Ministry of Health & Family Welfare
Government of India

Control of Environment

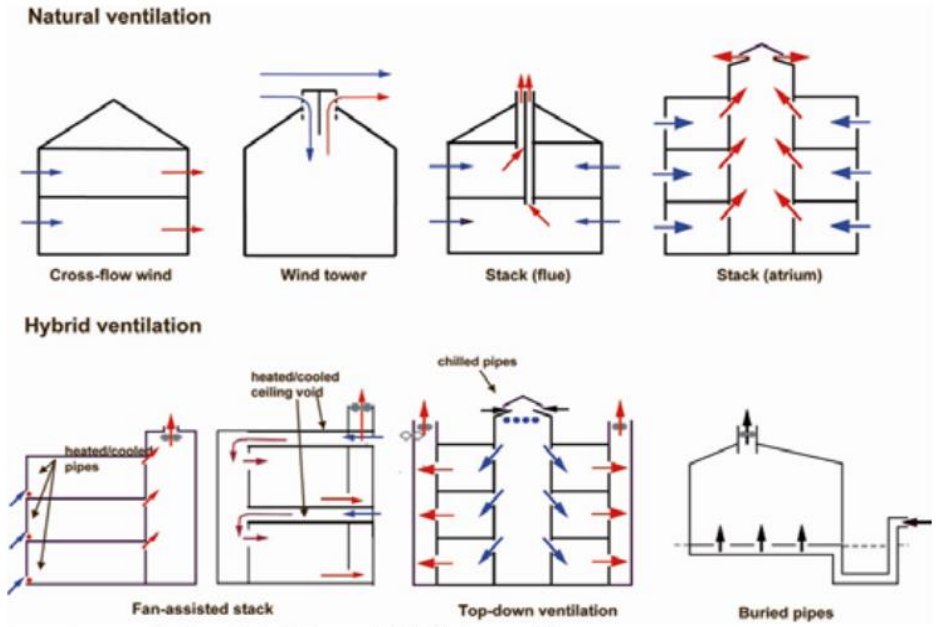
Training Session – V

Outline

- Air and ventilation
- Ventilation systems in HCF
- Standards for natural ventilation
- Airborne precaution room
- Cleaning and sanitation
- Spill management
- Policy for cleaning, sanitation and disinfection
- Safe water and food
- Biomedical waste management

Air and Ventilation

- Airborne infection occurs through droplet nuclei of <5 microns
- Ventilation can reduce infection risk through dilution and removal of particles through air exchanges
- Improved ventilation in HCFs is essential in preventing airborne transmission
- Mechanical ventilation vs Natural ventilation vs Hybrid ventilation



Source: Courtesy of Professor Martin Liddament, VEETECH, Coventry, UK.

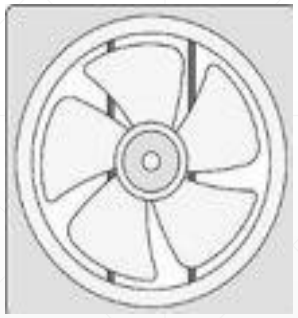
natural_ventilation.pdf (who.int)

Natural ventilation

- Refers to fresh air that enters and leaves a room or other area through windows or doors preferably on opposite sides
- Unless adequate ventilation is present, mixing fans will not be useful in dispersing infectious particles and reducing transmission
- Openings should constitute >20% of floor area
- Variability of airflow patterns are likely due to varying weather

Mechanical ventilation (HVAC)

- Mechanical ventilation can be fully controlled and combined with AC, heating and filtration systems
- Mechanical ventilation (with or without climate control) may be appropriate where natural ventilation is sub-optimal or inadequate



Fans (Ventilator) could be used to direct the air flow towards or away from patient

Mechanical ventilation – challenges

- Effective ventilation is often at odds with efforts to make indoor climate more comfortable
- In practice, air cooling or heating with re-circulation of air is more energy efficient
- Although window and split AC provide temperature control, there is inadequate air exchange

Careful attention must be given to ensuring adequate ventilation when installing climate control

Heating ventilation and AC systems

- In modern hospitals, heating, ventilation and AC (HVAC) systems control the concentration of airborne particulates in high-risk areas such as transplant units, OTs, ICUs, and burn units to minimize the risk of infection by means of air pressure, flow control and air filtration
- The three types of filtration used in central AC are:
  - coarse or pre-filters for large particles
  - micro-fine filters which filter up to 5 microns
  - HEPA filters which keep out up to 0.3 microns with 99.97% efficiency

Evidence indicates a lower incidence of infection when immune-compromised and other high-acuity patients are housed in HEPA-filtered isolation rooms

