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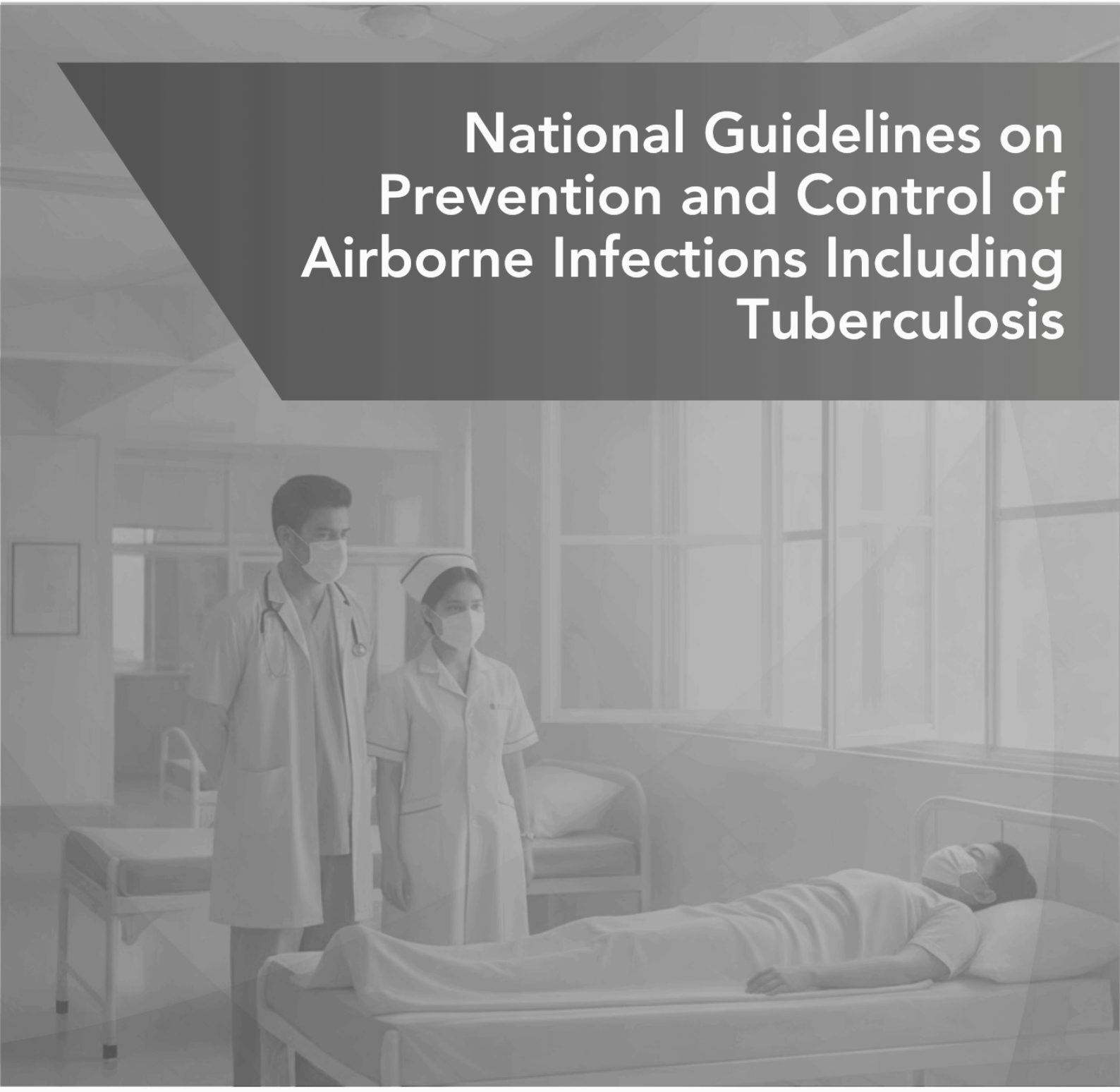
Ministry of Health & Family Welfare
Government of India

National Guidelines on Prevention and Control of Airborne Infections Including Tuberculosis

March 2026

National TB Elimination Programme
Central TB Division, Ministry of Health and Family Welfare
Government of India, New Delhi

National Guidelines on Prevention and Control of Airborne Infections Including Tuberculosis



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स्वास्थ्य एवं परिवार कल्याण मंत्रालय
Government of India
Department of Health and Family Welfare
Ministry of Health and Family Welfare

MESSAGE

The National Guidelines on Prevention and Control of Airborne *Infection including Tuberculosis, 2025* introduce a framework for integrating infection prevention within health systems, with renewed emphasis on leadership, accountability and multi-sectoral coordination. The updated guidelines call for active engagement with key stakeholders to operationalize airborne infection control at health facilities to prevent spread of TB along and other airborne infections.

Healthcare managers are now tasked with responsibility to implement facility-specific AIC plans that integrate administrative controls, infrastructure upgrades and personal protection for health staff. State's Mission Directors of NHM are expected to prioritize AIC through infrastructure improvements, aligning with TB elimination targets.

The District Magistrates can play a pivotal role in convening district-level Airborne Infection Control (AIC) – Infection Prevention and Control (IPC) committees for cross sector collaboration and oversight of infection control measures in both health and non-health settings.

To institutionalize these measures the States/UTs may allocate dedicated budgets for AIC activities through their Program Implementation Plans (PIPs) under NHM that reflect a systems-based approach to infection control at all public health facility and accelerates India's progress toward a TB-free future.

(Aradhana Patnaik)

#StopObesity
टीबी हारेगा देश जीतेगा / TB Harega Desh Jeetega

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आज़ादी का अमृत महोत्सव

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Message

The release of the National Guidelines on Prevention and Control of Airborne Infections, including Tuberculosis (2025), marks a significant step in strengthening India's health systems to address airborne diseases, particularly tuberculosis. These guidelines offer a structured, evidence-based framework to institutionalize administrative, environmental, and personal protection measures, to minimize transmission risks across healthcare and congregate settings in the community.

From a programmatic perspective, the guidelines are aligned with the TB Mukt Bharat Abhiyaan and Global End TB targets. Emphasizing early triage, prompt diagnosis, and cost-effective measures–such as improving natural ventilation and installing germicidal ultraviolet (GUV) systems–in high-burden facilities can significantly strengthen TB control efforts through AIC. The guideline ensures interventions that are tested and are scalable to adapt across various health facility level. Importantly, it stresses upon multisectoral engagement–covering not only public and private health facility but also non health settings like the prisons, night shelters, and households–thereby extending prevention beyond hospitals into communities.

The cost-effectiveness of AIC measures is evident in their preventive value. Simple personnel protection interventions such as proper use of masks, N95 respirators, and seeking timely healthcare, yields substantial savings by averting new TB infections, reducing drug-resistant TB burden and lowering healthcare expenditure on long-term treatment.

As India strives towards TB elimination, programmatic adoption of these guidelines will not only protect healthcare workers and patients but also optimize resources through reduced transmission and treatment costs. The Ministry calls upon all states and institutions to ensure committed implementation, thereby safeguarding public health while strengthening system resilience for future respiratory pandemics.

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MINISTRY OF HEALTH & FAMILY WELFARE

FOREWARD

Airborne infections, particularly tuberculosis (TB), continue to pose a significant risk in healthcare settings, especially in high-burden and high-footfall facilities. This risk is further amplified in settings serving vulnerable populations, where susceptibility to TB infection and severe disease is higher. Effective Airborne Infection Control (AIC) is therefore a critical public health intervention to protect patients, healthcare workers, and the community, and to prevent healthcare-associated transmission.

The National Guidelines on Airborne Infection Control in Healthcare and Other Settings, 2025 provide an updated, evidence-based framework to reduce transmission of TB and other respiratory pathogens. Aligned with the National TB Elimination Programme (NTEP) and End TB Strategy goals, the guidelines emphasise the systematic implementation of the hierarchy of controls—administrative measures, environmental controls, and respiratory protection—across all levels of healthcare. Central to this approach is the effective functioning of Hospital Infection Control Committees (HICC), which are responsible for facility-level planning, implementation, monitoring, and continuous improvement of AIC measures.

All public and private healthcare facilities are urged to operationalise these guidelines through active HICCs to break the chain of airborne transmission, safeguard healthcare workers, protect vulnerable patients, and advance India's TB elimination and health system safety goals.

(Dr. Shobini Rajan)

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FOREWORD

The *Guidelines on Airborne Infection Control in Healthcare and Other Settings* (2010) were a hallmark in shaping infection control practices. The newly released *National Guidelines on Prevention and Control of Airborne Infections, including Tuberculosis* (2025) represent a revised edition that incorporates newer concepts and approaches. Airborne infection control continues to be the cornerstone of TB prevention, protecting patients, healthcare workers, and the wider community from airborne diseases. These updated guidelines adopt a risk-based, evidence-driven framework, reaffirming India's commitment to TB elimination by reducing transmission through practical, scalable, and cost-effective interventions across all levels of the health system.

This edition emphasizes disinfection of closed spaces in hospitals, healthcare facilities, and households, alongside innovative strategies to maintain adequate Air Changes Per Hour (ACPH) even in extreme climates. It expands environmental control measures with detailed ventilation guidance—including the use of exhaust and supply fans, ACPH calculations, and HVAC planning—and provides updates on Germicidal Ultraviolet (GUV) technology for TB control. Importantly, hospital administrators are assigned a central role in implementing these measures, ensuring accountability through structured policies, resource allocation, and oversight of Infection Prevention and Control (IPC) practices. Patient education is equally prioritized, with emphasis on counselling, awareness-building, and household-level precautions to strengthen adherence and community engagement. A new sanitation chapter draws key highlights from Kayakalp 2015 and NTEP guidelines to address airborne infection control in laboratories and DR-TB centres. Structured surveillance for both TB disease and TB infection among healthcare workers is prioritized, with documentation through the Ni-kshay portal. The book underscores healthcare worker safety, risk assessment frameworks, and expands IPC recommendations beyond healthcare facilities to include household and congregate settings. It also features replicable good practices from field observations—such as fast-tracking of patients, cross-ventilated DR-TB wards and OPDs, and well-ventilated waiting areas. Additional chapters cover facility-level IPC training, simplified monitoring and evaluation mechanisms, family counselling, patient education strategies, and the role of Hospital Infection Control Committees (HICCs) in TB IPC, with emphasis on strong administrative leadership and engagement with TB program personnel.

Aligned with the mainstay of the TB Jan Andolan under the TB Mukt Bharat Abhiyan, these guidelines reaffirm TB prevention as one of the core principles of the public health response. By translating scientific advancements into operational practices—such as improved ventilation, disinfection of closed spaces, administrative control in healthcare facilities, and patient education—this document effectively bridges policy and action.

Together, with collective commitment and implementation of these enhanced measures, we can create safer healthcare environments and move closer to a TB-free India.

Prof (Dr.) Urvashi B Singh

Dr. Veena Dhawan
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Preface

The National Guidelines on Prevention and Control of Airborne Infections, including Tuberculosis (2025), mark a significant shift from earlier versions by embedding infection prevention more deeply into daily behaviour and workplace practices. The guidelines adopt a risk-based approach, focusing on high-risk areas such as TB outpatient departments (OPDs), intensive care units (ICUs), antiretroviral therapy (ART) centres, and drug-resistant TB (DR-TB) wards, rather than applying uniform measures across all settings. The scientific framework has also been updated with the newly endorsed concept of Infectious Respiratory Particles (IRPs), replacing the older droplet–aerosol classification to provide greater clarity in training and practice.

Existing governance structures are to be strengthened through multi-level AIC-IPC (Airborne Infection Control–Infection Prevention and Control) committees, integrated with National Health Mission (NHM) Quality Assurance systems, and the inclusion of TB focal persons within Hospital Infection Control Committees. Every healthcare facility is advised to prepare a written infection control plan covering human resources, budgeting, ventilation, water, sanitation and hygiene (WASH), and monitoring. The guideline introduces upper-room germicidal ultraviolet (GUV) systems, enhanced ventilation standards with benchmarks for air changes per hour, and engineering solutions adapted to India's diverse climatic conditions.

Workforce protection is reinforced through routine surveillance of healthcare workers, mandatory respirator fit-testing, screening for TB disease, initiation of TB Preventive Treatment for high-risk individuals, and linkage to Ni-kshay for reporting. To drive accountability, the guidelines prescribe quarterly reporting formats, structured audits, and facility-level risk assessments. Importantly, the scope now extends beyond healthcare facilities to community settings—such as the homes of persons with TB, to prevent transmission among family members, and congregate environments like prisons and shelters. These efforts are supported by the engagement of TB champions and community volunteers.

In summary, the National Guidelines on Prevention and Control of Airborne Infections, including Tuberculosis 2025 move beyond technical infection control to serve as a system-strengthening tool, embedding infection prevention into policy, governance, infrastructure, and workforce systems. This approach not only supports the Prevent pillar of the National Strategic Plan for TB Elimination but also enhances preparedness for future respiratory pandemics.

7/10/25

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Message

The National Guidelines on Prevention and Control of Airborne *Infection including Tuberculosis, 2025* introduce targeted measures to curb the transmission of Tuberculosis (TB) and other non-Tb airborne infections in healthcare and congregate settings. These guidelines emphasize a layered approach to infection control, prioritizing early triage, rapid diagnosis, and separation of presumptive TB. Environmental safeguards such as improved ventilation and germicidal ultraviolet (GUV) systems are mandated in high-risk zones, while fit-tested N95/FFP2 masks are now standard for healthcare workers.

Facilities treating infectious patients like TB must implement integrated infection control plans combining administrative, environmental, and personal protection strategies. Dedicated Infection Control Officers and Nurses will lead these efforts, supported by digital training platform for capacity building. Surveillance of healthcare workers and quarterly reporting through Hospital Infection Control Committees ensure accountability and timely corrective action.

The revised guidelines integrate Airborne Infection Control (AIC) more deeply into national policy and governance frameworks. The guidelines emphasize infrastructural upgrades—particularly improved ventilation—alongside enhanced healthcare surveillance and stronger Hospital Infection Control Committees. These measures are designed to accelerate TB elimination and curb the spread of other airborne infectious diseases within both healthcare facilities and community settings.'

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Acknowledgements

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Thank you to everyone involved for your collaboration and commitment to ensure the success of the comprehensive guidelines. This will play a major role in breaking the chain of transmission of TB and other airborne infections in healthcare and community settings.

Table of Contents

Abbreviations

ACH / ACPH	Air changes per hour
ACSM	Advocacy, Communication and Social Mobilization
AHU	Air Handling Unit
AIC	Airborne Infection Control
BMWM	Biomedical Waste Management
BMI	Body Mass Index
CQSC	Central Quality Supervisory Committee
DST	Drug Susceptibility Testing
DQAC	District Quality Assurance Committee
GUV	Germicidal Ultraviolet
HCWs	Healthcare Workers
HEPA	High Efficiency Particulate Air
HAI	Healthcare Acquired Infection
HICC	Hospital Infection Control Committee
IPHS	Indian Public Health Standard
ICN	Infection Control Nurse
ICO	Infection Control Officer
IPC	Infection, Prevention and Control
IRP	Infectious Respiratory Particles
IEC	Information, Education and Communication
LGBTQAI++	Lesbian, Gay, Bisexual, Transgender, Queer/Questioning, Asexual, and Intersex individual
M.tb	Mycobacterium tuberculosis
NAAT	Nucleic Acid Amplification Test
NQAS	National Quality Assurance Standards
NTEP	National Tuberculosis Elimination Programme
PAO	Poly Alpha Olefin (a liquid used in HEPA filter integrity test)
PwTB	Persons with TB

PPE	Personal Protective Equipment
PIP	Programme Implementation Plan
PMDT	Programmatic Management of Drug-Resistant TB
STS	Senior Treatment Supervisor
SQAC	State Quality Assurance Committee
TBHV	TB Health Visitor
TNF	Tumor Necrosis Factor
TPT	Tuberculosis Preventive Treatment
WASH	Water Sanitation and Hygiene
WHO	World Health Organization

Definitions

Airborne transmission of Mycobacterium tuberculosis (M.tb): spread of M.tb caused by the dissemination of infectious respiratory particles when suspended in air over long distances and time.

Air changes per hour (ACH / ACPH): is a metric used in ventilation systems to quantify the number of times the air within a specific area is completely replaced in one hour. One air change has occurred when the volume of air entering or exiting a room is equal to the volume of the room. The proportion of airborne particles eliminated with each air change is 63%, under ideal conditions of mixing. A second air change removes 63% of what remains, and so on. Subsequent increases in air changes leads to an exponential reduction in airborne particles. If a room has a 12 ACPH, 99% of removal efficiency is achieved in 23 mins and 99.9% efficiency is achieved in 35 mins. 6 ACPH on the other hand will take 46 mins for 99% and 69 for 99.9%.

Airborne precautions: a series of interventions to reduce spread of airborne infections, including patient placement in a separated well-ventilated area, the use of source control (like a medical mask) for patient for transportation outside patients' isolation area, and the use of particulate respirators (like N95) by HCWs. These precautions are generic for all airborne infections, but they also contribute to reduce the spread of TB.

Airborne isolation room: is a specialized single-occupancy room designed to isolate individuals with suspected or confirmed airborne infectious diseases, such as tuberculosis, measles, or chickenpox, having ≥ 12 air changes per hour (ACH) and controlled direction of air flow to contain airborne infections. It can be naturally or mechanically ventilated.

Antigen based skin test: These tests are used for screening of Tuberculosis infection among risk populations like household contacts of Persons with TB and Healthcare workers. Modern intradermal TB antigen-based skin tests contain a combination of two recombinant proteins, which are specific to Mycobacterium tuberculosis. Some of these tests are Cy-Tb, Diaskintest and CTB. Currently, Cy-Tb is used under NTEP.

Cough Corner: an area of separation of respiratory symptomatic patients. This area should be well ventilated with availability of masks.

Cough hygiene also known as cough etiquette. It refers to the practice of covering the mouth and nose during coughing with a tissue, cloth, or by your elbow or by wearing a medical mask to prevent the spread of respiratory infections when coughing or sneezing.

