ventilator changes or any other problem with your ventilated patient.
    - Call your DOCTOR
- NEVER hit the silence button!
-

Recommended elements of Preventive Bundle for VAP

- Avoid unnecessary antibiotics
- Avoid unnecessary stress ulcer prophylaxis
- Sucralfate for stress ulcer prophylaxis
- Oral intubation
- Chlorhexidine oral rinse
- Selective digestive decontamination
- Short-course parenteral antibiotics
- Appropriate hand disinfection
- Appropriate staffing
- Avoid tracheal intubation
- Shorten duration of mechanical ventilation
- Semirecumbent positioning
- Avoid gastric overdistention
- Subglottic suctioning
- Avoid ventilator circuit changes/manipulation
- Drain ventilator circuit condensate
- Prevent accidental extubation

****