How to calculate Air Changes / Hour

As a rule of thumb, wind-driven natural ventilation rate through a room with two opposite openings (e.g. a window and a door) can be calculated as follows:

$$\text{ACH} = \frac{0.65 \times \text{wind speed (m/s)} \times \text{smallest opening area (m}^2\text{)} \times 3600 \text{ s/h}}{\text{room volume (m}^3\text{)}}$$

Ventilation rate (l/s) = 0.65 × wind speed (m/s) × smallest opening area (m2) × 1000 l/m³

Example for calculating ventilation flow rate

- Table below provides estimates of the ACH and ventilation rate due to wind alone, at a wind speed of 1 m/s
  - assuming a ward of size 7 m (length) × 6 m (width) × 3 m (height)
  - with a window of 1.5 × 2 m^2 and a door of 1 m^2 × 2 m^2 (smallest opening)

Estimated air changes per hour and ventilation rate for a 7 m × 6 m × 3 m ward

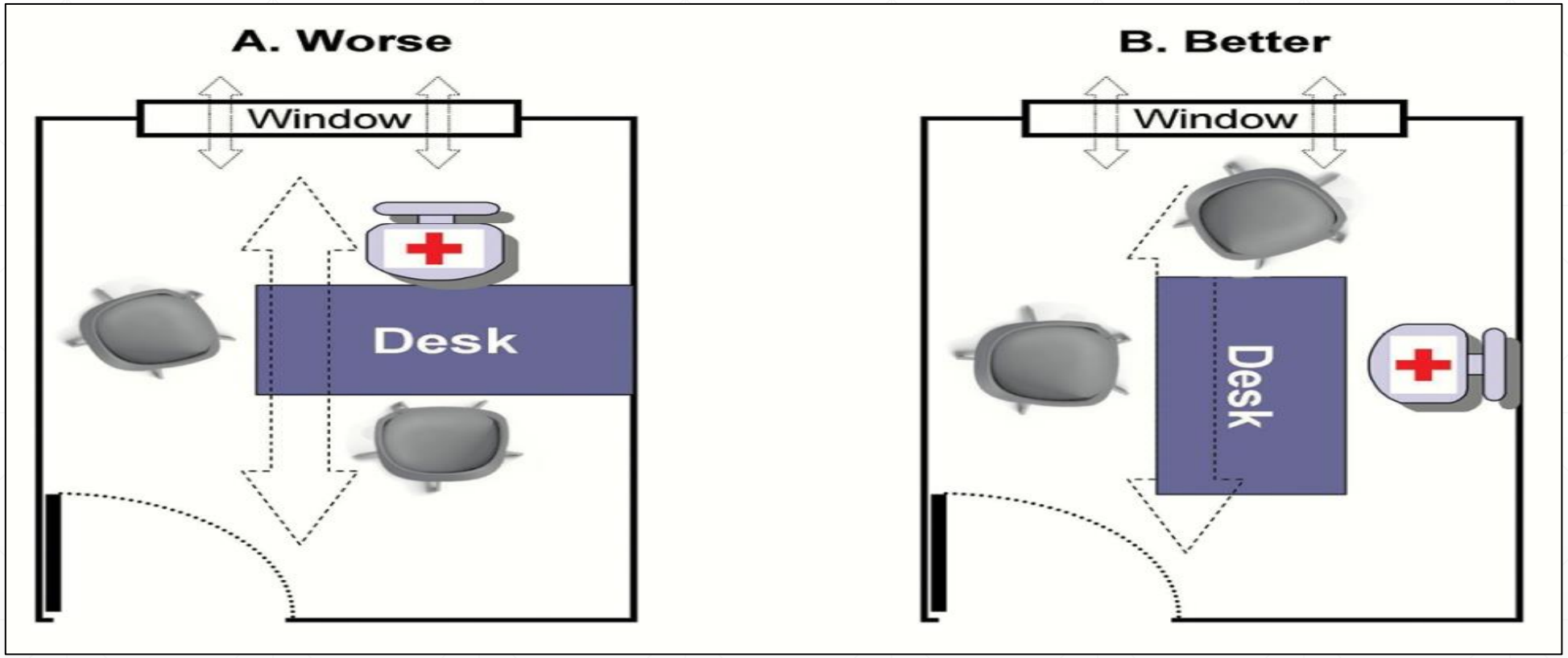
Openings	ACH	Ventilation rate (l/s)
Open window (100%) + open door	37	1300
Open window (50%) + open door	28	975
Open window (100%) + door closed	4.2	150

https://www.who.int/water_sanitation_health/publications/natural_ventilation.pdf

Minimum air-changes per hour (ACH)