Environmental Controls: include methods to reduce the concentration of infectious respiratory particles in the air, and methods to control the direction of infectious air. The choice of environmental controls is intimately related to building design, construction, renovation and use, which in turn must be tailored to local climatic and socioeconomic conditions.

GUV: Germicidal Ultraviolet: A modern term for UVG Irradiation (UVGI). The terminologies given below are used for explaining different aspects of GUV

- Upper Room GUV: Continuous upper air room disinfection by GUV, in which shielding placed below the GUV sources prevent injury to occupants.

- In-duct GUV: High-intensity GUV in the ducts of a mechanical ventilation system (in-duct GUV);
- Dosage: Dosage the irradiance absorbed in unit time and is expressed in Joules (J), microjoules (μJ), millijoules (mJ) per area.
- Irradiance: Is the flux of radiant energy per unit area and is expressed in W, mW or μW per m^2, cm^2 etc.
- Output: Output is the flux (flow) of radiant energy that is emitted from the UV lamp. The output can be that of the lamp and that of the fixture. The lamp output is modified by louvers to provide safety in occupied zone. GUV output is usually expressed in Watts (W).
- Louvers: Louvres are shutters of upper-room GUV fixtures with horizontal slats that are angled to allow UV light to be transmitted to the upper part of the room
- Kill zone/ Disinfection zone: Upper-room GUV systems aim to create a disinfection zone located above the people occupying a room. They kill or inactivate any airborne pathogens that pass through the disinfection zone and thus reduce the risk of airborne infection.
- Occupied zone/ breathing zone: This is the zone occupied by healthcare workers and patients and the irradiance levels here should confine to the prescribed safe limit.

Healthcare Associated Infection (HAI): An infection occurring in a patient during the process of care in a hospital or other healthcare facility, which was not present or incubating at the time of admission. HAIs can also appear after discharge.

Hand hygiene: A general term referring to any action of hand cleansing, that is, the action of performing hand hygiene for the purpose of physically or mechanically removing dirt, organic material, and/or microorganisms.

Healthcare facility: any establishment that is engaged in direct patient care on-site.

Healthcare setting: A setting where healthcare services are provided (e.g. hospital, outpatient clinic or home).

Healthcare workers: all people, in public and in private services, in the health sector and other sectors, whose main activities are oriented towards patient-care. This includes providers - such as doctors, nurses, pharmacists, laboratory technicians, paramedical worker and support workers such as janitor, security guard, administration and finance staff in healthcare settings.

Hierarchy of TB infection prevention and control (IPC) measures: it consists of a structured combined approach measures designed to minimize the risk of airborne/ M.tb transmission within populations. Three-level of controls comprising administrative controls, environmental controls and respiratory protection, reduces exposure to M.tb and helps prevent transmission.

HEPA filtration: 'High Efficiency Particulate Air' filtration that removes at least 99.97% of particulates that are 0.3 microns or larger, such as respiratory particles, from the air and thus improving air quality. This represents the minimum acceptable performance standard.

Hospital Infection Control Committee (HICC): an integral component of infection prevention and control of healthcare facility and responsible for establishing and maintaining the IPC program and its various functions of monitoring, surveillance, reporting, research and education. The HICC should have wide representation from all relevant disciplines or departments in the facility.

HIV care settings: facilities involved in healthcare of primarily HIV-infected persons. These

include anti-retroviral treatment centres and community-care centres.

HVAC system: Heating, Ventilation and Air conditioning system to enable mechanical ventilation.

Infection control assessment: is a systematic assessment of a healthcare facility's infection prevention and control (IPC) practices being implemented through, administrative controls, environmental controls, and respiratory protective equipment.

Infection control nurse (ICN): a designated nursing staff having training in infection, prevention and control, preferably through an accredited course. The duties of ICNs are primarily associated with ensuring the practice of IPC by HCWs.

Infection Control Officer (ICO): usually a clinical microbiologist or epidemiologist or any other physician or an officer designated by HICC, specializing in infectious diseases or any other physician with training in infection prevention and control. ICO is the member secretary of HICC. As a leader of the IPC team, ICO is responsible for monitoring day-to-day infection prevention and control activities in the health facility.

Infection, Prevention and Control Team (IPC team): comprises of Infection control physician, ICO, ICN and one link nurse from every unit responsible for day-to-day monitoring activities of infection, prevention and control.

Infectious Respiratory Particles (IRP): pathogens contained within a particle (known as 'infectious particles'), that travels through the air and is carried by expired airflow, which enter the human respiratory tract (or are deposited on the mucosa of the mouth, nose or eye of another person); pathogens from any source (including human, animal, environment), that cause predominantly respiratory infections (e.g., TB, influenza, SARS, MERS) but also those pathogens causing infections involving respiratory and other organ systems (e.g. COVID-19, measles).

Link nurse: a nurse from each patient-care unit is designated for monitoring day-to-day infection, prevention and control activities in the unit is called link nurse. Link nurse is a useful adjunct to the ICN to implement infection control practices in the ward and to assist in surveillance of hospital acquired infection. The link nurse does not replace an ICN as the link nurse's primary responsibility and area of work is patient care in the ward.

Mechanical ventilation: ventilation is created by using a supply and/or an exhaust fan to force air exchange and to drive airflow. It works by generating negative or positive pressure in the room to drive air changes.

Medical masks: flat or pleated mask and are affixed to the head with straps around the ears, the head or both. Their performance standards are tested using a set of standardized test methods – American Society for Testing Materials (ASTM) ASTM F2100, EN 14683 or equivalent – that aim to balance high filtration, adequate breathability and (optionally) fluid penetration resistance.

Mixed-mode ventilation: a system that combines the use of both mechanical and natural ventilation. It provides the opportunity to choose the most appropriate ventilation mode based on the circumstances.

Personal protective equipment (PPE): Equipment and/or clothing worn by personnel to provide a barrier against biological agents, thereby minimizing the likelihood of exposure. PPE includes, but is not limited to, laboratory coats, gowns, full-body suits, gloves, protective footwear, safety glasses, safety goggles, masks and respirators.

Particulate respirators: a special type of closely fitted mask with the capacity to filter particles

to protect from inhaling airborne particles of very small sizes. The N95 respirator has filter efficiency level of 95% or greater against particulate aerosols free of oil when tested against 0.3 μm particles. The "N" means "Not resistant to oil". The "95" refers to 95% filter efficiency. The FFP2 respirator has filter efficiency level of 94% or greater against a 0.4 μm particles and is tested against both oil and a non-oil aerosol. The performance of N95 respirators is approved by the National Institute for Occupational Safety and Health (NIOSH) of the United States Centers for Disease Control and Prevention. The performance of FFP2 respirators must comply with the essential health and safety requirements set out in European directives; that is, with "Conformité européenne" (CE).

Risk: a combination of the likelihood and consequences of an event related to a specific hazard.

Risk assessment: the process of evaluating the risk or risks arising from a hazard or hazards, considering the adequacy of existing control measures; an in-depth facility description of risk of HAI transmission including airborne transmission, as well as assessment of patient population, work practices and ventilation.

Respiratory protection: use of personal protective equipment over the nose and mouth in situations that pose a high risk of exposure to M.tb and/or other airborne infections.

Respiratory separation (or isolation): measures aimed at decreasing or eliminating the risk of airborne M.tb and other respiratory infections transmission from infectious individuals to other people seeking medical attention in a healthcare facility or to healthcare workers; such methods include use of pressure rooms, individual rooms or designated units like cough corners, or timing of care procedures.

Seal check: the person using a respirator performs a seal check to determine whether the respirator is being properly worn/ sealed to their face.

Standard precautions: practices that are applied to all patients receiving care in health facilities, regardless of their diagnosis or presumed infectious status so as to minimize the risk of transmission of infectious agents in all situations. Standard precautions minimize the likelihood of transmission of infectious agents between HCWs and patients, and from patient to patient.

Triage (in relation to TB): in the context of TB IPC, this refers to a simple and preliminary intervention for identifying people with signs or symptoms of TB among those seeking medical attention in health care facilities. Triage is used to fast-track the diagnosis of TB disease and facilitate further separation or other precautions, when necessary, to minimize transmission from infectious patients.

Water Sanitation and Hygiene (WASH): infrastructure that supports water, sanitation, hygiene (WASH) and healthcare waste management practices that help prevent the spread of diseases within the healthcare facility and to the surrounding community.

Key Implementing Stakeholders

In 2020, the Revised National TB Control Program (RNTCP) was renamed as the National TB Elimination Program (NTEP) to emphasize the aim of the Government of India to eliminate TB in India.

Synergistic efforts of all stakeholders involved in TB control in India is the key towards realising the goal of 'Universal access to TB care and treatment for all'. The NTEP recognizes the importance of multisectoral collaboration in its fight against TB.

This guideline document on AIC-IPC provides a set of strategic steps and activities for the prevention pillar, for effectively engaging the different stakeholders so that they are aware, informed and empowered. This document will further enrich the nation's efforts and commitment to achieve a TB-free society. The different stakeholders can play a critical role in the mission to end TB by supporting scale-up of TB prevention interventions at health care facilities.

This guideline will provide directions for TB infection prevention and control in health care and congregate settings. The different stakeholders who will be benefitted by the guideline are state and district level health officials, Dean/Principals, Medical Superintendents, clinical and paraclinical staff, Hospital Managers/Quality Managers/Health Managers, Housekeeping-in-charge, Class 3 & Class 4 staff of the hospitals, Medical Officers and para-medical healthcare workers of the general health system/other health programmes and private sector, other health providers, Community Health Workers, and Civil and Bio-medical Engineers of the medical institutes. The recommendations in this volume are crosscutting, starting from the family and community level to the health system from Ayushman Arogya mandirs and upwards, up to the tertiary care and referral hospitals. It is applicable equally to public and private sectors. It is also applicable to any congregate settings where there is risk of airborne infections.

1 INTRODUCTION

Tuberculosis (TB), caused by Mycobacterium tuberculosis (M.tb), is an airborne infectious disease. Due to its mode of transmission, individuals in close contact with TB patients—particularly in high-risk settings such as healthcare facilities, densely populated urban slums, prisons, homeless shelters, and other congregate environments—are at increased risk of infection.

Recognizing this, India's National Strategic Plan (NSP) 2017–2025 for Ending TB outlines a bold and accelerated approach through four strategic pillars: Detect – Treat – Prevent – Build. A key focus under the 'Prevent' pillar is the scale-up of Airborne Infection Control (AIC) measures in both healthcare facilities and community settings. The NSP emphasizes the implementation of AIC interventions in accordance with established guidelines to reduce the risk of transmission.

At the global level, the World Health Organization (WHO) End TB Strategy highlights the critical importance of implementing effective infection prevention and control (IPC) practices, particularly in countries with a high TB burden. The WHO's Consolidated Guidelines on Infection Prevention and Control – Module 1 offer comprehensive recommendations to support countries in establishing and strengthening IPC measures in healthcare and other high-risk settings where TB transmission is likely.

1.1 Importance of airborne infection control in TB Elimination

Airborne infectious diseases including TB is an important occupational risk for healthcare workers and hence Airborne infection control measures implemented at healthcare facilities is crucial for limiting the spread of such respiratory infection, protecting both patients and healthcare workers, and reducing the overall burden of the disease in affected populations. The risk is increased with inadequate infection control strategies.

COVID 19 pandemic drew the attention of the healthcare authorities to the need for implementing standard infection control precautions and improve preparedness for controlling transmission of respiratory infection.

Implementing effective infection control practice is crucial for cutting the chain of transmission by reducing exposure of infectious respiratory particles in healthcare, congregate settings and community settings and thus help reduce the incidence of TB and the spread of drug-resistant TB strains.

1.2 Objectives of the guidelines

This document is a consolidation of AIC strategies and operational aspects presented in the various national and global guidelines and will serve as guidance document for stakeholders.

This guideline emphasizes the need to implement the hierarchy of infection control for strengthening IPC and reducing the risk of M. tb transmission.

Reference national and global guidelines

- National Guidelines on Airborne Infection Control in Healthcare and Other Settings 2010
- National Guidelines for Infection Prevention and Control in Healthcare Facilities-2020
- Operational Guidelines for Improving Quality in Public Healthcare Facilities, 2021
- National Guidelines – Rejuvenating the Public Healthcare Facilities, 2024
- National Guidelines for Implementation of "KAYAKALP" Initiative, 2015
- National Guidelines for Management of Healthcare Waste as per BMWM Rules, 2016 amendments 2018
- Healthcare Worker Surveillance for Tuberculosis in India, A handbook for health facilities, 2016
- National Guidelines for Programmatic Management of TB Preventive Treatment in India, 2021
- National Guidelines for Programmatic Management of Drug-Resistant TB in India, 2021
- NTEP Training Modules, 2020
- Biosafety Manual for Tuberculosis Laboratories under NTEP, 2023
- Tuberculosis Laboratory Safety Manual, WHO, 2012
- WHO Operational handbook on tuberculosis, Module 1: Prevention, 2023
- WHO Guidelines on core components on Infection Prevention and Control, 2016
- WHO Global technical consultation report on proposed terminology for pathogens that transmit through the air, 2024
- Laboratory Safety (Tuberculosis work safe), The Handbook Global Edition, 2019
- Care, Cleaning, Disinfection and Sterilization of Respiratory Devices; WHO
- Tuberculosis infection control: a practical manual for preventing TB. San Francisco, CA: Curry International Tuberculosis Center; 2024

Also indebted to:

- Open sources for illustrations
- Institutions for photographs of good practices

2 MODES OF TRANSMISSION OF TB AND OTHER RESPIRATORY PATHOGENS

Understanding the modes of transmission for any pathogen is essential for developing and adapting effective and appropriate public health, clinical, infection prevention and control measures and mitigate the spread of that pathogen. However, one of the major challenges to describe infection transmission through air was resurfaced during the COVID-19 pandemic. During the pandemic, the terms 'airborne', 'airborne transmission', 'droplets' and 'aerosols' were used in different ways, by different stakeholders, which contributed to confusion in communicating how this pathogen was transmitted in human populations via air. This highlighted the need for better alignment of these terms across disciplines, agencies and pathogens.

2.1 Infectious Respiratory Particles (IRPs)

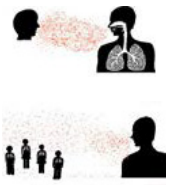
In November 2021, WHO convened a global technical consultation with the aim to resolve inconsistencies and seek agreement regarding descriptors and terminology relating to the transmission of pathogens through the air. The agreed guidance is mentioned below.

- Infectious respiratory particles" (IRPs) is a term introduced by the World Health Organization (WHO) to describe particles expelled from the mouth or nose when an infected person breathes, talks, sings, coughs, sneezes, or spits. These particles can carry pathogens responsible for respiratory diseases such as COVID-19, influenza, measles, MERS, SARS, and tuberculosis.
- IRPs exist on a continuous spectrum of sizes, meaning there is no strict cutoff between smaller and larger particles. This terminology helps move away from the traditional distinction between "aerosols" (smaller particles) and "droplets" (larger particles). The WHO's goal is to create a unified understanding across scientific disciplines, improving public health communication and response strategies

2.2 Modes of transmission of IRPs

The mode of transmission (Table 2.1) includes the formation, release, transport and biophysical/biochemical changes in IRPs that occur when they move away from an infectious individual and travel towards another individual. In addition, IRPs may directly deposit on the mouth, nose or eye of another individual, and can potentially lead to infection in the individual.

Table 2.1 - Features of IRP and descriptors for modes of transmission

Mode of transmission	Typical distance from the source	Routes of transfer to another human	Respiratory tract entry mechanism	Respiratory tract entry portal	Schematic depiction
THROUGH THE AIR					
Airborne transmission / inhalation	Any distance	Through the air (suspended in air or moving via airflow)	Inhalation	Anywhere along the respiratory tract	
Direct deposition	Short	Through the air (semi-ballistic trajectory)	Deposition on the mucosa	Mouth, nose or eyes*	
CONTACT #					
Direct contact	Short	Not through the air	Direct transfer (via touch @, usually with hands)	Mouth, nose or eyes*	
Indirect contact	Any distance	Not through the air, although IPRs may reach the intermediate object through the air	Indirect transfer (via touching an intermediate object)	Mouth, nose or eyes*	

Note:

- The mucosa of the eyes is not part of the human respiratory tract but is also a portal of entry into the respiratory system.
- This mode of transmission to another human does not involve a 'through the air' route but is included here for completeness. Depictions above assume that the human(s) on the left is/are the infectious person(s) and the human on the right is the recipient of the IRP.
- 'Touch' is not through the air transmission but included for completeness and it does not include sharp injuries like needle prick.

- **Airborne transmission/inhalation:** Occurs when IRPs are expelled into the air and enter through inhalation the respiratory tract of another person. This form of transmission can occur when the IRPs have travelled either short or long distances from the infectious person. The penetrance of the IRP within the respiratory tract, during airborne transmission, can occur to any point along the human respiratory tract (the bronchi, bronchioles and alveoli) but the degree of penetrance is pathogen specific. It should be noted that the distance travelled may depend on multiple factors including particle size, mode of expulsion and environmental conditions (such as airflow, humidity, temperature, setting, ventilation, etc.). This is the route of transmission for Tuberculosis infection.
- **Direct deposition:** Occurs when IRPs are expelled into the air following a short-range semi-ballistic trajectory, then are directly deposited on the exposed facial mucosal surfaces (mouth, nose or eyes) of another person, thus, entering the human respiratory tract via these portals and potentially causing infection.

- **Contact transmission:** Contaminated surfaces are created when IRPs expelled into the air settle on a surface, or when an infected person transfers infectious respiratory secretions by firstly touching their own mouth, nose or eyes and then touching a surface or shaking hands. Infectious pathogens on the contaminated surfaces are then transferred to another person who touches that contaminated surface and then their own mouth, nose or eyes. This is commonly known as indirect contact transmission. In addition, direct contact transmission can occur when an infectious person directly transfers infectious pathogens from their own respiratory tract, not via IRPs, to another person by being in direct contact with that person (e.g. via a handshake), who then directly transfers the IRPs into their own mouth, nose or eyes. This form of transmission does not directly involve the transmission of pathogens to humans through the air, so is not considered part of the 'through the air' descriptors covered by this guideline but is included here for completeness.