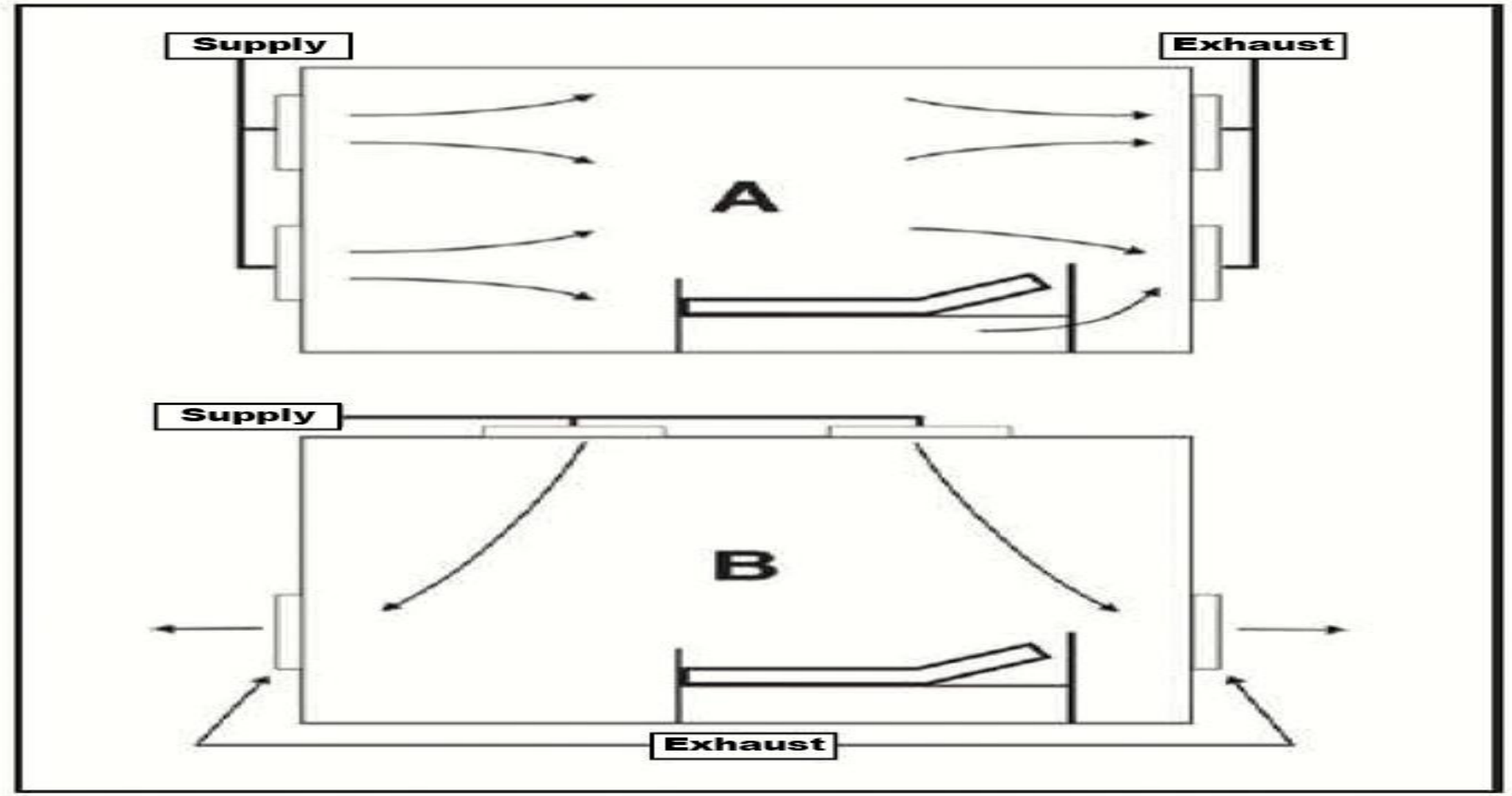
Type of healthcare setting	Minimum air changes per hour	Minimum hourly averaged ventilation rates (litres/second/ patient)
Registration areas	>6 ACH	> 40 litres/ second/ patient
Outpatient departments and waiting areas	>6 ACH	>40 litres/ second/ patient
Inpatient departments	>6 ACH	>40 litres/ second/ patient
High-risk settings and their waiting areas, ART centres, TB/chest departments (outpatient and inpatient bronchoscopy procedure room MDR-TB wards and clinics) Airborne precaution rooms	>12 ACH	80–160 litres/ second/patient

Seating arrangement in a naturally ventilated room



The healthcare worker is marked with a red cross. Seating “B” is better than seating “A” as the potentially infected air from the patient with airborne disease does not cross the healthcare worker.

Mechanical ventilated room with optimum directional airflow



Filtration (HEPA filters)

- Filtration may be considered where:
  - Sustainable resources for membrane replacement and maintenance are assured
  - Transmission risk is high in areas such as bronchoscopy suites, laboratories and individual rooms for patients with TB, COVID-19 etc.
- Filtration devices perform poorly in high-dust conditions, as the effectiveness in terms of equivalent air exchange can diminish rapidly

HEPA membrane filters are rated to remove 99.97% of 0.3 micron particles

Laminar airflow

- This is HEPA-filtered air blown in a unidirectional pattern with 100–400 ACH
- LAF systems are thought to minimize contamination of the surgical field with airborne microbes and thus to contribute to reducing surgical site infections (SSIs)
- Should be available for prolonged procedures such as transplant and replacement surgery, neurosurgery, orthopaedic and implant surgery

Negative pressure Airborne Precaution room

- Post signage on the door and ensure hand-washing facilities
- Ensure appropriate room ventilation (>12 ACH)
- Ensure directional control of air flow, with air flow entering the room only when the door is open, and exhausted outside safely
- Monitoring devise to monitor the pressure

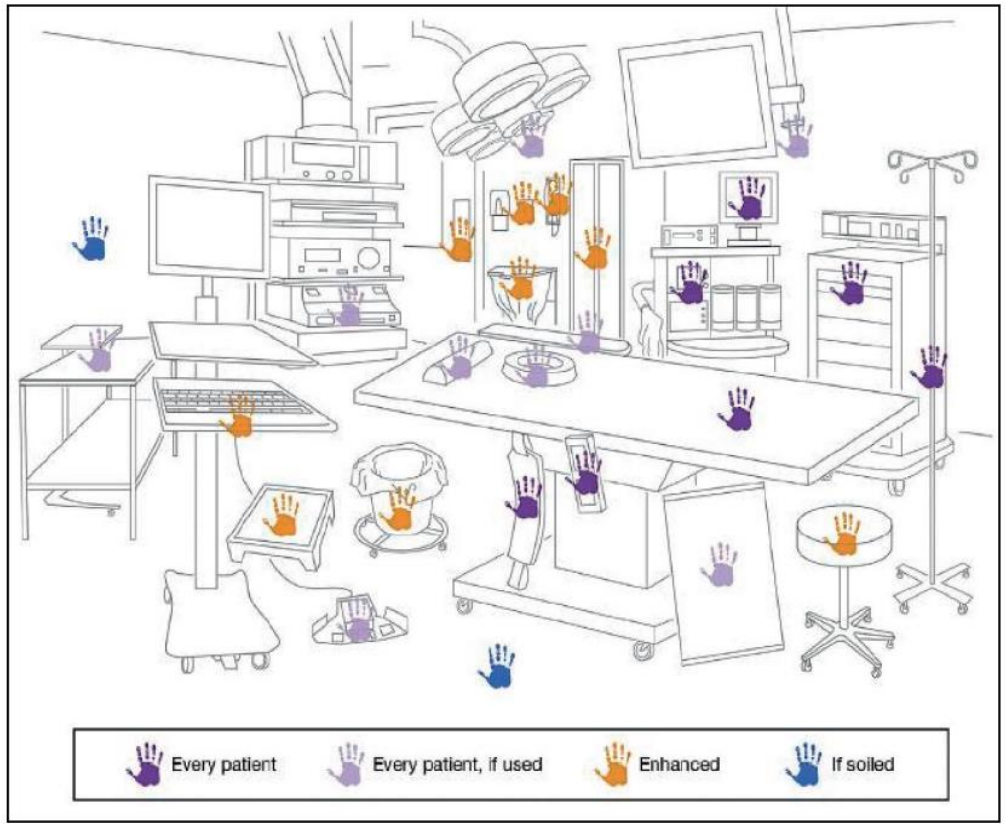
Protective Environment (PE) Positive pressure isolation room

- Immunocompromised patients would benefit in a PE room
- Use an anteroom to ensure appropriate air balance relationships and provide independent exhaust of contaminated air to the outside, or place a HEPA filter in the exhaust duct if the return air must be recirculated
- Ensure that rooms are well sealed by properly constructing windows, doors, and intake and exhaust ports;
- Ventilate the room to maintain ≥12 ACH
- Maintain positive room air pressure (≥2.5 Pa [0.01-inch water gauge]) in relation to the corridor