2.3 Factors that influence airborne transmission

There are many factors that can influence the particle distribution, spread and subsequent effect on an individual of exhaled IRPs:

- **Host:** Immune status of the host, including prior infection, vaccination, status of innate, cellular and humoral immunity.
- **Pathogen characteristics:** The ability of the pathogen to remain infective after suspension in the air and the dose-infection relationship for the pathogen after it deposits on a surface in the host's respiratory tract;
- **Particle size:** IRPs are formed with a continuous spectrum of aerodynamic sizes, and no single cut off points should be applied to distinguish smaller from larger particles, this allows to move away from the dichotomy of what have previously been known as 'aerosols' (generally smaller particles) and 'droplets' (generally larger particles). Nonetheless, there are usually more numerous smaller, compared to larger, particles.
- **Speed of expulsion:** The speed of expulsion can vary depending on the force of expiration and other factors relating to the surrounding conditions. Because of dilution, the concentration of IRPs is higher closer to the source (where the IRPs exit the infectious person's respiratory tract) and become less concentrated as they disperse randomly further away from the source.
- **Influence of gravity:** Under the influence of gravity, after being expelled, larger IRPs rapidly fall, eventually reaching the ground or another surface, usually within 1-2metres of where they were emitted from the infectious person's respiratory tract.
- **Mode of expulsion:** Activities resulting in more forceful expiration (i.e., larger total momentum), such as sneezing, coughing, loud singing and shouting, are known to propel IRPs further than 1-2 metres.
- **Evaporation:** Following emission from the mouth and/or nose, IRPs of all sizes undergo evaporation of some of their water content. IRPs decrease in size and weight at various rates in a common environment. Evaporation rate has an impact on how long particles remain in the air and how far they may be transferred before settling on a surface. The smaller the particle, the longer it is likely to remain in the air, and the further it is likely to travel.

- **Environmental conditions:** In addition to the above factors for transmission, the ambient air temperature, sunlight, humidity, airflow and size, occupancy and use of the space where IRPs are expelled impact the infectivity, duration, speed of transmission and distance travelled of IRPs.
- **Concentration of IRPs:** With increasing distance from the source, dilution with ambient air increases and concentrations of IRPs decrease. Concentrations are also affected by ambient airflows from ventilation systems. Concentrations can increase over time if ventilation is inadequate.
- **Quantum of Infection:** It refers to the minimum number of infectious airborne particles required to cause infection in a susceptible host.

After IRPs are emitted from an infectious person, they progressively diminish in infectivity over a time frame specific to the pathogen. This is either due to decrease in an organism's infectivity with time, or more dispersion, or dilution leading to lower concentrations of particles in the air at any given position. The modes in which IRPs travel, enter and potentially infect another individual can broadly be described as in table 2.1.

3 POLICY LEVEL INTERVENTIONS - MANAGERIAL ACTIVITIES: AT NATIONAL, STATE, DISTRICT AND FACILITY LEVELS

The first crucial step for successful implementation of AIC is a strong commitment from the policy makers. Such efforts should ensure political and institutional commitment and leadership at all levels (national, state, district and facility level). The managerial activities are based on public health principles and represent the foundation of any public health program. Facility level managerial activities should be in line with the national, state and district level managerial activities and support the implementation of the policies through administrative mechanisms.

3.1 Multilevel approach for AIC-IPC

Effective enablement of AIC-IPC is not confined to the facility alone. Mechanisms should be defined and facilitated though all levels. All levels of the health system, at the management level, should have commitment and clear policies to implement effective AIC. An indicative list of policy interventions at each level is shown in the table 3.1. The flow of information and policies will be a top-down approach whereas the reporting pattern will be from a bottom-up approach. Such a process will ensure continual improvement.

Table 3.1: Multilevel approach for AIC (National, State, District, Facility)

Level	Committees	Policies
National	National Infection Control Committee / Central Quality Supervisory Committee or Equivalent.	Designate Nodal Person/Department responsible. Frame the guidelines, staffing norms, training needs and M&E mechanisms.
State	State Infection Control Committee / State Quality Assurance Committee or Equivalent.	Designate nodal person, allocate budgets and staff, disseminate guidelines. Ensure capacity building and Health facility supervision. Monitor and evaluate the implementation.
District	Sub-committees for BMW and IPC under District Health Societies / District Quality Assurance Committee or Equivalent.	Designate nodal person, allocate budgets and staff, disseminate guidelines. Ensure capacity building and HCW surveillance. Monitor and evaluate the implementation.

Facility	Hospital Infection Control Committee.	Allocate budgets, develope Facility Infection Control Plan that includes administrative, environmental and respiratory protection. Implement HCW surveillance, risk assessments and capacity building of all staff for AIC-IPC.

3.2 Core components

National guidelines for infection prevention and control in healthcare facilities by National Centre for Disease Control (NCDC) has enumerated 8 core components that need to be addressed at the policy level.

The figure 3.1 denotes the core components that are to be addressed through the management to enable effective Infection Prevention and Control. Five of these components are depicted as pillars and others as the foundation. Compliance with the core components through policy development will create an enabling environment to achieve IPC and AIC. The details of each are explained below.

Figure 3.1: Core components of IPC

Table 3.2 : Core components of managerial responsibilities in context of AIC-IPC

Core Component	National/State/District Level AIC IPC Policy level Interventions	Facility Level AIC IPC Policy level Interventions
IPC programs:	The national government addresses the need for AIC-IPC through committees to define policies that address the specific needs of each level of healthcare. National Guidelines on Airborne Infection Control in Healthcare and Other Settings 2010 also outlines committees at national, state and district levels. Further, the Operational Guidelines for Improving Quality in Public Healthcare Facilities 2021 clearly states inclusion of TB discussions in the NHM committees. The integration with Central Quality Supervisory Committee (CQSC) State and District Quality Assurance Committees (SQAC and DQAC) of the NHM will synergize AIC practices at all levels of healthcare. Inclusion of focal person from TB or respiratory medicine in these committees is important for AIC to be prioritized in overall IPC program structure.	A well-organized IPC program is a basic requirement in every Health Care Facility. The head of the institute should chair the Hospital Infection Control Committee (HICC). TB focal persons at that level should be included in the composition of committee.
IPC Guidelines	The following guidelines are available in the country for AIC with implementation Guidelines for Kayakalp, National guidelines for infection prevention and control in healthcare facilities, Guidelines on Airborne Infection Control in Healthcare and Other Settings.	Facility-specific Infection Control Plan/ IPC manual should be available in each facility to guide the users on each aspect of AIC. It should be clear, unambiguous and preferably translated in the local language.

Education and training	Multiple resource material listed under Section 1.4 of this document are available as educational material. Additionally, The Central TB Division undertakes regular training for all components of AIC. Training trainers at regional levels followed by facility level training are being carried out. The training of trainers facilitates the development of pools of resource people in each region. The training modules are being uploaded on Swastya e Gurukul for wider reach and continued education. Link: https://swasth-egurukul.in	HICC should organize and conduct regular AIC educational and training activities for all HCWs. Resource material for these trainings is provided by the CTD. The method of training is further detailed in Chapter 12 of this document.
HAI surveillance	Healthcare Worker Surveillance in the context of TB differs from the other HAIs. At National Level, Guidelines for HCW surveillance, for both TB disease and infection, testing, treatment, TPT etc. are available. (Healthcare worker Surveillance for Tuberculosis in India 2016, Guidelines for programmatic management of tuberculosis preventive treatment 2021.)	At Facility levels: HICC should implement the surveillance activities as directed by this guidelines. Chapter 11 of this document details the surveillance methodology for both TB disease and TB infection among healthcare workers. This data should be documented in the facility and uploaded on the Ni-kshay portal for centralized monitoring and larger policy level decisions.
Multimodal Strategies	Multiple modalities are employed by the NTEP to address the elimination of TB. In the prevention pillar these include advocacy and communication to the patients, their families and the larger community. Advocacy, Communication, and Social Mobilization (ACSM) is one of the important components of the National TB Elimination Program (NTEP). Multiple IEC materials are available for TB awareness under the NTEP.	Increased accountability via monitoring and timely feedback to be provided and acted upon. HICC to monitor and take timely action. Reminders in the workplace (IEC) (Standardized IEC material to be displayed in all necessary places for patient & community education, and as work instructions/job-aids for the staff).

	System changes with appropriate infrastructures and supplies to enable IPC practice is made available. (e.g. finance division to ensure resources allocation through state program implementation plan (PIP))	Culture change within the establishment is to be sought by HICC, with leadership engagement to enable positive reinforcement strategies to promote practices that ensure patient and HCW safety. Sensitization of the higher management and handholding of the frontline staff to be regularly undertaken by HICC
Monitoring and Feedback	Chapter 13 of this document gives guidance on monitoring and evaluation of AIC-IPC practices. In addition, the NQAS assessments capture IPC as one of the areas of concern. HAI Surveillance networks are available at the national level	The HICC should facilitate periodic risk assessments, deliberation of observations and provide mitigative measures. A mechanism for quarterly reporting of AIC activities has been suggested in this guideline. Both the minutes of the HICC meeting, and the quarterly report should be transmitted to the health system, as described in Chapter 13, for the program to take informed decisions.
Workload, staffing and bed occupancy	Guidance such as staffing norms, ambulatory care and minimizing admission, decentralized treatment in context of TB and drug-resistant TB are given from the national level.	Bed occupancy should be as per the capacity of the hospital keeping AIC in the forefront. OPD footfall may be regulated with spaced appointments More information on this given in Chapter 5, Administrative Controls.
Built environment, materials, and equipment, WASH	Chapter 6 of this guideline gives recommendations on basic engineering considerations with emphasis on ventilation. Remedial measures for inadequate ventilation are also suggested. Chapter 7 of this guideline enumerates sanitation practices with refence to TB-IPC. Guidelines for Kayakalp (2015), National guidelines for infection prevention and control in healthcare facilities give recommendations for WASH practices.	The facilities should implement all the aspects of chapters 6 and 7 to enable optimum built environment. HICC should monitor ventilation and the elements around WASH.

3.3 Multistakeholder and multisectoral approach for AIC

The management activities at all levels, for TB IPC, involves engagement of all stakeholders, both within multiple levels of health system and outside of it. TB AIC will require a multisectoral and multistakeholder approach. The stakeholders start with healthcare facilities in all sectors, public, private, and community-based organizations. All these facilities should practice AIC measures, being coordinated by the National TB Elimination program (NTEP). Coordination with other National programs like NACP (national AIDS Control Program), NPCDCS (National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular diseases, and Stroke) and RMNCHAH+N (Reproductive, Maternal, Newborn, Child Adolescent Health and Nutrition) is also vital to prevent transmission. TB AIC activities should also inform and take inputs from the PMAs (Professional medical associations like IMA). Additionally, non-healthcare congregate settings like prisons, refugee camps, shelters should be covered under the TB AIC activities. Lastly, prevention of transmission from households should be addressed through the community and patient education programs through community volunteers. TB champions should be engaged at all levels for effective communication.

Figure 3.2 Diagramatic representation of multisectoral, multi stakeholder engagement for AIC-IPC activities.

3.4 Establishment of AIC program at facility level

- Conduct a facility-risk assessment and develop a facility plan for airborne infection control
- Rethink and reevaluate the use of available or existing spaces and consider renovation and/or construction to optimize implementation of controls
- Designate focal points for the facility-level activities, and support training of frontline HCWs
- Ensure proper implementation of the administrative controls (listed below)
- Ensure budget for maintenance
- Regularly supervise and monitor infection control activities
- Recording and Reporting
- Address training and communication needs of HCWs, patients and visitors

All the above points are discussed in detail in subsequent chapters, given as annexures or links.

3.5 Facility infection control plans

Each healthcare facility caring for patients with respiratory infections should develop and implement an appropriate infection control plan, including the airborne infection control component.

Infection control plans serve to establish visible commitment of facility and facility administration for infection prevention. The plan should also identify the resources in terms of human, material and funding for executing the infection control plan.

Broad areas of infection control suggested to be covered in facility infection control plan:

- Facility procedures for Standard precautions
    - ◊ Hand hygiene
    - ◊ Use of personal protection tools (gloves, gowns, masks, shields)
    - ◊ Following respiratory hygiene and cough etiquette
    - ◊ Prevention of injury from needles or other sharp objects
    - ◊ Cleaning and disinfecting medical equipment
    - ◊ Keeping the patient care environment free from infection
    - ◊ Linen and waste management
- Facility bio-medical waste management protocol
- Procedures for de-compression of crowded areas
- Infection control training of HCWs
- HCW safety Surveillance

4 HIERARCHY OF CONTROLS TO REDUCE THE RISK OF TRANSMISSION OF RESPIRATORY PATHOGENS

In settings where there is a high risk of M. tb transmission, it is important to develop and implement multisectoral actions for AIC across the health and non-health sectors. These actions should include administrative, environmental, and respiratory control measures. The selection of the combination of controls will be based on the results from infection control assessment and informed by local epidemiological, climatic, socioeconomic conditions and availability of resources. Interventions within the three-level hierarchy of IPC should be implemented as an integrated package and not be prioritized individually or implemented separately.

Table 4.1: Three levels of hierarchy of AIC-IPC

Administrative controls	Environmental control	Respiratory protection
• Triage of PwTB or presumptive TB • Respiratory separation • Prompt diagnosis and initiation of TB treatment of people with TB disease and preventive treatment to eligible high-risk individual • Respiratory hygiene	• Ventilation system • Upper-room germicidal ultraviolet (GUV) systems • Sanitation	• Particulate respirators or masks, within the framework of a respiratory protection recommendation

Administrative controls: Administrative controls are interventions aimed at reducing exposure and thus the transmission of M. tuberculosis in health facilities and congregate settings. Administrative controls are to identify persons with respiratory symptoms, separate them into appropriate environment, fast-track them through the Healthcare facility to reduce exposure time with others, and diagnose/treat them with minimal delay. Hospitalization should be reduced or avoided to the greatest extent possible. At facility level, administrative controls play a major role in reducing the risk of TB transmission and are essential for the implementation of other controls (i.e. environmental controls and respiratory protection).

Environmental Controls: They are the second pillar of the triad of AIC-IPC measures and should be implemented in combination with other AIC measures. The aim is to reduce the concentration

of infectious particles in the air through a mix of interventions for dilution, removal, filtration or disinfection. The choice of environmental controls is largely determined by local factors and resources. Ventilation should be prioritized to reduce the number of infectious particles in the air. Effective ventilation may be achieved by natural ventilation wherever possible. In high-risk settings where optimal ventilation cannot be achieved through natural or mechanically aided means, properly designed, placed and maintained shielded germicidal ultraviolet (GUV) systems should be considered as a complementary control.

Respiratory protection: It should be implemented as a part of a package of AIC interventions. Respiratory protection (e.g. particulate respirators models certified as N95 or FFP2 and respirator fit testing for all high-risk HCWs) should be available as required in high-risk situation, especially drug- resistant tuberculosis, and during high-risk aerosol-generating procedures such as bronchoscopy or sputum induction. However, inappropriate implementation of respiratory protection measures, or reliance on these measures alone, may create a false sense of security and increase the risk of TB.

5 ADMINISTRATIVE CONTROL STRATEGIES

The administrative controls serve as a first line of defence in the three-level hierarchy for preventing the spread of TB and other airborne infections in healthcare settings. Key strategies under administrative controls are mentioned in figure 5.1 and elaborated further in this chapter.

Figure 5.1:Key strategies under administrative controls

Administrative controls

- Triage of patients with TB or presumptive TB
- Respiratory separation
- Prompt diagnosis and initiation of effective TB treatment of people with TB disease and preventive treatment to eligible high-risk individual
- Respiratory hygiene

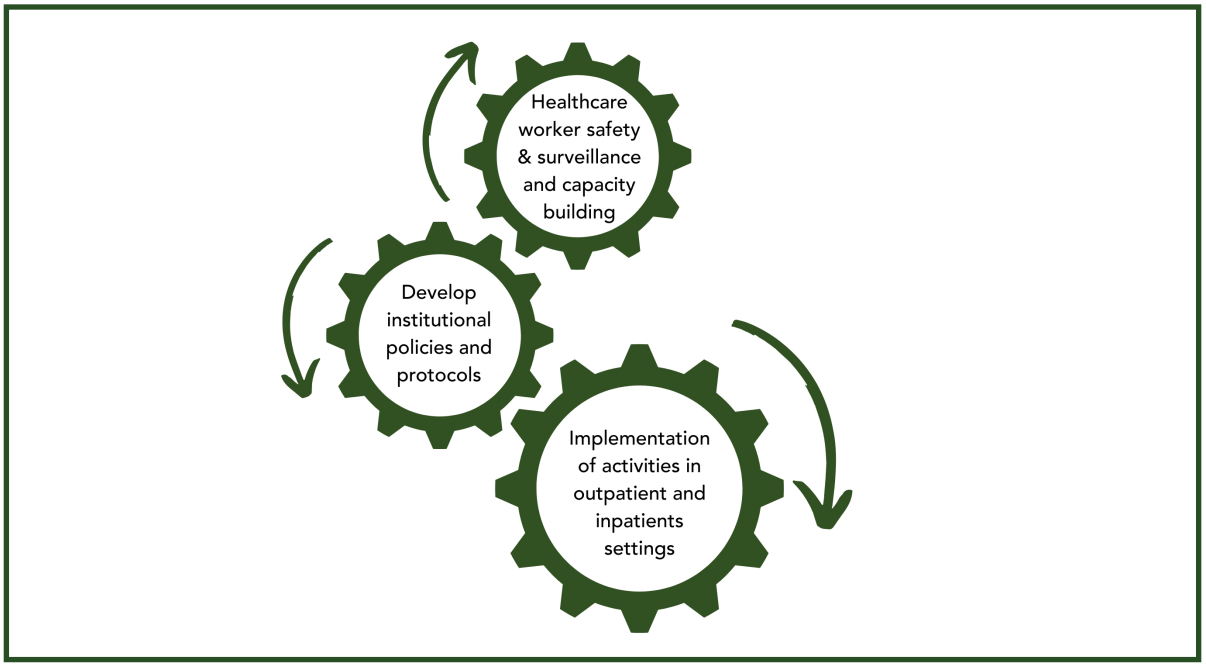
The administrative controls implemented at the facility level are broadly classified into 3 components-

a) Development of institutional policies and protocols;

b) HCW safety and surveillance; and

c) Implementation of activities in outpatient and inpatient settings (figure 5.2).