General Principles of Cleaning & Disinfection

General principles

- “High touch surfaces” (e.g. doorknobs, bedrails, light switches, wall areas around the toilet in the patient’s room, and the edges of privacy curtains) need more frequent cleaning than those with minimal hand-contact (e.g. floors and ceilings)
- Appropriate PPE should be worn
- Log of all cleaning procedures must be maintained
- Either hot water with neutral detergent or a detergent with disinfectant can be used



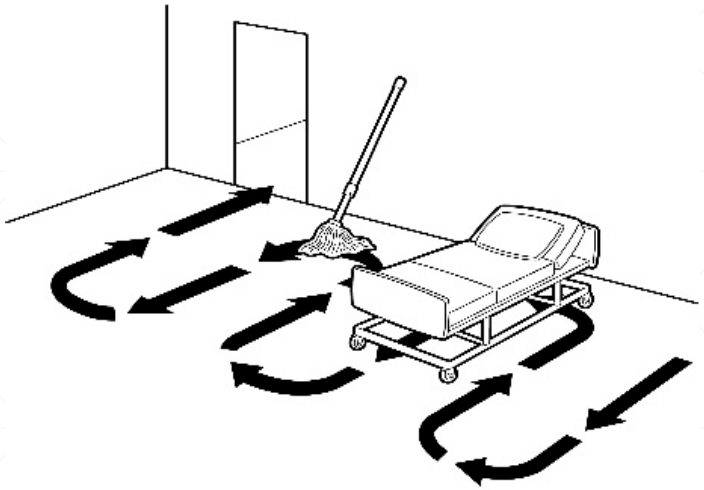
Global guidelines for the prevention of surgical site infection, 2nd ed. (who.int)

Cleaning & disinfection

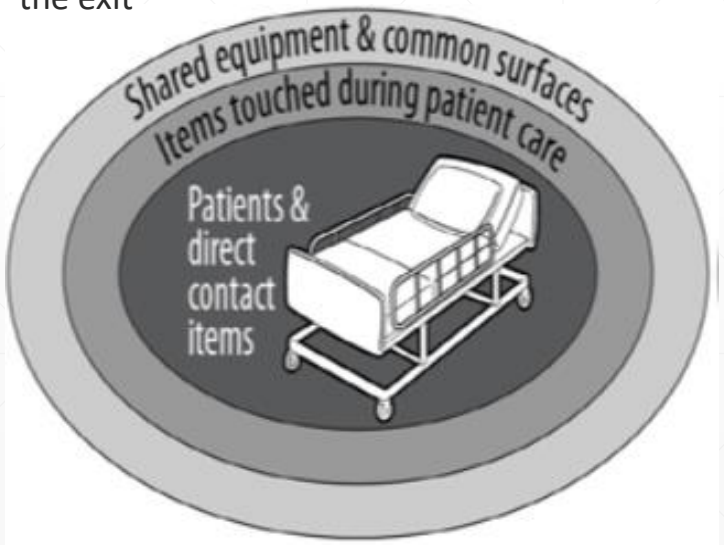
- Housekeeping surfaces should be cleaned with a detergent/ disinfectant solution on a daily basis or more frequently in specific high-risk areas
- All horizontal surfaces and all toilet areas including washbasins and commodes should be cleaned daily
- Staff should be properly trained on the practices of cleaning and decontamination of hospital surfaces
- Fresh detergent/disinfectant solutions must be prepared every day according to manufacturers' instructions
- Diluted disinfectant solutions may become contaminated with resistant pathogens, after the day's use, the remaining solutions discarded and containers be cleaned and dried

Cleaning methods

- Floor cleaning methods include wet mopping, and vacuum cleaning with filters attached
- Avoid use of brooms, as this generates dust aerosols
- Horizontal surfaces must be wet dusted with a cloth moistened with a hospital disinfectant (or detergent)
- For wet mopping, a three-bucket method should be used
- Buckets should be cleaned and kept inverted to assist drying



Example of mopping strategy, working toward the exit



Equipment for cleaning in HCF

- It is preferable to have three-bucket trolleys with a wringing mechanism
- The trolley should have provision to store bottles of disinfectants and mop sticks
- A separate storage space used for hand mops should be available on the trolley
- It is important to ensure that the trolley/bucket is clean before using it. While mopping, utilizing the three-bucket system is ideal

Three bucket system for cleaning in HCF

- First bucket contains water with detergent and is used in the beginning
- Second bucket contains water in which the mop is rinsed
- The mop is then dipped in the third bucket that contains a disinfectant and the mopping is done again