Figure 5.2: Components of administrative controls implemented at the facility level

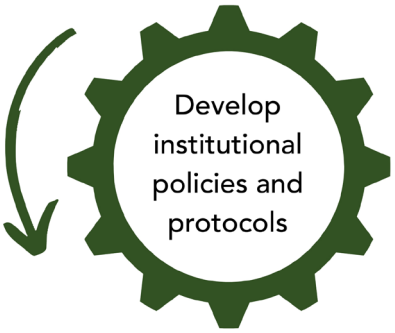


5.1 Develop institutional policies and protocols

Each facility should have a written IPC and AIC plan, protocol and policies in alignment with the national polices. Institutional policies and protocols at facility level are summarized below in figure 5.3.

Figure 5.3: Summary of development of institutional policies and protocols at facility level

- Formation of HICC and regular meetings
- Written IPC and AIC plans
- Adequate staff
  - ◊ Infection control officer
  - ◊ Infection control nurse (1 per 250 beds)
  - ◊ Link nurse (1 per unit)
- Regular facility risk assessment (at least once a quarter)
- Design/layout of building to optimize IPC and AIC
- Policy for use of respiratory protection
- Patient education and communication
- Supervision and monitoring plan
- Budgetary provision

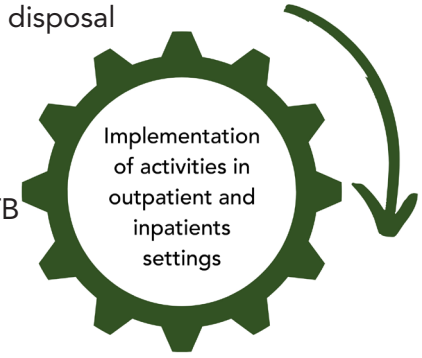


5.2 Implementation of activities in outpatient and inpatient settings

Implementation of administrative controls in outpatient and inpatient settings are summarized in figure 5.4.

Figure 5.4: Administrative controls in outpatient and inpatient settings

- Outpatient settings
  - ◊ Triaging
  - ◊ Patient education on cough hygiene and sputum disposal
  - ◊ Signages and audio-visual aids
  - ◊ Provide and promote use of mask
  - ◊ Screening of all high risk outpatients for TB
  - ◊ Separate and fast-track presumptive TB and PwTB
  - ◊ Separate sputum collection area
  - ◊ Rapid testing and Prompt DST-based treatment initiation



- ◊ Ventilation and seating arrangement in OPD
- ◊ Crowd management for organized patient flow

- Inpatient settings
  - ◊ Minimize hospitalization
  - ◊ Seperate room / ward for infectious respiratory disease; designated isolated or spaced beds for TB / DR-TB
  - ◊ Screening of all inpatients for TB
  - ◊ Patient education
  - ◊ Safety in radiology and bronchoscopy
  - ◊ Adequate distance between beds
  - ◊ Frequent change of bed linen
  - ◊ Policy for visitors and attendants
  - ◊ Regular removal of hospital junk

5.2.1 Implementation of administrative controls in outpatient settings

The aim of administrative interventions in the outpatient area of any healthcare facility catering to TB or presumptive TB patients is to:

(a) reduce the total time that a patient with respiratory symptoms stays in the healthcare facility, and

(b) reduce airborne transmission to other patients and healthcare workers in this limited time.

Due to heavy patient loads, infectious or respiratory symptomatic patients often wait long periods before seeing a physician, raising the risk of airborne infection transmission. Reducing their stay in healthcare facilities is the most effective way to minimize transmission, achievable by identifying and fast-tracking these patients through various measures.

Fast-tracking will depend upon the type of healthcare facility. In healthcare facilities having most patients as respiratory symptomatic, fast-tracking has no real application. But the process will be very useful for general hospitals and OPDs.

a) Triaging

Triaging (screening and separation) for patients with respiratory symptoms should be done as early as possible upon the patient's arrival at the healthcare facility. Hospital attendees should be effectively screened at the registration counter by asking simple questions related to respiratory symptoms, and those with presumptive TB give special card or priority slip or simply stamp on the OPD registration paper.

- Existing staff at the registration counter can be used for this purpose, or a special screening counter can be established prior to the registration process.

- This screening can be performed by a designated volunteer, nurses, paramedic staff or doctor.
- If a separate screening counter is used, individual with suggestive symptoms can be encouraged to first visit this counter by appropriate signages, posters, or announcements in the registration area.
- Even if screening/ triaging at registration is not possible, it can be done when patients register at specific OPDs or in waiting areas.

Figure 5.5: The picture below shows a good example of triaging and fast tracking of the medical college in Khammam Telangana painted a green line for fast tracking of individual with respiratory symptoms. These individual patients reach a separate counter made to fast track the coughing individual at the common registration area. Individuals follow the innovative self-guiding color-coded line ("Follow the Green Line"), which reduces their time to reach the designated clinic.

b) Education on cough etiquette and respiratory hygiene

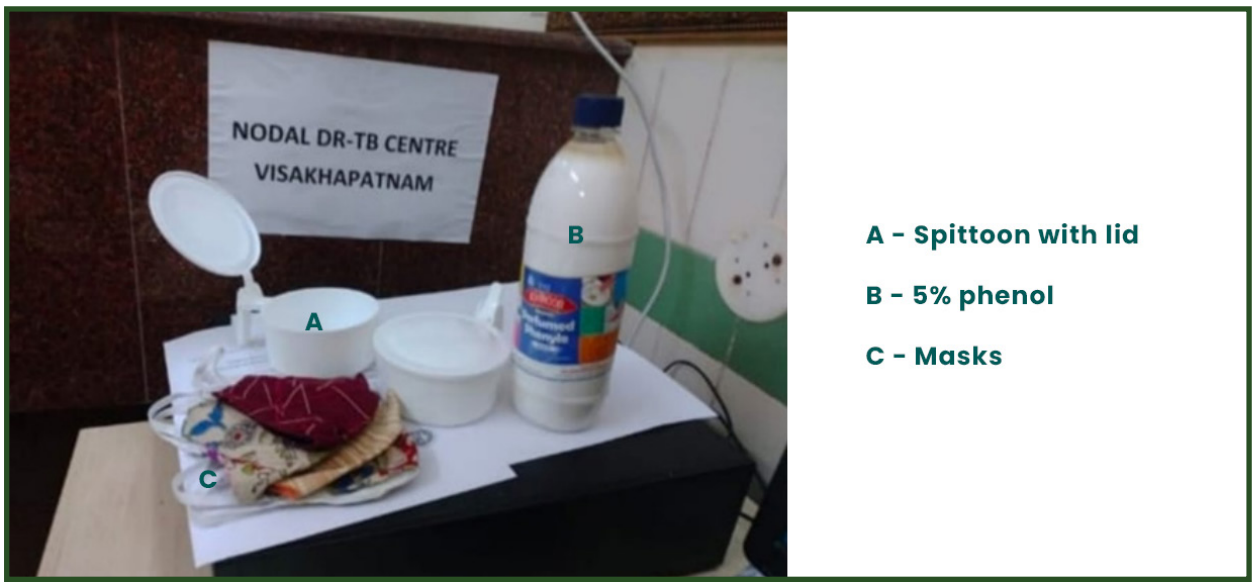
Educating the patient on cough hygiene and safe sputum disposal can help in reducing transmission of airborne infection.

- This can easily be done through posters and audio-visual aids in the waiting area, as well as by actual discussion by paramedical staff or volunteers while the patient is in any waiting area.
- Cough etiquette should be reinforced by all staff members.
- Individuals should be discouraged from spitting on walls and open area.
- Disposal of sputum in health settings needs to be considered. Follow-up patients must

be instructed to carry spittoons. Hand washing facility should be made available for these patients

- AIC kits can be provided to the PwTB, inclusive of spittoon with lid, soap, hand sanitizer, mask etc. for maintaining cough etiquette and safe sputum disposal while in the hospital and after discharge.
- Handouts and patient education resources are available at www.tbcindia.mohfw.gov.in/pmtpt/, TB Aarogya Saathi App, National TB call centre- "Nikshay Sampark" toll-free helpline number 1800-11-6666. TB champions could be helpful in disseminating this information among the community.

Figure 5.6: Nodal drug-resistant TB centre (NDR-TBC) in Visakhapatnam, Andhra Pradesh, was observed giving AIC kits to all the PwTB admitted in the ward.



c) Provide and promote masks to patients

Wherever possible, disposable medical masks should be provided to patients by healthcare workers or volunteers.

- The health staff / paramedical worker at health facility should explain to the patients and attendees on how and when to use masks.
- The disposable mask should be made available at registration counters, OPDs, laboratories, and other places as deemed appropriate by the institute.
- Institute should ensure that there is an adequate supply of medical masks.
- While designing protocols for children, it is important to note that children are paucibacillary and contribute much less to TB transmission and those with severe illness may have difficulty in breathing when masked.
- Signages on the use of masks can be displayed for patient education.

d) Screening of all high-risk outpatients for TB

The high-risk screening approach for early detection and prompt initiation of treatment is mainstay for TB prevention. Thus, it is recommended that all vulnerable populations should be screened for TB.

The following table 5.1 depicts the high-risk population which can be screened for TB

EXISTING KEY POPULATION GROUPS		NEWLY ADDED KEY POPULATION GROUPS	
Anti-TNF treatment	Liver Impairment	Undernourished / Malnourished (BMI <18.5 kg/m^2)	Marginalized populations at risk of HIV
Bronchial Asthma	Migrant	Elderly (age >60 years)	LGBTQAI++
Cancer	Miner	Workplace settings (coal, sandblasting, brick kiln)	Substance abuse (alcoholic, intravenous drug users)
Cardiovascular Disorder	Palliative Care Patient on immunosuppressants	Tea garden worker	Tobacco/smoker
Contact of Known TB Patients	Pregnancy	Construction site worker	Silica exposure
COPD	Prison	Congregate settings	Tribal
Diabetes	Renal Impairment	Attendees of de-addiction centres	
Dialysis	Transplantation	Person exposed to indoor air pollution	
Health Care Worker	Urban Slum		
Hypertensive			

The Intensive case finding (ICF) in outpatient settings of hospitals and health care facilities shall help identify the TB cases early.

e) Patient Separation

Separation of individual with respiratory symptoms can be achieved by having a separate waiting area for them, within the overall outpatient area and other waiting areas in the hospital.

Care should be taken so that specific areas designated for symptomatic patients should not appear to be discriminatory or stigmatizing.

- If feasible, a separate doctor can be deputed to assess these patients in the separated waiting areas, so that these patients do not mix with other non-infectious patients.
- Institute should implement a patient flow control mechanism at the entry point of the waiting area, so that patients with respiratory symptoms (who have been screened earlier and are carrying priority slips or other similar identification) are diverted to this special area (cough corner) rather than the common waiting area.

Figure 5.7: Designated cough corner in RPGMC, Kangra, Himachal Pradesh

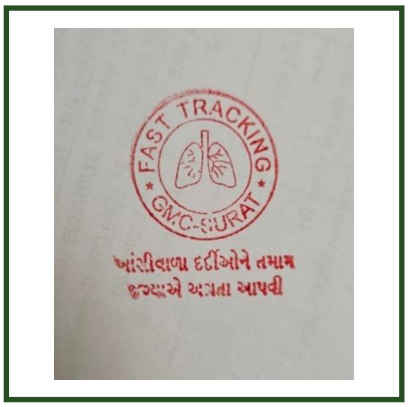
- The outpatient area, especially those having chest symptomatic patients, should be well ventilated to reduce the risk of airborne transmission.
- For the individuals with requirements for laboratory investigations, a sample referral system may be considered instead of a patient referral system. This means that the samples can be drawn in the separated setting and sent to the central labs. This will avoid the mixing of patients near the central laboratories.

f) Fast tracking of patients with respiratory symptoms

Individuals identified as presumptive TB or with any of respiratory symptoms can be further fast-tracked in both their clinical and laboratory evaluation.

- One option could be upfront Nucleic Acid Amplification Test (NAAT) before they see a doctor. This can be done by designated screening staff.
- The other options are to allow these presumptive individuals to be examined on priority, or to have separated physician areas for these patients.
- One of the mechanisms for fast tracking patients can be using fast tracking stamps on registration forms as shown below.

Figure 5.8: Fast tracking of respiratory symptomatic patients using fast tracking stamps, in Government Medical College, Surat, Gujarat



In Government Medical College, Surat, Gujarat red colour stamps are affixed in the registration slip of presumptive TB at the registration counter. An individual with such stamp is separated, fast-tracked and allowed to jump the queue and get attended on priority basis at OPD, laboratory and radiology services. The other important area where these individuals can be given priority is while performing chest radiography. In bigger institutes where multiple X-ray machines are available, an X-ray machine can be dedicated for X-rays of presumptive TB patients The principle is to avoid mixing of possibly infectious and non-infectious individuals as much as possible.

g) Dedicated sputum sample collection area

Presumptive TB or PwTB have to provide sputum sample for of TB diagnosis or as a follow-up test. A dedicated space should be designated for such individuals to collect their sputum samples. This area should be away from crowded areas but easily accessible, in an open, well-ventilated space, accessible from the OPD building/Lab.

- Such individuals have to cough and produce the sputum to collect their sample and hence the identified designated area should be away from general public as it will minimize the risk of transmission to others.
- Signages and posters on the procedure for collecting sputum sample should be displayed in the sputum collection facility. It will also reduce the stigma and allow them to have privacy for coughing out an adequate sputum sample.
- There should be provision for hand washing as well as hand sanitizers.

h) Prompt diagnosis and treatment for disease and infection

NTEP advocates for prompt initiation of treatment after diagnosis of TB disease or infection. Ensuring prompt treatment will render the patient non-infectious as early as possible.

Prompt initiation of treatment should be complemented with treatment adherence support, nutritional support, linkages to social support schemes etc.

FAST approach is recommended by WHO which focuses on **F**inding TB cases **A**ctively, **S**eparating safely and **T**reating effectively.

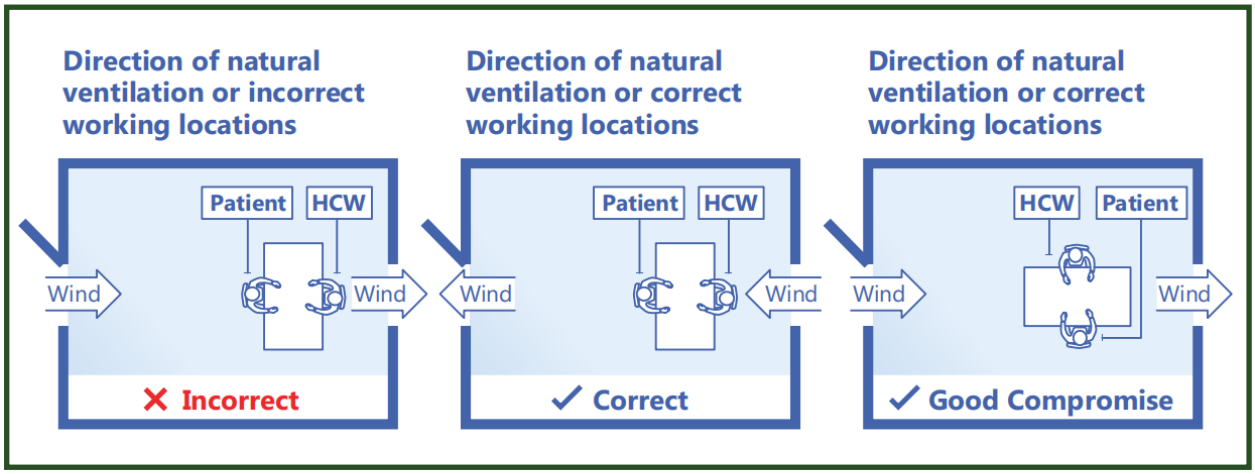
- Conduct surveillance for respiratory symptoms at selected entrance and other identified areas of the healthcare facility.
- Fast track the patient, identified with cough, for screening of TB and other symptoms according to NTEP guidelines following the diagnostic algorithm for TB.
- Educate the patient on respiratory hygiene: cough etiquette and temporary separation,
- Once diagnosed with TB, initiate treatment as soon as possible.

i) Ventilation and seating arrangements in OPD

Simple adjustments to seating arrangements in OPD consultation rooms can prevent transmission and ensure safety of doctor and other HCWs. The general principles with regard to ventilation and seating arrangement in OPD settings is as mentioned below. Seating arrangements in the OPD should ensure optimum ventilation.

- All furniture/ junk obstructing the windows and doors should be removed to ensure adequate ventilation.
- All windows and doors must be kept open to maintain adequate air changes per hour (ACPH).
- There should be signages to educate the staff regarding keeping air entry and exit points open.
- The administration should monitor and document the ventilation.
- Seating arrangements, ventilation, and respiratory protection should be specifically considered in TB OPDs where there is space constraints.

Figure 5.9: Schematic representation of seating arrangement in OPD setting



The first picture from the left in the row indicates the wind direction is from left to right. The patient is sitting upwind and the HCW downwind. This is hazardous to the HCW. In the second picture, the wind direction is from right to left. Here the HCW is sitting upwind and the patient downwind. This is the safest seating arrangement.

In the third picture, again the wind direction is from left to right. Here the patient and the HCW are facing each other in the direction of the wind. This is less hazardous than the first arrangement

The same principle should be applied in all areas where risk of exposure is present. However, the wind direction is variable and therefore the third picture gives a more practical solution to the problem.

j) Crowd management

WHO recommended a minimum of one meter or 3 feet distance between the two patients in the COVID-19 guidelines. The risk of transmission increases if the duration of contact with infectious person increases. In a heavy load health facility, mixing of patients occurs during registration, OPD, common waiting area, laboratory or sample collection area, pharmacy, radiological unit and other areas where queuing is there. The institute should ensure that these areas are well-ventilated and adequate in size based on the daily footfall at these places. The general principles with regard to crowd management are mentioned below.