Do’s and Don’ts of Cleaning & Disinfection in HCFs

- Mop heads must be changed after cleaning spills and at the beginning of the day
- Mop heads and cleaning cloths must be decontaminated regularly by laundering (heat disinfection) with detergent and drying at 80°C
- Walls, blinds and window curtains must be cleaned when visibly soiled or contaminated
- Disinfectant fogging is not recommended for patient care areas
- Random or undirected bacteriological testing of the environment is not recommended as a routine unless seeking a potential source of an outbreak

Spill management

- Splashes of body fluids on walls and surfaces can be cleaned by using a high-level disinfectant
- Use PPE (gloves, face masks and fluid-resistant gowns) for cleaning blood spills
- Wear protective shoe covers/boots when cleaning large spills
- Refer to NGIPC for details

Cleaning agents and disinfectants for environmental cleaning

Disinfectants	Recommended use	Precautions
Sodium hypochlorite 1% in-use dilution; 5% solution to be diluted 1:5 in clean water	Disinfection of material contaminated with blood and body fluids	• Should be used in well-ventilated areas • Protective clothing required while handling and using undiluted • Do not mix with strong acids to avoid release of chlorine gas • Corrosive to metals
Bleaching powder 7 g/L with 70% available chlorine	Toilets/ bathrooms – may be used in place of liquid bleach	Same as above
Alcohol (70%) isopropyl, ethyl alcohol, methylated spirit	Smooth metal surfaces, table tops and other surfaces on which bleach cannot be used	• Flammable, toxic – to be used in well-ventilated area, avoid inhalation • Keep away from heat source, electrical equipment, flames, hot surfaces • Allow it to dry completely, and avoid diathermy burns

Policy for cleaning and disinfection

- The healthcare facility should develop a policy for cleaning, sanitation and disinfection of environmental surfaces. The key elements are:
- A hospital cleaning manual should be developed to provide detailed guidelines for procedures and practices
- The interiors and external areas and premises of the hospital should be kept clean and odour-free
- Solid waste and garbage should be removed and disposed of hygienically
- There should be a cleaning schedule for daily, weekly and terminal cleaning
- The cleaning process, be it for a single room, or ward, must be coordinated with the nurse in-charge

Safe water

- HCFs should have adequate and continuous supply of safe water
- Safe water should be available for drinking, handwashing, food preparation, personal hygiene, medical activities, cleaning and laundry
- Water in healthcare facilities should be of drinking water quality and meet the national standards for drinking water
- Biofilms in storage tanks, tap water and showers have been linked to HAI outbreaks

Safe water contd.

- Medical usage of water requires additional treatment
- Waste water from a hospital needs to be treated by an effluent treatment plant as directed by the Biomedical Waste Management and Handling Rules 2016 and amendments 2018, 2019
- Microbiological testing of water
- Water used for drinking, handwashing, cleaning and disinfection should be tested as decided by the HICC
- Suggested sites of collection of water for testing are: hand wash/scrub sinks in the OT, ICUs, OPD/emergency, ward that caters to the maximum number of patients, RO/filtered water, drinking water sources
- Samples should show absence of coliform organisms

Safe food

- Quality and quantity of food are key factors for patient convalescence
- Dietary department should have a manual in which all the procedures for preparation and handling of food are available
- Guidance document by the FSSAI (Food Safety and Standards Authority of India) on the food management system must be followed

https://archive.fssai.gov.in/dam/jcr:84485705-ae48-4b97-bdd2-1a7426e42986/Guidance_Document_Catering_Sector_19_01_2018.pdf

Kitchen procedures – Storage facilities

- The storage facilities should be designed and constructed to avoid cross-contamination
- Cold storage at 4–8°C and freezer at −18°C should be provided for foods that need refrigeration and for frozen foods, with a separate refrigerator and freezer for vegetarian and non-vegetarian products
- Separate storage sections should be provided for raw, processed, packaged, rejected, returned or recalled food items
- Allergenic material or foods like Mushrooms/groundnuts must be distinguishably marked

Kitchen procedures – Food temperature

- Cold food items are refrigerated and maintained at 4–8°C or below
- Walk-in storage facilities and Refrigerators- the temperatures are checked daily
- Foods prepared to be served cold are cooled from their preparation temperature to 4°C or below
- The cooling period should not exceed 4 hours
- Hot foods are held at an internal temperature of 63°C or above
- Both hot and cold food items should be transported in food trolleys in such a manner that appropriate temperatures are maintained during the transportation of the food

Kitchen procedures – Special food

- Special formula food
  - Infant formulas and other formulas prepared by the dietary department and ward pantry are subject to specific preparation and storage policies and procedures that may be found in the dietary department manual
  - These are microbiologically checked only when epidemics occur
- Food for Immunocompromised patients
  - The food for this set of patients should be double cooked
  - Food should be cooked again in a pressure cooker just before serving