- Avoid congregation of people in above mentioned areas through the appropriate design of the building.
- Waiting areas should be spaced out with regulated patient flow. Decompression of waiting areas through token system and public announcement system should be considered.
- Waiting area should be outdoors as far as possible.
- The institutes with heavy load of OPD may introduce online registrations, kiosks for registration, token systems for regulated patient flow, phased appointments for specialized OPDs.

Certain challenges may exist in implementation of some of these aspects considering the heavy load of patients, staff scarcity and other socio-cultural factors. However, innovative approaches will surely lead to effective crowd management.

With all the ethnic, linguistic, social, economic, and educational diversity existing in Indian patients, it is unlikely that a single measure will work well for all groups of patients. This field is an important area of operational research, and pilot projects need to be undertaken to identify what sets of administrative measures are likely to yield good results in a particular OPD setting.

5.2.2 Implementation of administrative controls in inpatient settings

a) Minimize hospitalization of PwTB

One of the most effective means to reduce the risk of transmission of airborne pathogens including M.tb in hospital settings is to manage such patients on outpatient basis whenever possible.

- Most patients can be managed entirely as outpatients, thereby avoiding hospitalization and the risk of exposing other patients and staff. To reduce infection transmission (and improve case outcome) it is more important to provide rapid testing to identify pathogen, its drug susceptibility and to promptly initiate effective (DST-based) treatment, than to hospitalize.
- Only those requiring treatment for comorbidities to be hospitalized. If hospitalized, such patients should be re-evaluated frequently for discharge with continuation of therapy as outpatients.

b) Establish separate rooms, wards, or areas within wards

Whenever hospitalization is required, patients with infectious respiratory diseases should be physically separated from other patients so that others are not exposed to the infectious respiratory particles that they generate.

- Policies on patient separation inevitably generate concern about stigma, but with appropriate measures – such as training and public posting of separation rules – stigma can be minimized.
- Administrative procedures should ensure that separation happens promptly and automatically, like the automatic separation of men and women during inpatient admission.
- DR-TB wards should be separated and not very far away or neglected from the main hospital. If they are far away, then mechanisms for prompt referring of these patients to other specialties should be in place.
- If diagnostic test like NAAT or sputum-smear microscopy, or other relevant diagnostic tests are performed for patients with respiratory symptoms at the time of admission, then those who are most infectious can be quickly identified for separation from other patients.
- Prioritization for separation of patients can be done as follows:
    - ◊ Separation of patients with confirmed or presumptive symptoms of diseases of public health concern, such as epidemic influenza, from all other patients.
    - ◊ Separation of diagnosed TB or DR-TB from immune-compromised patients.
    - ◊ Separation of PwTB or presumptive TB from all other patients.
    - ◊ Separation of DR-TB and DS-TB patients from each other.
- The infectious or potentially infectious patients should be admitted in special airborne precaution rooms. Where such airborne precaution rooms are not feasible, other options for physical separation include-
    - ◊ Having a separate well-ventilated ward designated for patients with infectious respiratory disease.
    - ◊ Keep a designated area with good ventilation available for the placement of potentially infectious patients.

c) Screening of all IPD patients for TB

All the patients at the time of admission in hospitals and health care facilities should be screened for TB. This will augment Intensive case finding (ICF) in the inpatient settings of hospitals and health care facilities. Also, it will augment early patient separation, thereby reducing the risk of transmission to other patients and relatives. Among the high-risk population identified in the IPDs, after ruling out TB disease, TPT to be considered after a positive test for TB infection.

d) Educate inpatients on cough hygiene and provide spittoons

Wards housing infectious patients should display signboards in the ward demonstrating cough etiquettes and respiratory hygiene.

- All patients admitted in the ward/area should be issued medical masks and counselled on their proper use.
- Adequate measures for safe collection and disposal of sputum.
- Patients should be provided with spittoons with lids containing 5% phenol for safe collection of sputum.
- Appropriate bio-medical waste management protocols to be followed during disposal of sputum.
- Patients and their attendants should be counselled by the nursing staff and counsellors on cough hygiene, sputum disposal, treatment adherence and nutrition.

e) Safe radiology procedure rooms

When catering to infectious/ presumptive TB or PwTB, the radiology department can try the following interventions to minimize risk of infection.

- Schedule inpatient chest radiographs on infectious and presumptive TB patients for off-peak, non- busy times, such as the end of the afternoon.
- If feasible, designate an X-ray machine for chest radiograph, especially with digital technology for TB patients.
- Provide medical masks or tissues/ cloth to patients with cough.
- Provide priority service to potentially infectious PwTB, to minimize the length of time spent in the department.
- Restrict access to the radiology suite to patients and essential personnel only.

f) Bed spacing

It is recommended that the distance between the two adjacent beds should be at least 6 feet in the inpatient settings.

- Whenever possible avoid bed occupancy beyond the available beds.
- Additional space needs to be identified if the bed occupancy is more than the available beds but avoid compromising the distance between the two adjacent beds.

g) Daily change of bed linen

The linen needs to be changed daily and the patient material like the side stand, IV stand, separating curtains, mattresses, pillows etc., should be disinfected at regular scheduled intervals.

- Every ward should maintain a log of daily linen change.
- Interview patients and staff to understand if the bed linen is changed daily.
- Linen should be changed when a patient is discharged.
- Institute should ensure availability of adequate linen, mattresses, pillows for the patients.
- Annual budgetary provisions should be made for the replacement of linen.

h) Policy for visitors and attendants

It is important to keep the number of visitors restricted in the wards (TB and other respiratory illnesses), however also balancing the need for emotional well-being and care of patients.

- Visitors and attendants should always wear masks while visiting the patient.
- Whenever possible visitors should meet patients outdoors.
- Visitors and attendants should not sit or lie on the patient's bed.
- Hand washing with hand sanitizers should be available for visitors and attendants.
- Institute should keep medical masks and hand sanitizers at the entry of the wards when visitors are entering in the wards.
- Children, pregnant women, and immunocompromised persons should avoid visiting the patients.
- Separation of passages to the specific high-risk wards may be considered.
- The institute should display signages in local language about the visiting hours, restricted entries, no entry without mask for visitors and attendants.

i) Removal of hospital junk for unrestricted airflow

- All junk material stored in the hospital poses a potential fire risk and can lead to accumulation of pests in these areas.
- Furniture and other condemned material blocking air circulation and impairing sanitation, must be removed/disposed.
- All health facilities need to have a condemnation policy framed in the hospital and it must be implemented and followed.
- The condemnation policy at the health facility should align with the state level condemnation policy framed at the state (if any).

5.3 Healthcare worker safety, surveillance and training

HCWs are at an increased risk of acquiring TB and other airborne infections when AIC- IPC measures are not implemented appropriately. The key measures to ensure HCW safety include-

- Uninterrupted access to respiratory protection (masks, certified respirators and their fit-testing)
- A written policy on supply, availability, and use of medical masks and N95 respirators.
- Appropriate IEC about TB screening, diagnosis, and TB prevention strategies.
- All HCWs (Old, newly recruited, permanent, and contractual) should undergo free of cost periodic screening through chest X ray with symptom screening and clinical evaluation, upfront NAAT (if symptomatic), and have prompt treatment. After ruling out active TB disease, HCWs may be tested for TB infection and Tuberculosis preventive treatment (TPT) services.
- They should get information and access to HIV testing and if HIV positive should not be posted in any of the high-risk settings.
- If diagnosed with TB, they should be linked to social schemes and employment benefits as per the prevailing national or the state guidelines.
- Annual training calendars should be prepared in advance and trainings to be conducted as per the plan. Institute should ensure that all the HCWs are trained in IPC, Biomedical Waste Management (BMWM) and airborne infection control measures annually.
- A written policy of HCW vaccinations should be part of the overall IPC plan.

The details on HCW safety and surveillance along with relevant vaccination is given in Chapter 12.

6 ENVIRONMENTAL CONTROL STRATEGIES

Environmental controls are the second line of defence for preventing the spread of TB and other airborne infections in healthcare settings. It includes ventilation (natural, mechanical and mixed mode), upper room germicidal ultraviolet fixtures. Some environmental control measures are simple and inexpensive while many others are technically complex and expensive. It is important to recognize that if administrative controls (policies and protocols) are inadequate, environmental controls may not eliminate all the risk.

Key strategies under environmental controls are as mentioned below:

Environmental controls

- General Engineering Considerations
- Ventilation system
- Germicidal Ultraviolet (GUV) systems
- Sanitation for TB-IPC

This chapter is explained in three parts

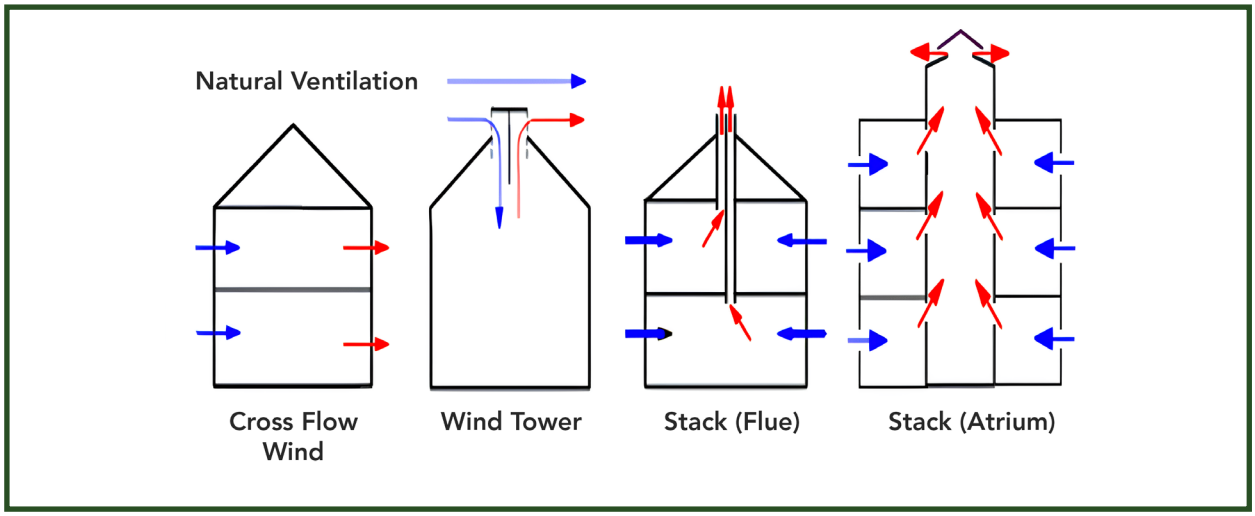
- **Role of Architects / Engineers in AIC Compliant Building Design:** Basic engineering requirements for AIC are outlined in this section
- **Ventilation:** Explains the 3 modes of ventilation, natural, mixed mode, and mechanical & Air Changes per Hour
- **Germicidal Ultraviolet (GUV):** Explains the concept GUV with a brief background on the theory. Details of Upper room GUV, types of fixtures, units of expressing the different parameters; output, irradiance, dosage and an SOP for installation & maintenance are explained. In-duct GUV system is also briefly explained.

Sanitation is explained in the next chapter.

6.1 Role of Architects / Engineers in AIC

Professionals responsible for the design, building refurbishment and organization (physical layout) of health care facilities need to consider patient flow patterns so that airborne infection transmission is minimized. These professionals need to be engaged in finding affordable solutions to improve the ventilation in existing and new facilities. To do so, they should also be included in training opportunities that underscore principles of AIC and the role they play to ensure that the elements of AIC are considered. Particular attention is required for facilities that are designed or reorganized, to provide optimum airborne infection control in TB and other high-risk infectious settings.

Figure 6.1 Indicates the types of natural ventilation that are considered in construction of a building *(M Liddamant, via CDC presentation)*



These are four examples of construction that use natural ventilation to facilitate air movement within the interior space. In these building designs, the blue arrows indicate air intake points and red arrows indicate areas where air is exiting the building.

- The first diagram demonstrates the use of windows on opposite walls to facilitate air movement. (Cross ventilation)
- The second example depicts air movement in a wind tower roof design.
- The third and fourth examples demonstrate the use of the stack effect in which a provision is made in the centre of the building to facilitate air movement based on the principle that hot air rises and cold air replaces it from below creating continous air currents.

6.1.2 General engineering recommendations for optimising ventilation

- Health-care facilities should seek to achieve minimum standards for air exchange.
- High-risk settings should be prioritized for immediate assessment and implementation of improved ventilation.
- Ensuring effective natural ventilation in healthcare settings is recommended as it is cost effective and easy to maintain. To ensure effective natural ventilation, the total surface area of openable window and door area should be >/=20% of floor surface area of the room. In all climatic conditions, ensure adequate ventilation through regular checks and ensure unrestricted openings to allow >20% window area. In place of sliding windows, openable windows can be installed as sliding windows block a part of the air-passage.
- Openings like metal grillwork or concrete with openings that allow for more air movement should be considered.
- The construction design should take advantage of the prevailing winds.
- Additional mechanical assistance to ensure good air movement within the facility should

be assessed well before construction. Mixed mode ventilation methods can be used where natural ventilation standards cannot be met. Addition of exhaust fans, mixing fans, turbine or whirly birds, air supply fans etc can be used.

- However, poor engineering design can increase the risk of contamination or produce short-circuiting of air. A poorly installed exhaust fan in an open window space or in the close proximity of an air inlet window, causes "short-circuiting" of airflow. In this case, the fan adds little to ventilation, rather will be an impediment to ventilation.
- Existing facilities without adequate air exchange, should rethink the use of available space and infrastructure and make minor modifications to improve ventilation. E.g. replacing fixed windowpanes with openable ones. Consider renovation and/or new construction of physical infrastructure to optimize the implementation of infection control measures.
- Consider developing outdoor waiting areas for high-risk settings. Crowded waiting areas should be decompressed and moved out of poorly ventilated corridors. Open waiting sheds are ideal for AIC.
- New construction designs to avoid interior central corridors that are poorly ventilated waiting and prone to airborne infections.
- Heat-collecting glass walls and partitions can be avoided to reduce air conditioning needs.
- Separate or designated areas can be allocated or constructed in well-ventilated spaces to accommodate coughing patients. These are called cough corners.
- Departments with high airborne risk settings should not be in the vicinity of paediatric patients or departments handling immuno-compromised patients.
- While allocating space to high airborne risk departments, particularly OPDs, it should also be kept in mind that they are not assigned to the upper floors of the building. This is to minimize patient traffic within the building and reduce air contamination. Respiratory OPDs should be, as far as possible, on the ground floor.
- If high airborne risk wards are on the upper floors, administrative controls should be implemented to minimize contamination in elevators. Ramps will mitigate the indoor traffic of patients to some extent.
- False ceiling lowers the ceiling height and reduces the scope of stack ventilation. High-roofed wards, with air vents near the ceiling, facilitated stack ventilation improves ventilation. However, false ceilings may be employed if HVAC systems are installed in the hospital.
- Low roofs also prevent installation of air decontamination measures like Upper Room GUVs.
- In cold climate areas, building design should seek to capture the solar heat and minimize conduction loss through the wall. Proper insulation of walls and the use of double glazing on windows are desirable.
- In hot climatic zones, minimize solar heat gain through proper use of sunshades or external shading.
- Installing of air conditioning system for thermal comfort can be used but careful attention must be given to ensuring adequate ventilation. If absolutely necessary, window ACs with air vents are preferable compared to split AC. Installation of exhaust fan on the opposite side of the room can be done to achieve adequate air exchange. Alternatively, the exhaust fan can be used to push air into the room by installing it in reverse. Both these will compromise the thermal comfort but will render the room safer.

- Mechanical ventilation systems use dilutional strategies, remove contaminated air, and control airflow patterns in a room or setting through mechanical means.

Many of these concepts are elaborated subsequently in this chapter.

6.2 Ventilation

Ventilation achieves air exchange and directional control of airflow.

Figure 6.2: The two important aspects of ventilation

Directional control of airflow	Air exchange
• Clean air should come 'in' • Contaminated air should go 'outside' (not to patient care areas)	• >6 Air-changes per hour (ACPH) in typical health care setting • >12 ACPH in high-risk settings

Air exchange: Dilution of infectious particles through real or 'effective' air exchange. In the case of ventilation, dilution occurs through the introduction of fresh, uninfected air and the removal of infected air. When clean or fresh air enters a room, by either natural or mechanical ventilation, it dilutes the concentration of infectious respiratory particles in room air. As room air exchange doubles, the concentration of airborne particles in the room falls by half. This concept is detailed later.

Control of airflow: Certain circumstances may require directional control of airflow, so that air containing infectious particles is not introduced into clean air where staff or other patients are located. This is discussed later. The direction of airflow should be maintained in such a way that clean air should come 'in' and contaminated air should go 'out'- away from the patient care area.

There are three types of ventilation systems.

- Natural ventilation
- Mechanical ventilation
- Hybrid (mixed mode) ventilation

Advantages and disadvantages of these systems are mentioned in table 6.1.

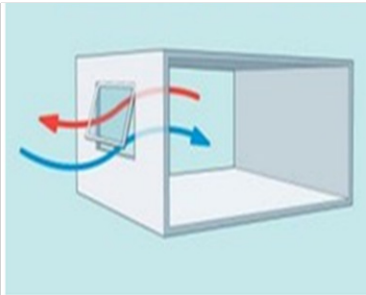
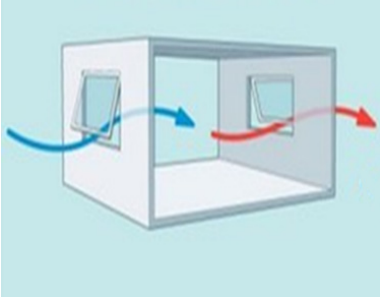
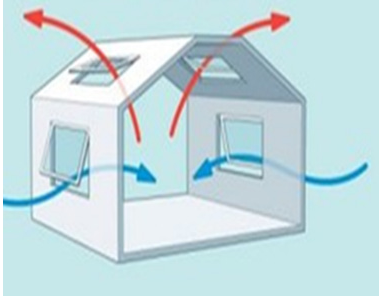
Table 6.1: Advantage and disadvantages of ventilation systems

	Natural ventilation	Mechanical ventilation	Hybrid (mixed mode) ventilation
Advantages	• Suitable for warm and moderate climates • Lower capital, operational and maintenance costs for simple implementations • Capable of achieving very high ventilation rates	• Suitable for all climates • More controlled and comfortable environment • Occupants have limited access to control and thus affect ventilation	• Suitable for most climates • Energy saving, relative to mechanical ventilation • More flexible
Disadvantages	• Easily affected by outdoor climate and occupants' behaviour • May be difficult to plan, design, and predict performance • Reduced comfort level of occupants in extreme weather • Cannot achieve directional control of airflow, if required	• Expensive to install and maintain • Can fail to deliver required ventilation rates, through faulty design, maintenance, or operation • Noise from equipment	• May be more costly than natural ventilation or difficult to design

6.2.1 Natural ventilation

Natural ventilation refers to fresh air that enters and leaves a room or other area through openings such as windows or doors. Natural ventilation is 'controlled' when openings are fixed and unrestricted to maintain air flow. Effective ventilation can be achieved by proper operation, maintenance of opening, and regular assessment to see that the opening remains free from obstruction. Natural ventilation could be three types as represented in the figure 6.3.

Figure 6.3 : Schematic representation of types of natural ventilation

Single sided ventilation	Cross ventilation	Stack ventilation
Air flowing naturally from single side of the room.	Air enters from one side and exits from the opposite side of the room.	Movement of air in and out of the building through unsealed openings due to temperature difference.
		

Single sided ventilation: Air is entering from single window and going out from the same window. It is known as single sided ventilation. This kind of ventilation is not very effective in airborne infection control.

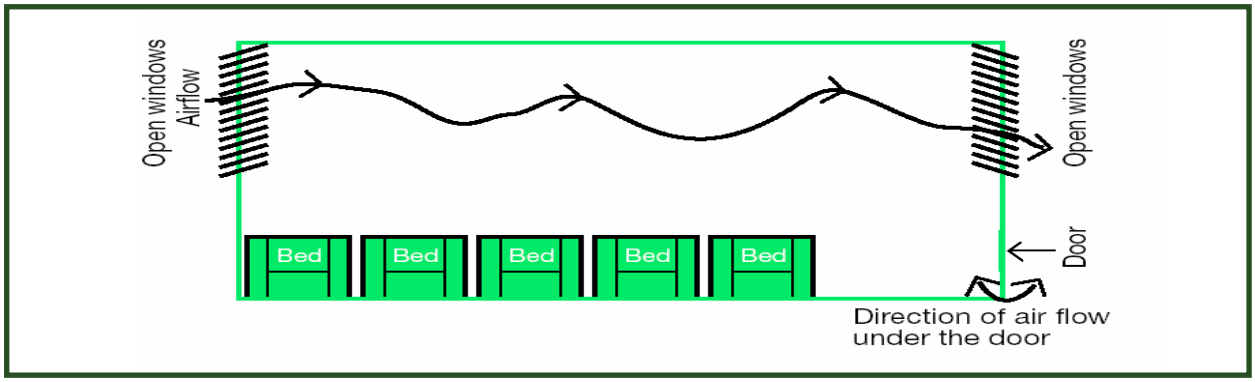
Cross ventilation (unidirectional airflow): It is a good type of ventilation where air enters from one side and exits from opposite side. It is important to keep entry and exit points open.

Stack ventilation: It represents air entering from the windows below and going out from the upper openings. Such systems are possible because warm air, which is lighter, rises and leaves the room through the opening at the top, and gets replaced by cooler air from outside.

Figure 6.4: Well-ventilated DR-TB ward in RBIPMT, Delhi

Fixed unrestricted openings on both sides of the room/ward allow for adequate air exchanges.

Figure 6.5: Schematic representation of natural ventilation in a ward



Challenges in natural ventilation: A common problem with reliance on natural ventilation is that patients or staff close windows during cold weather or at night. Further, there is likely to be variability of airflow patterns due to varying weather. In colder climates where rooms are closed to ensure thermal comfort, natural ventilation can be enabled by opening the windows at frequent intervals. Effective ventilation can thus be achieved by proper operation and maintenance of openings, and by regular checks to see that openings always remain free of obstruction. The upper floors of a building are better ventilated than lower floors.

Simple natural ventilation may be optimized by minor structural modifications like maximizing the size of the windows, opening fixed windowpanes and locating windows on opposing walls.

6.2.2 Hybrid (mixed mode) ventilation

Where natural ventilation standards cannot be met, the addition of other measures should be considered. Improvements in ventilation should be based on the assessment of the facility and informed by local climatic conditions, building structure, regulations, and cost. In addition to natural ventilation, mechanical interventions should be considered to achieve the minimum ACPH standards. This is called hybrid (mixed mode) ventilation.

Four kinds of mechanical interventions are suggested below that can complement natural ventilation.

a) Exhaust fans

It is the simplest form of mixed ventilation, when placed in such a way to enable moving of air from inside a room to outdoors. It is more acceptable to staff and patients than keeping windows consistently open. It is appropriate in high-risk areas where people tend to close the windows and doors when it is cold or at night-time for safety and comfort.

Figure 6.6 shows picture of exhaust fan and mechanism of air extraction with it. It is important to ensure that airflow is adequate and across the room (not in and out from the same window or vent). The exhaust fan and air intake (window or vents) should not be located close to each other to prevent short-circuiting of air current.

Figure 6.6: Exhaust fan and mechanism of air extraction through exhaust fan

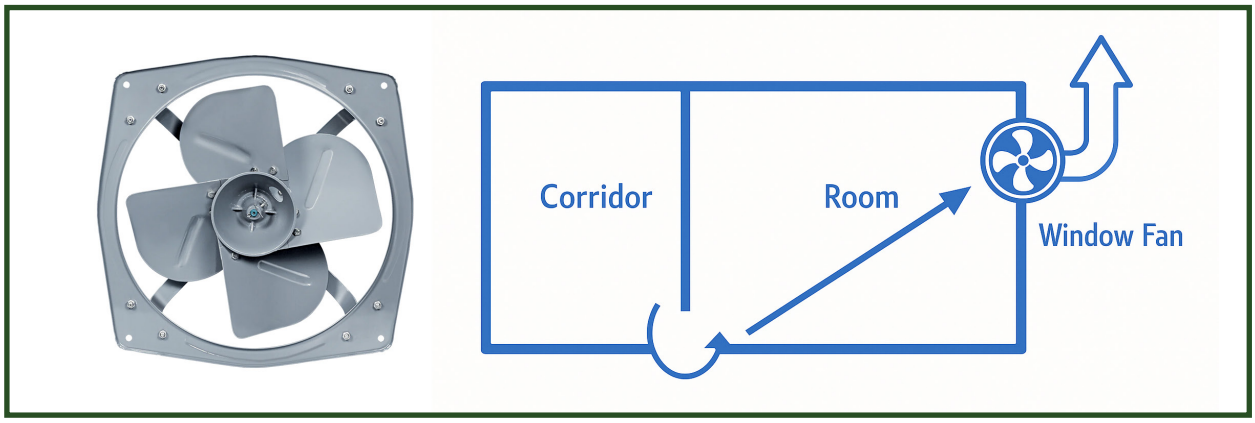


Table 6.2: Four parameters to select right exhaust fan

Calculate exhausting capacity in cubic feet per minute (CFM)	Conversion of CFM to cubic meter per hour (m3/hr)	Rotation per minute (RPM) and sweep relationship	Adjustments for air leakage and resistance
Measure length, breadth and height of room using a measuring tape of laser meter. Calculate volume of room in cubic feet using formula – L * B * H. (e.g. if room length and breadth 20 feet and height 30 feet then volume of room would be 20 * 20 * 30 = 12000 cubic feet) Decide desired ACPH (assume 12 ACPH is required) Formula for CFM = (volume of room * target ACPH) / 60 In the given example, volume of room is 12000 cu. ft. and target ACPH is 12, therefore, CFM requirement is = 12000 * 12 / 60 = 2400. Thus, exhaust fan with minimum rating of 2400 CFM required to achieve desired target of air exchanges. https://universalfans.com.au/exhaust-fan-calculator/	The commercially available exhaust fans state their capacity in m3/hr rather than CFM. 1 m3/hr = 0.589 CFM 1 CFM = 1.699 m3/hr Therefore, in our example, 2400 CFM = 4077 m3/hr In case of room has space for 2 – 4 exhaust fans, we can install fans with capacity of 1000 – 2000 m3/hr	RPM and sweep (length of blades) of exhaust fan directly related to the air volume delivery. However, high RPM and big sweep generate noise that can be addressed by using multiple units to achieve desired ACPH.	Fan rating should be adjusted depending on the estimates of- Efficiency of installation Air leakage and resistance from any covering mesh or screen Typical adjustment to the fan rating would be to assume the fan operates at 75% of rated efficiency.

However, selecting an exhaust fan should not be arbitrary. The four key steps in this process is explained above

1.Calculate exhausting capacity in cubic feet per minute (CFM)

2.Conversion of CFM to cubic meter per hour (m^3/hr)

3.Rotation per minute (RPM) and sweep relationship

4.Adjustments for air leakage and resistance

Figure 6.7: The relationship between sweep, RPM, noise in decibels and air displacement in CFM/ m^3 per hour.

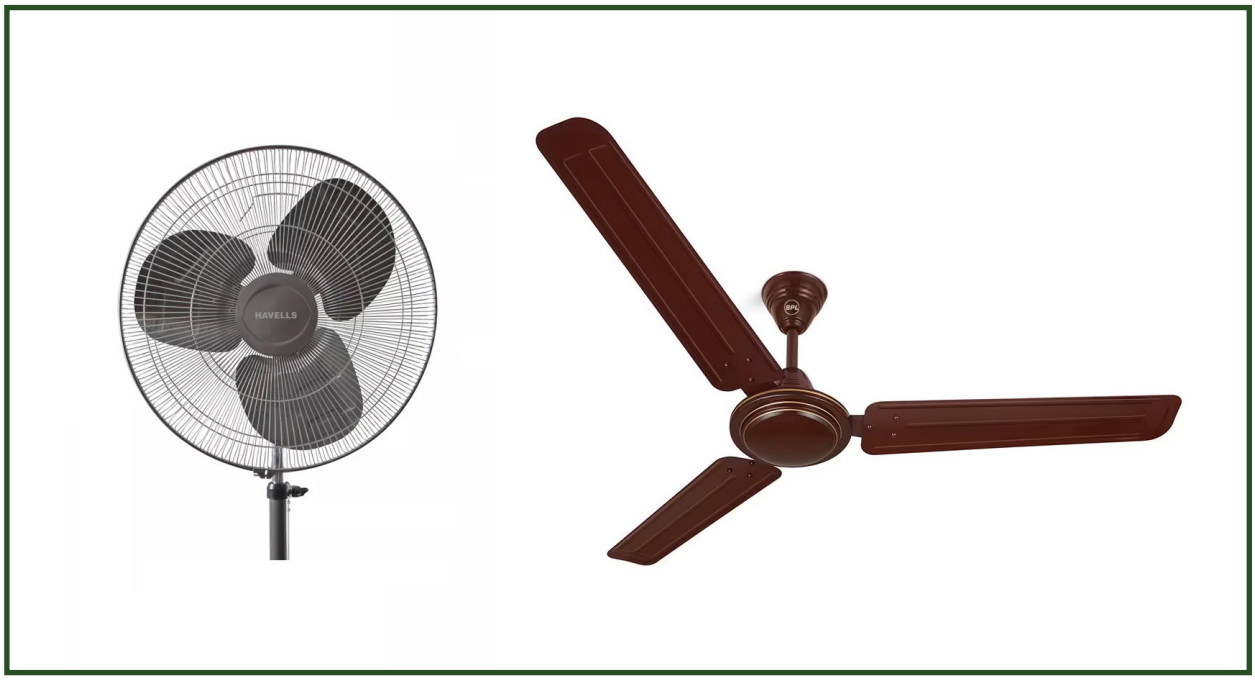
FAN SWEEP	SPEED (R.P.M.)	POWER INPUT (WATTS)	CURRENT IN AMPS.		SOUND LEVEL	AIR DISPLACEMENT (in free air flow condition)
			1-Ph.	3-Ph.		C.F.M.
			230V.	400V.		m^3/h.
230mm(9")	1370	40	0.18	-	49	440 759
300mm(12")	920	45	0.2	-	46	750 1270
	1420	82	0.38	0.18	FQ	1120 1920
380mm(15")	920	78	0.35	0.18	Q	1450 2460
	1420*	150	0.70	0.36	NI	2350 4000
450mm(18")	720	90	0.40	0.2	Q	2000 3400
	920	132	0.60	0.30	FQ	2550 4340
	1420*	370	1.65	0.70	FN	4000 6800
600mm(24")	720	240	1.10	0.50	FQ	4650 7900
	920*	500	2.40	1.90	NI	6150 10450
	570*	740	-	1.50	NI	13000 22100
900mm(36")	720*	1200	-	2.80	FN	16500 28000

Q-Quiet (50-55 dB)
FQ-Fairly Quiet (55-60dB)
NI-Normal Industrial Noise (60-65dB)
FN-Fairly Noisy (Above 65 dB)

A hospital is classified as a silent zone and according to Central Pollution Control Board guidelines, the permissible noise levels in hospitals should be less than 50 dB during day and less than 40 dB at night.

b) Mixing Fans

Figure 6.8: Examples of mixing fans - Pedestal, wall-mounted, table & ceiling fans



Use of any of these mixing fans is primarily for thermal comfort and only beneficial if there are adequate air exchanges. Mixing of air can disperse pockets of high concentrations, such as in the vicinity of patients. The total number of infectious particles in the room will not change with mixing; the concentration of particles near the source may be reduced, and the concentration in other parts of the room may increase. In other words, unless adequate ventilation is present, the fan will not be useful in reducing infectious particles and the risk of transmission. The doors and windows must stay open to allow airflow while using domestic fan. Desk mounted and pedestal fans may be better for directing airflow than the ceiling fan.

c) Turbine or Whirly Birds

It is a type of stack ventilation as shown in figure 6.9. Installation of wind turbine or whirly bird is meant to convert wind energy into an exhaust fan by causing suction and exhausting air from the room. The temperature difference between inside (warmer) and outside (cooler) causes the air to move vertically upward and exhaust to outside through wind turbine or whirly bird attached over the roof. This is an enhancement of the natural stack ventilation.

Figure 6.9: (L) Photographs, wind turbine and the room below. (R) Schematic representation of ward with open windows as air inlets. Stack effect enhanced by wind turbines.

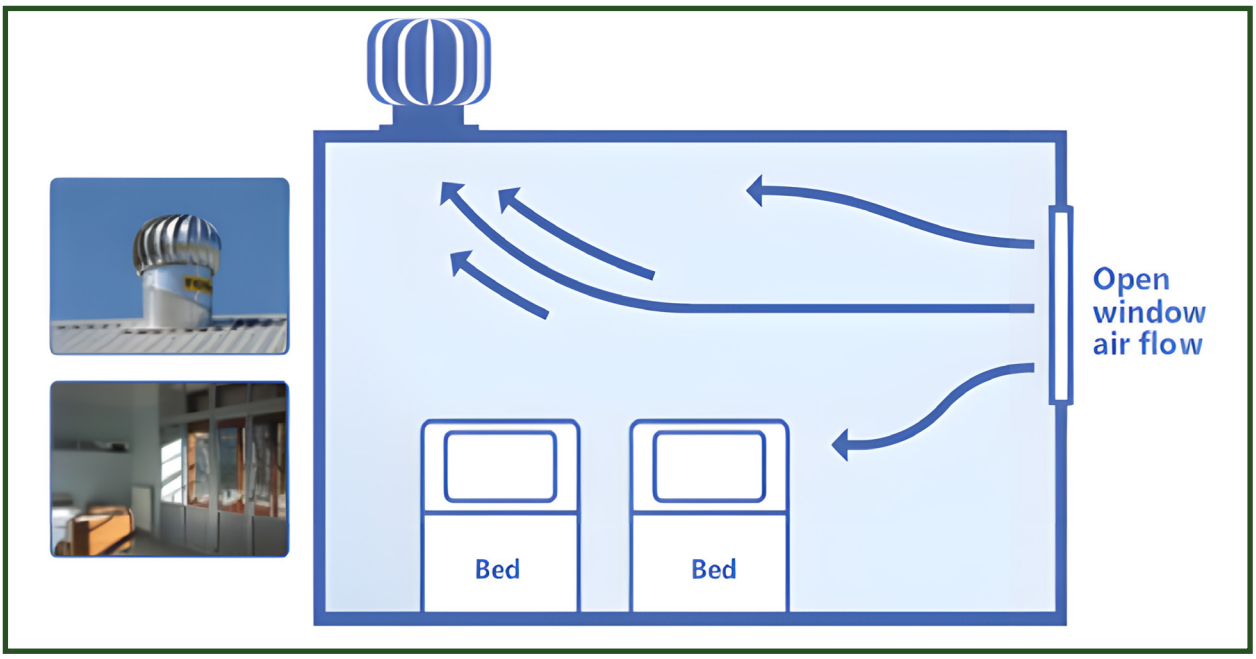


Figure 6.10: Registration Area, HIMS Jolly Grant, with stack ventilation enhanced with turbines.

Inside and rooftop views.

d) Air supply fans

An underutilized form of mixed mode ventilation is the use of air supply fans, which move

air from outside to inside a room. This is usually the same device as a typical exhaust fan but mounted in reverse. Air supply fans often have value when attempting to ventilate clinical exam rooms. Example of air supply fan is desert cooler.

Figure 6.11: Air supply fan (desert cooler)

Figure 6.12: Example of mixed-ventilation at DR-TB ward in Chhatarpur, Madhya Pradesh

6.2.3 Mechanical ventilation

Mechanical ventilation systems use dilutional strategies, remove contaminated air, and control airflow patterns in a room or setting through mechanical means. This includes the building's heating, ventilation, and air-conditioning (HVAC) system but may also entail specialized systems

for a room or workstation. An engineer or other professional with expertise in ventilation should be included as part of the staff of the healthcare setting so as to maintain and operate such systems effectively.