Kitchen hygiene -Environmental control

- This includes maintenance of ventilation, lighting, plumbing, drainage system, floors, walls, ceilings, doors and windows, service lift cleaning schedule and maintenance
- Weekly thorough cleaning of the kitchen should be carried out and recorded
- Natural/mechanical ventilation systems including air filters and exhaust fans should be provided
- They should prevent grease or condensation from collecting on the walls and ceiling, and must be easy to clean
- Regular cleaning of all vents/AC filters must be carried out in a systematic manner at least once a week; record to be maintained by the engineering department

Biomedical Waste Management

Infectious waste

- Any waste contaminated with blood, body fluids, excretions and secretions is potentially infectious
- One of the most hazardous waste is contaminated sharps waste, which is a part of infectious waste and can also cause injury
- Most common documented transmission of infection from waste to HCWs is through contaminated needles
- Laboratory waste is a major potential reservoir of pathogenic microorganisms and requires appropriate handling

Health hazards associated with poor healthcare waste management

- Injuries from sharps to all categories of hospital staff and waste handlers
- HAIs in patients because of poor IPC and poor waste management
- Risks of infections outside hospitals for waste handlers, scavengers, and eventually the general public, changes in microbial ecology, spread of antimicrobial resistance
- Risks associated with handling of hazardous chemicals and drugs at all levels

National rules for biomedical waste management

- The Ministry of Environment, Forest and Climate Change notified the Biomedical Waste Management Rules on 28 March 2016
- These rules superseded the Biomedical Waste (Management and Handling) Rules 1998
- The 2016 Rules have been amended in 2018 and 2019
- COVID-19 related Biomedical management guidance from Central Pollution Control Board (CPCB), 2020

National rules for biomedical waste management 2016

- Biomedical waste is a broader term applied to waste generated in the diagnosis, treatment or immunization of humans and animals, in research or in the production and testing of biological products
- Safe and proper identification, handling, storage, and disposal of biomedical waste from laboratories and related facilities is the responsibility of every occupier
- "Occupier" means a person having administrative control over the institution and the premises generating biomedical waste, irrespective of their system of medicine and by whatever name they are called

National rules for biomedical waste management 2016 contd.

- These Rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form, including
  - Hospitals, nursing homes, clinics, dispensaries
  - Veterinary institutions, animal houses
  - Pathological laboratories, blood banks
  - AYUSH hospitals
  - Clinical establishments
  - Research or educational institutions
  - Health camps, medical or surgical camps, vaccination camps, blood donation camps
  - First-aid rooms of schools, forensic laboratories and research laboratories

Waste segregation at point of generation

- Of the waste generated in healthcare settings, approximately 10% to 25% is infectious but if not segregated properly, the entire waste becomes infectious thereby escalating the overall cost of waste management
- HCF/laboratory waste requires management at every step from generation, segregation, collection, transportation, storage, and treatment to final disposal
- The most practical approach to the management of biomedical waste is to identify and segregate infectious waste, which would in turn drastically reduce the cost of waste disposal in healthcare settings

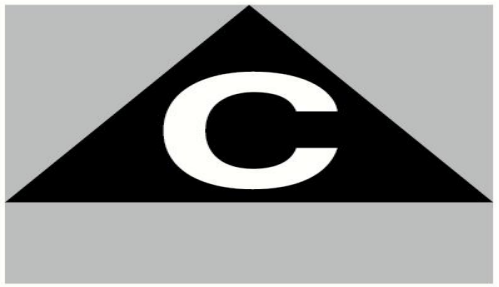
Waste segregation at point of generation contd.

- Biomedical waste should be segregated into containers or bags at the point of generation in accordance with the Biomedical waste management 2016 Rules
- Colour-coded leak resistant, heavy duty bags made of non-chlorinated plastic with biohazard sign and labels mentioning the date and details of waste need to be placed in appropriate containers with the appropriate label/logo (e.g. the use of a biohazard symbol for infectious waste)
- Puncture-proof containers made of plastic or metal with a biohazard symbol should be made available in blood collection areas, injection trolleys, nursing stations and OTs for collecting metallic wastes

Label for biomedical waste containers or bags

BIOHAZARD SYMBOL

CYTOTOXIC HAZARD SYMBOL



HANDLE WITH CARE

Note: The label shall be non-washable and prominently visible.

Waste category Number	Day .....Month ..... Year .....
Waste quantity.....	Date of generation .....
Sender's Name and Address	Receiver's Name and Address
Phone Number	Phone Number .....
Fax Number	Fax Number .....
Contact Person	Contact Person .....
In case of emergency please contact Name and Address: Phone Number:	

Waste segregation at point of generation contd.

- Syringes should be either mutilated or needles should be cut and/or stored in tamper-proof, leak-proof and puncture-proof containers for sharps storage
- Ensure segregation of liquid chemical waste at source and ensure pre-treatment or neutralization before mixing with other effluent generated from HCFs

Categories of waste

- Yellow: for human anatomical waste, animal anatomical waste, soiled waste, expired or discarded medicines, chemical waste, chemical liquid waste, discarded contaminated beddings and microbiology, biotechnology and other clinical waste
- **Red bin: for contaminated plastic waste**
- White sharps bin: for metallic sharps
- **Puncture proof and leak proof boxes/ containers with blue colored marking: Broken/ discarded and contaminated glass (except contamination with cytotoxic wastes)**

As per the categories mentioned in Schedule I of Biomedical Waste Management Rules 2016, and Biomedical Waste Management Rules (Amendment) Rules, 2018

Pre-treatment, packing, storage and transport

- Pre-treated through disinfection or sterilization on-site before sending to a common biomedical waste treatment facility for final disposal
  - Laboratory waste, microbiological waste
  - Blood samples and blood bags
- Storage facility for segregated biomedical waste prior to being transported to the authorized common biomedical waste treatment facility must be
  - Safe, ventilated, at secured location
  - Inaccessible to scavengers and protected against insects, birds, animals and rain
  - To ensure that there is no secondary handling, pilferage of recyclables, or inadvertent scattering or spillage by animals

Transport, treatment and disposal

- Transport of biomedical waste to common biomedical waste treatment facility to be done only in vehicles complying to the Biomedical Waste Management Rules 2016
- In cases where service of a common biomedical waste treatment facility is not available, the HCF shall set up requisite biomedical waste treatment equipment after approval from prescribed authority
- On-site biomedical waste treatment and disposal facilities are not to be established unless a common biomedical waste treatment facility is not available within a distance of 75 km

Transport, treatment and disposal contd.

- Every operator of the common biomedical waste treatment facility shall set up requisite biomedical waste treatment equipment such as an incinerator, autoclave or microwave, shredder and effluent treatment plant as a part of treatment before commencement of its operation
- The standards for treatment and disposal of biomedical wastes in Schedule III of Biomedical Waste Management Rules 2016 must be complied with
- The handling and disposal of all the mercury waste and lead waste is to be done in accordance with respective rules and regulations

Biomedical waste handlers

- Immunize all HCWs and others involved in handling of biomedical waste for protection against diseases including hepatitis B and tetanus, which are likely to be transmitted by handling of biomedical waste, in a manner as prescribed in the National Immunization Policy or the guidelines of the MoHFW issued from time to time
- Ensure occupational safety of all HCWs and others involved in handling of biomedical waste by providing appropriate and adequate PPE
- Conduct health check-up at the time of induction and at least once in a year for all HCWs and others involved in handling of biomedical waste and maintain the records for the same

Maintenance of records

Annual Reports

- Every HCF has to submit an annual report to the prescribed authority in Form-IV* every year on or before 30th June
- The prescribed authority is the state pollution control board for states and pollution control committees for Union Territories
- For establishments under the Ministry of Defence, the prescribing authority is the Director General, Armed Forces Medical Services

Maintenance of records contd.

- Maintain and update on a day-to-day basis the register for biomedical waste management and display on the website the monthly record of the biomedical waste generated in terms of category and colour coding
- Records related to the generation, collection, reception, storage, transportation, treatment, disposal or any other form of handling of biomedical waste must be maintained for a period of 5 years
- All records must be available for inspection and verification by the prescribed authority or the Ministry of Environment, Forest and Climate Change at any time
- Maintain records for operation of incineration, autoclaving, etc. for a period of 5 years

Reporting of accidents

- Any major accident at any institution or facility or any other site while handling biomedical waste must be intimated immediately to the prescribed authority and a report forwarded within 24 hours in writing regarding the remedial steps taken in Form I of the Biomedical Waste Management Rules 2016
- Information regarding all other accidents and remedial steps taken shall be provided in the annual report

Biomedical waste management: Training

- All workers involved in handling of biomedical waste must be provided training at the time of induction and at least once a year thereafter
  - Records of the training programmes conducted
  - Number of personnel trained
  - Number of personnel who have not undergone any training must be maintained

Summary points

- Air and ventilation in HCF
- Standards for natural ventilation
- Airborne precaution room
- Cleaning and disinfection
- Spill management
- Policy for cleaning, sanitation and disinfection
- Safe water and food
- Biomedical waste management

Questions?