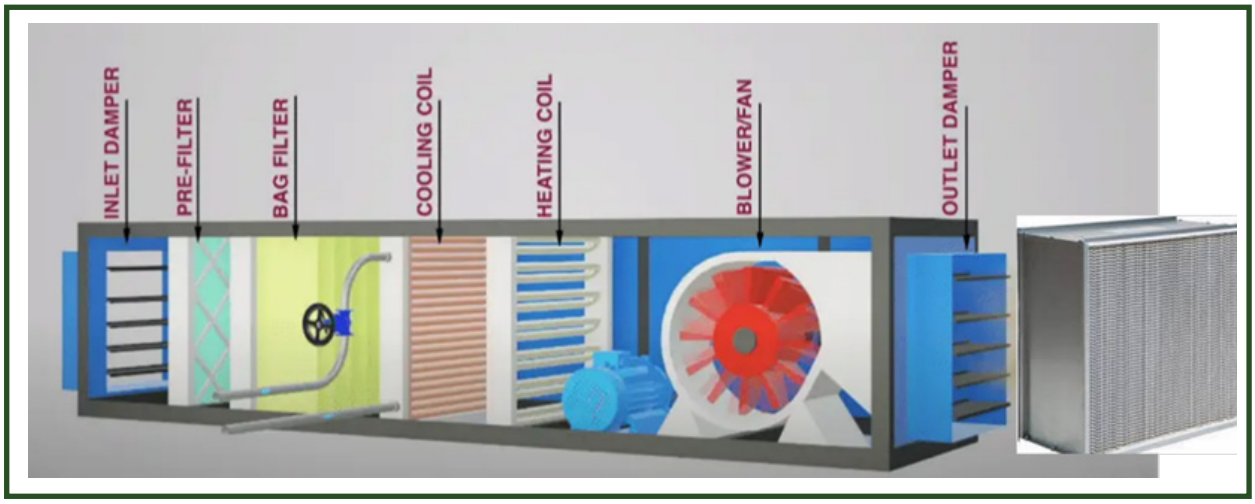
HVAC systems will:

- Clean the air
- Force Air Exchange: It uses fans to drive the air flow through a building.
- Drive Airflow/Directional Airflow: It works by generating negative or positive pressure in the room to drive air changes.
- Ensure Thermal Comfort.

a) The basic components of an HVAC

- Dedicated supply and exhaust with filtration systems that work by generating negative or positive pressure in the room
- Thermal control mechanism (Together, these two units is called the Air Handling Unit (AHU).

Figure 6.13: Air handling Unit (AHU), Diagrammatic representation



In addition, the HVACs also have:

- Ducting system to conduct the air in an optimum fashion.
- Can also contain germicidal ultraviolet lamps within the duct for better air disinfection
- The dampers are used to control the airflow.
- The pre filter is used to remove dust particles up to 10 microns.
- Bag filter is used to remove the particle up to 1-5 microns.
- Thermal control unit is used to achieve desired temperature and humidity.
- Motor blower assembly used to achieve the desired volumetric air as per the ACPH requirement of the area ventilated.

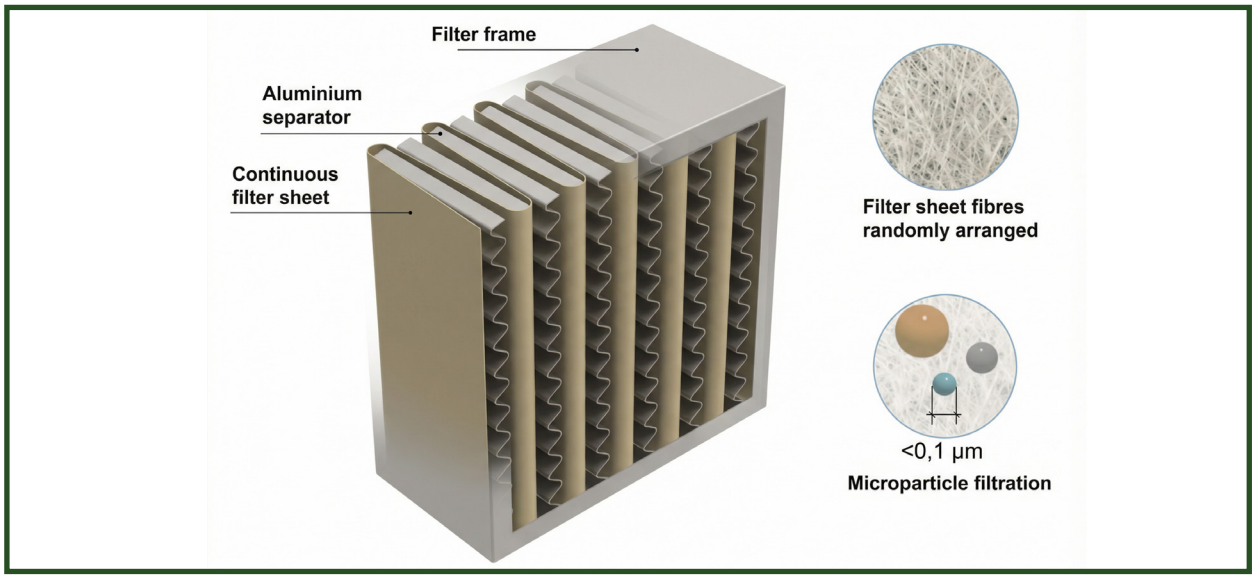
- HEPA filter does fine filtration up to 0.3 microns (depending upon the requirement unit).

HVACs can use 100% fresh air or can be recirculating units where the air is recirculated following filtration (explained later). In-duct UV systems also can be included in the HVACs.

HEPA (High Efficiency Particulate Air) Filters

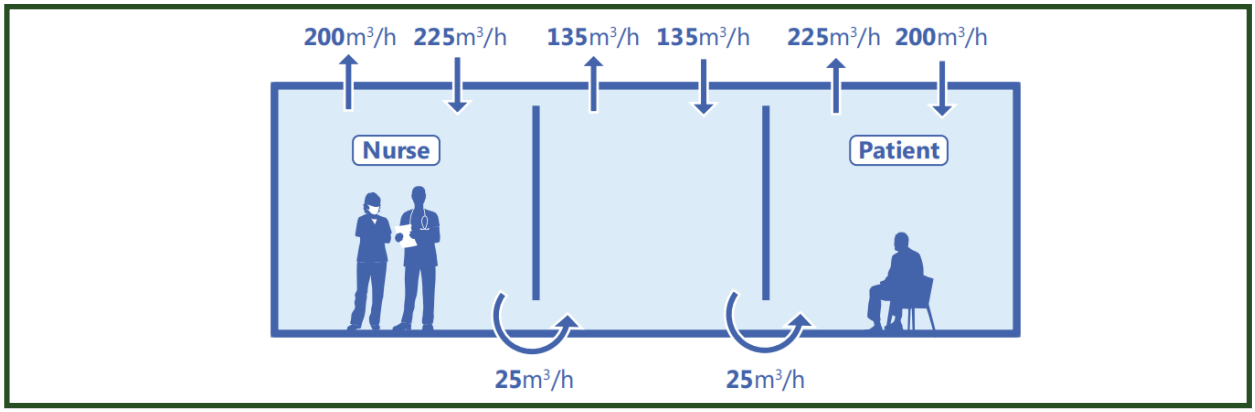
HEPA filtration is an option to remove infectious particles from the air. It may be considered where sustainable resources for membrane replacement and maintenance are assured, where natural ventilation is not possible, and where the risk of TB transmission and morbidity is high. Filtration devices perform poorly in high-dust conditions, as the effectiveness in terms of equivalent air exchange can rapidly diminish. Situations where it might be considered include small room volume settings like bronchoscopy suites, laboratories, or individual TB patient rooms.

Figure 6.14: Diagrammatic representation of HEPA Filter



b) Positive and negative pressure rooms

Figure 6.15: A diagrammatic representation of positive & negative pressure rooms and directional airflow in mechanical ventilation, using HVAC System



The diagram illustrates directional control of airflow from HCW to the patients and outside for the protection of HCW. The ducting system ensures the following-

In the nursing station, 225 m^3/h is the air supplied, and 200m^3/h is exhausted out (creating a positive pressure). The remaining 25m^3/h is moving towards the anteroom. In the patient room the supply volumetric airflow is 200m^3/h from the outside and air exhaust is 225m^3/h (creating a negative pressure) and this sucks in the 25m^3/h from the anteroom. The HCW is thus protected from the contaminated air.

Figure 6.16: Example of fully controlled Mechanical Ventilation – AHU/ HVAC system in JLNM&H, Agra.

c) Basic Design considerations for HVAC

The following aspects are to be kept in mind while installing HVAC systems:

- Type of mechanical ventilation system (100 % fresh air system or recirculating type) based on the risk assessment
- Type of filtrations required based on outdoor air quality
- Need for cooling and humidity control
- Selection of AHU, CFM and cooling tonnage (TR) based on required dehumidified CFM and ACPH
- Cost

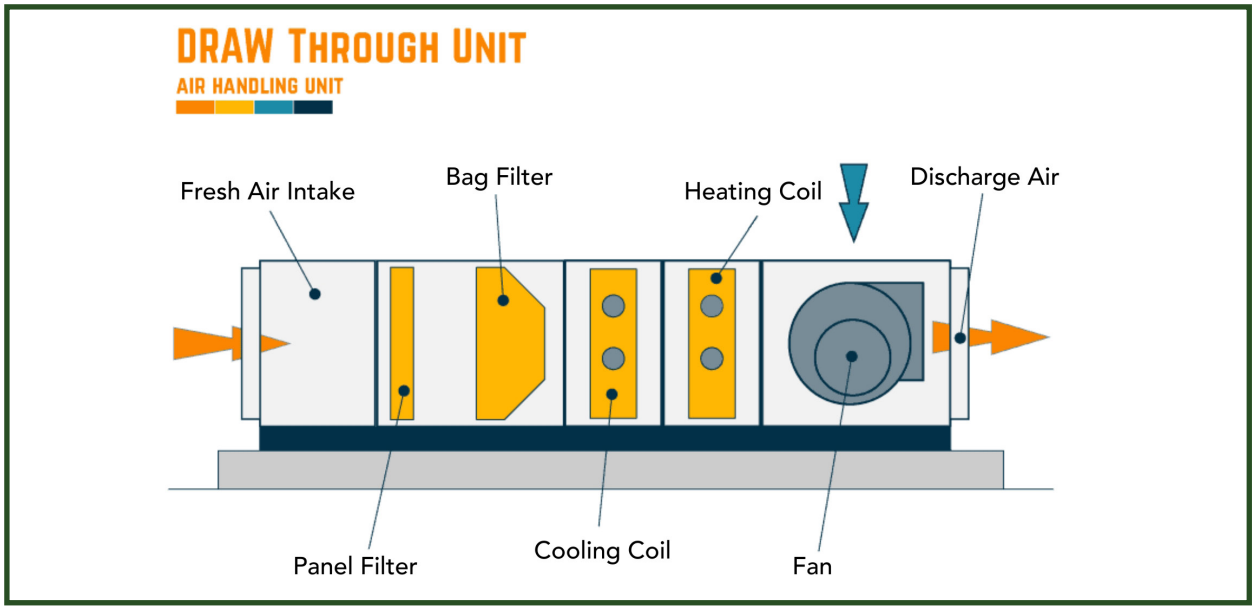
i) 100 % fresh air HVAC system

It works based on outdoor air. The air taken from outside is conditioned by the air handling unit and blown into the room. This is subsequently blown out through the ducting system or through natural openings. There is no heat recovery and mixing of air in these air handling units.

It is preferred in cases of high-risk settings like BSL2/ BSL3 laboratories, ICU, OT, isolation negative pressure rooms etc. For TB control, the best type of HVAC system is one without

recirculation, that is, a 100% outdoor air (single-pass or once-through) arrangement.

Figure 6.17: Diagrammatic representation of a 100% Fresh Air HVAC system.



This picture shows an AHU, with supply from outside which is filtered, cooled/ heated and adequate ACPH is generated by the fan-motor unit and supplied to the room. This air gets exhausted through the natural openings or can be vented out through an exhaust system. Such systems are more expensive to maintain than recirculating HVACs but are ideal for high-risk healthcare settings.

It is important, in HVAC systems that the exhaust must be placed 10 m away from the air entry point to avoid short circuiting of air (see pictures below). It may also be placed facing away from the air inlet direction.

Figure 6.18: Air Short circuiting in 100% fresh air HVAC, the air exhaust is right above the air inlet. This will suck the contaminated air back into the room.

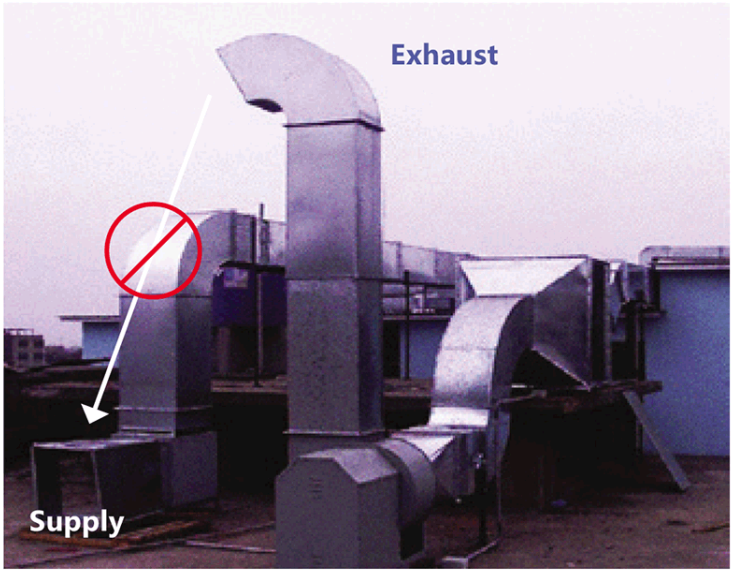
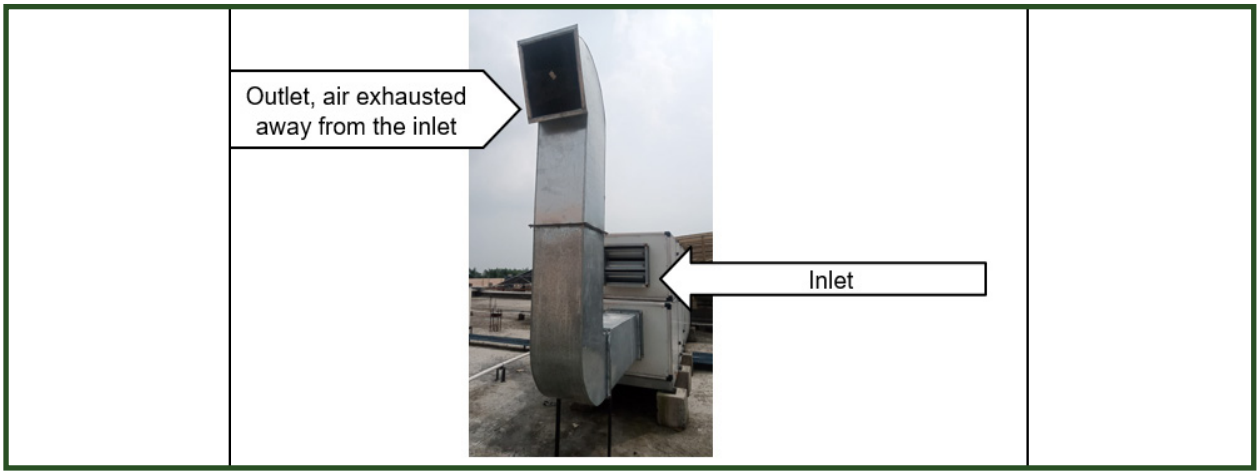


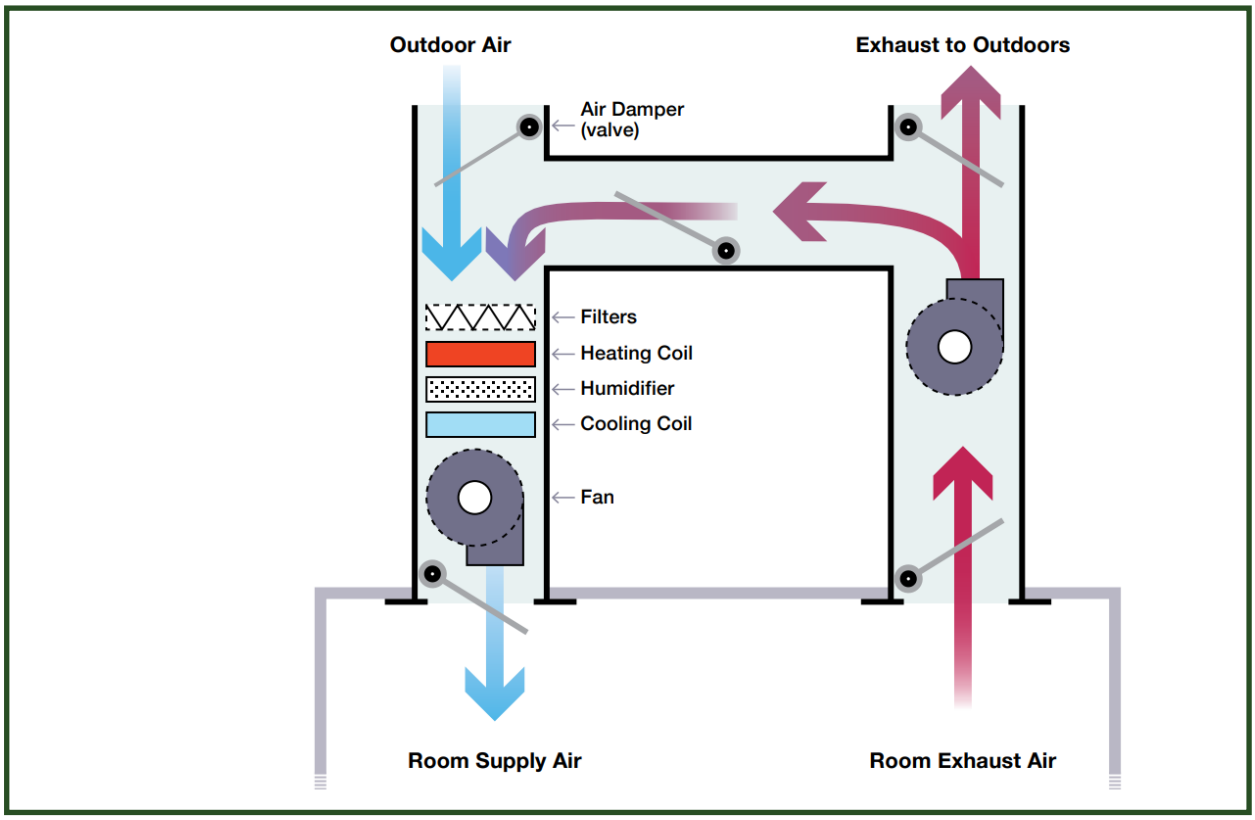
Figure 6.19: Appropriate installation of air exhaust and air inlet, HIMS, Jolly Grant



ii) Recirculating HVAC Systems

Recirculated air refers to the process by which a portion of the air within a space is captured, treated, and then reintroduced into the indoor environment. In HVAC systems, this is achieved through the circulation of air within the system itself. Rather than constantly drawing in outside air, a portion of the already conditioned air is recirculated to maintain a consistent temperature and humidity level.

Figure 6.20: Recirculating HVAC system



In the figure above, on the left-hand side, we have fresh air entering from outside (blue arrow), which is filtered, cooled and appropriate ACPH is generated by the fan (motor unit) and the air is supplied to the room. On the right-hand side, air is exiting (red arrow) from the room, and

the ducting system diverts part of the air, back into the air supply duct, which is again filtered and re-used. Rest of the air is exhausted outside. It is important to consider and decide on the following while installing recirculating systems

- Understand the percentage of air recirculation permissible
- Consideration for HEPA filter installed in return duct in the recirculating system along with their periodic maintenance plan
- Consideration for additional features of disinfection like provision of In-duct GUV system across supply cooling coil / Virus burn out system etc. along with their periodic maintenance plan
- Minimize recirculation from high contamination areas to immunocompromised areas, paediatric wards etc

d) Design Considerations: CFM, Cooling Load, Ducting

For the mechanical ventilation system these points should be considered while designing the unit

- CFM: the defined CFM is based on the required ACPH for that facility volume and the dehumidified CFM. Whichever is higher, the CFM is selected accordingly
- The design cooling load (or heat gain) is the amount of heat energy to be removed from a facility/ building by the HVAC equipment to maintain the defined indoor design temperature even when the worst case of outdoor temperature is being experienced
- Ducting

i) Deciding on the CFM

It is important to decide on the CFM requirement for a room. This can be calculated using the desired ACPH where, Total airflow required (in CFM) = (Room volume x ACPH)/60

Example:

- Assume the room L= 60 ft, B=20 ft, H=10 ft
- Assume ACPH requirement is 12*.
- What should be the CFM requirement for the room?
- Volume of the room=60*20*10=12000 cubic ft
- Airflow required per hour= 12000*12= 144000 cubic ft/ hour
- Airflow in CFM= 144000/60=2400 CFM
- Here, the AHU motors can be designed for 2400 CFM

Factors that modify the ACPH requirement are the occupancy (approx 15-20 CFM/ person), activity, hazard containment requirements, temperature and humidity requirements and the temperature and humidity generated in the space covered by the HVAC.

Note: Increasing the number of ACPH beyond 12 ACPH will have diminishing returns and will

be of very little benefit at a significant cost for most spaces. Exceptions could include small spaces, such as a sputum collection booth, where an ACPH >12 can be achieved at a reasonable cost for the added removal and/or inactivation rate.

ii) Deciding on the cooling load

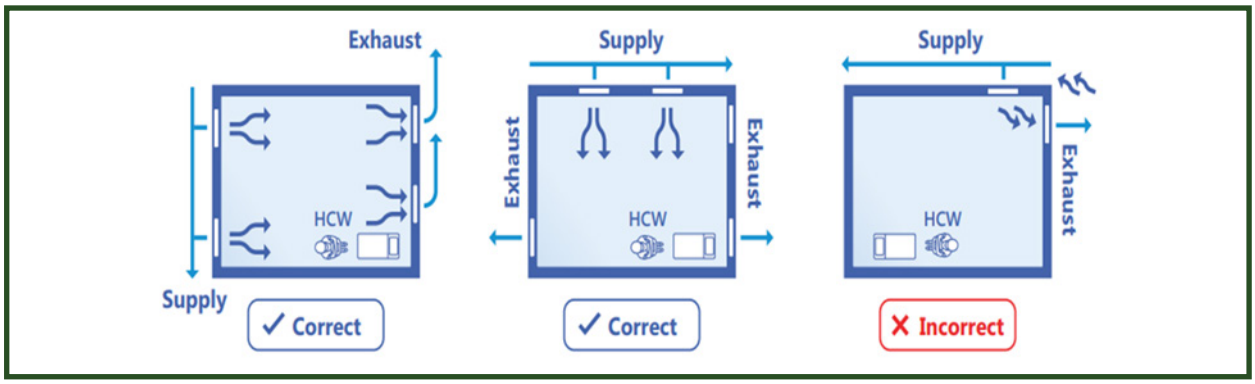
Factors affecting cooling requirements

- Glass windows or doors, sunlight striking windows, skylights, or glass doors and heating the room
- Exterior walls, partitions (that separate spaces of different temperatures), ceilings, roofs, floors over an open crawl space, air infiltration through cracks in the building, doors, and windows, lights
- Other factors that influence latent cooling load are occupancy, equipment and appliances
- Other latent heat gain by the HVAC equipment (Filters, Coil, Duct) before the air reaches the rooms (system gain)

iii) Deciding on the ducting

While installing the ducting system, sufficient consideration should be given for air mixing, with reference to inlets and outlets and seating arrangements of the healthcare workers.

Figure 6.21: Correct and Incorrect ducting systems. In the first figure the air entry and exhaust are on opposite walls and the HCW in the right corner is protected. In the second figure, the air entry through one side and exhaust through both sides also keeps the HCW safe. In the third figure the ducts are close to each other and all incoming clean air is immediately exhausted and the HCW is not safe. The first two pictures indicate good ducting that will ensure directional airflow conducive to the protection of the healthcare worker, whereas the third picture shows a ducting that will not allow this.



iv) Installation checkpoints for HVAC

- Installation Checks: Check installed equipment to ensure that all associated components and accessories are in place.
- Operational Checks: Verify and document that systems are performing as expected, and that all sensors and other system control devices are properly calibrated.
- Documentation: Confirm that all required documentation has been provided, such as a

statement of design intent and operating protocols for all building systems.

- Operations and Maintenance (O&M) Manuals and Training: Prepare comprehensive operation and maintenance manuals and provide training for building operations staff.

v) Common maintenance checkpoints for HVAC systems

Ongoing monitoring to ensure that equipment and systems continue to perform according to design intent. The airflow audit must include the following

- Ventilation rate: Using anemometer, determine the airflow and adequacy as per ACPH requirement, occupancy and other factors.
- Pressure-drop across HEPA filters: The pressure drop is measured using gauges across the HEPA filter. For e.g. the initial pressure can be around 100 Pa or 10mm of water column. However, this depends upon the size, construction and capacity of the filter. If the pressure gradient drops to three times the initial reading, it is an indication to change the filter. In BMS (Building Management System) this will be monitored automatically.
- HEPA filter integrity test: This test is conducted to check both supply and exhaust HEPA filters, the filter housing, and the mounting frames for possible leakage by using Aerosol generator (cool or hot) (PAO- Poly Alpha Olefin [a liquid used in HEPA filter integrity test] are recommended) or Aerosol Photometer or Particle Counter.
- Periodically clean the prefilters, which are washable & easy to maintain (once a month or more often depending upon the outer environment).
- Check for any sign for corrosion.
- Exterior of the motor should be cleaned periodically to remove dust that affects the heat dissipation from the motor.
- Promptly identify any abnormal noise and vibration.
- Periodic inspection of HVAC duct work can identify potential problems (like dirt, leak and corrosion).
- Replacement of HEPA filters as per the manufacturer's instructions.
- Monitoring of in-duct GUV systems for lamp functioning.

Table 6.3: Vent and Filter cleaning method

Area/Items	Process	Item/ Equipment	Method/Procedure
Air-vents and filters	Vacuum cleaner Duster Detergent solution	Cleaning	Vents are vacuumed to remove any dust and wipe out with a cloth and detergent. Some vents require removal to wash the back and entrance of the ducting. Metal vents and filters are washed under running water and dried with a lint-free cloth to remove stubborn soil age. It should be done in collaboration with the engineering department.

6.3 Challenges in achieving adequate ventilation and climate control

6.3.1 Air conditioning (AC) and Ventilation

Effective ventilation is often at odds with efforts to make indoor climate more comfortable. In practice, air cooling or heating is more energy efficient with re-circulation of air. The implication of installing an air conditioning system and closing the doors - windows is, however, a complete lack of air exchange. Points for consideration for ensuring adequate ventilation when installing such system to control the climate are as stated below.

It is possible for rooms with air conditioning or heaters to have adequate ventilation. Diagrammatic illustration in figure 6.22 shows installation of exhaust fan on the opposite side of the room to achieve adequate air exchange while airflow intake through doors and climate control through air conditioner. The air conditioner is located away from the exhaust, near the door, so that cool air sweeps across the room. An exhaust fan, adequate to achieve the required air exchange, is installed on the other side. Adequate air intake has been enabled by having enough space under the door (a few inches clearance) for air to freely enter the room. Alternatively, exhaust fans can be installed in the reverse direction to push in fresh air.

Figure 6.22: Schematic presentation on how adequate air exchange could be achieved in a room with air conditioning or heating system

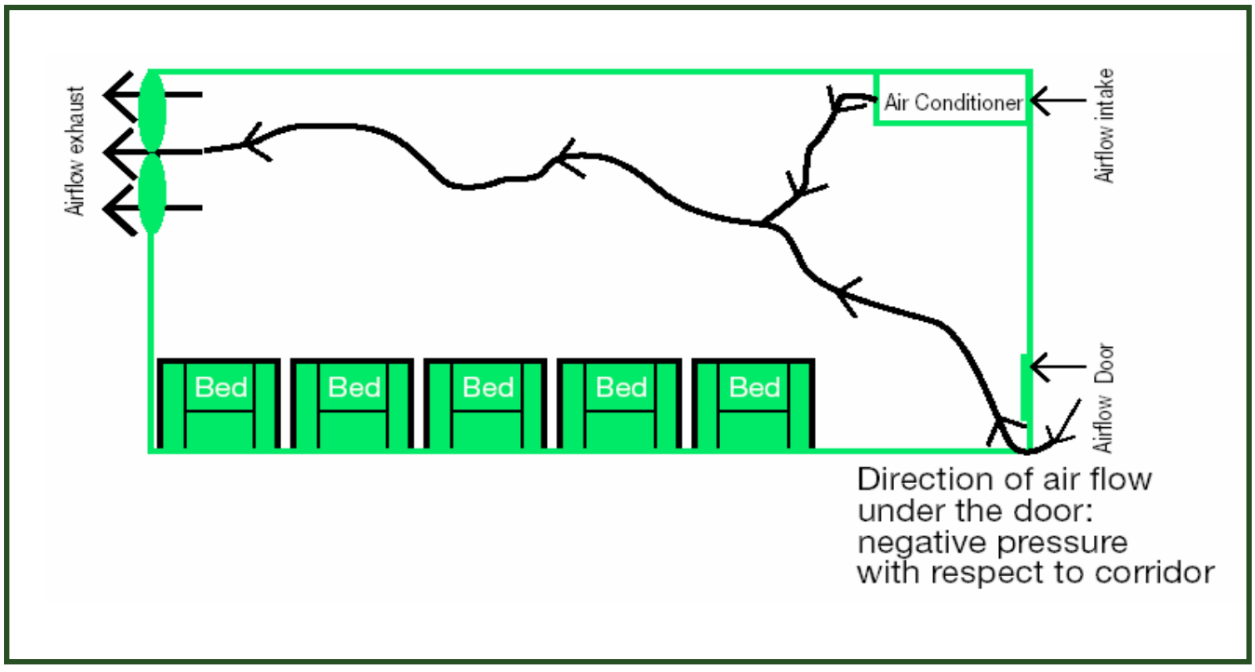
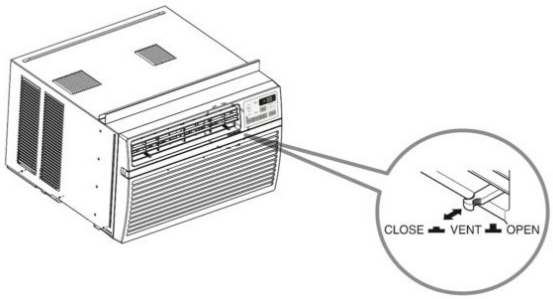


Table 6.4: Types of air conditioners

Split AC	Window AC
It is generally recirculating in nature and to be used with great caution, due to the harmful effect on air exchange. If re-circulating air conditioners must be used, then it would be desirable to have an exhaust fan installed, in the reverse direction (as an air supply fan) forcing fresh air in the room and giving directional control. This would compromise with comfort to some extent but add value to the safety of the room.	Most Window ACs are re-circulating However, there are some models that have a 'vent' lever (below picture) which opens to the outside and allows outside air to be drawn into the room.  These vents work by drawing fresh air which is conditioned (cooled) before blowing inside the room and thus helps in ventilation of the room/ facility. This may be effective for small spaces or rooms.

6.3.2 Air purifiers

A portable in-room air cleaner does not reduce the risk of TB transmission and should not be used as a TB IPC intervention. It removes contaminants from a room air to enhance the quality of air. It helps to trap airborne particles like dust, pollen, removes odour from the air, and prevent contaminants from the air being recirculated back into air. Air purifiers can be noisy, have high maintenance cost and need to be cleaned at regular interval. To choose appropriate model, check if CADR (Clean Air Delivery Rate, m^3/h or ft^3/min) allows to provide required ACPH in a room.

6.3.3 Considerations for hot climates

Climactic extremes may require some adjustments to ensure that minimum ventilation standards are achieved. In the case of hot climactic conditions, the following design considerations should be made.

- If air conditioners are used, it must be acknowledged that the need to maintain adequate

ventilation for airborne infection control may compromise the comfort of room occupants and the efficiency of the air conditioner. Consider using upper room GUV if adequate ventilation is not feasible in air-conditioned room.

- In case air conditioning is needed, it is recommended that window ACs with vents allowing outside air to be drawn into the room, would be a better option.
- Minimize solar heat gain through proper use of sunshades or external shading.
- Use outdoor shaded waiting areas to the greatest extent possible.
- Where augmentation of ventilation is required, use of air supply fans may help improve thermal comfort, compared to exhaust fans.
- The use of evaporative coolers (desert coolers) may be an effective solution to achieve both comfort and adequate ventilation, as these tend to have powerful fans.
- The installation of whirlybirds or wind turbines do not use electricity and provide a roof exhaust system that can greatly increase both ventilation and comfort.

6.3.4 Considerations for cold climates

In cold climates, high ventilation rates may adversely affect thermal comfort and are difficult to achieve as windows may be closed to keep the building warm. Even if normal heating is introduced, high ventilation rates usually mean energy efficiency will be low. Therefore, ventilation and heating strategies must be planned carefully.

- Building design should seek to capture the solar heat and minimize conduction loss through the wall.
- Proper insulation of walls and the use of double glazing on windows are desirable.
- Where augmentation of ventilation is required, use of air exhaust fans may help maintain adequate ventilation, even when windows or doors are closed.
- Targeted radiant or direct near-body heating methods are more effective than common convective radiators. This includes modern electric coil heaters and heated blankets/ mattresses.
- Installation of upper room GUV systems can be an effective mechanism of infection control, where adequate ventilation is a challenge.

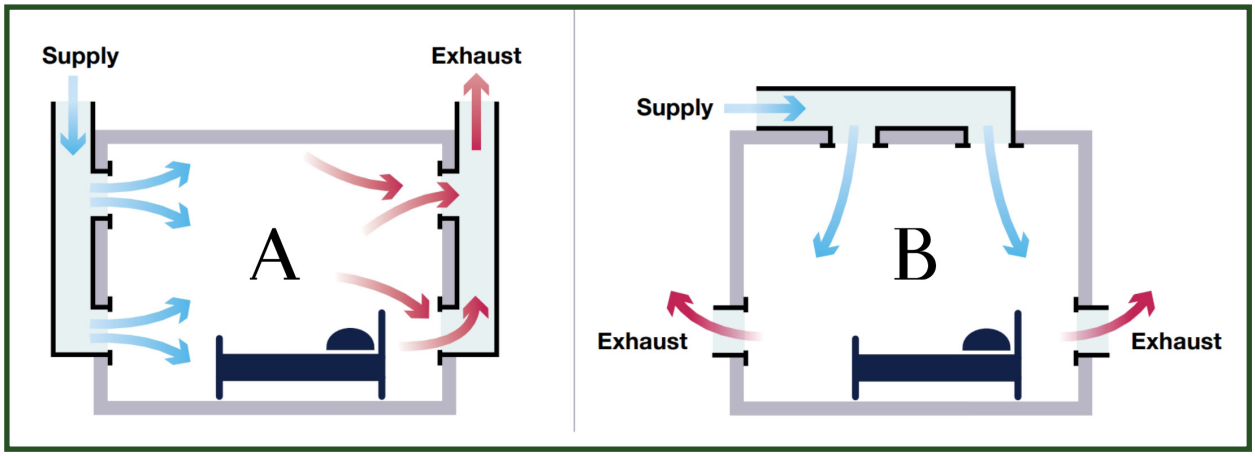
6.3.5 Optimal arrangement for patients and staff

Healthcare staff should be mindful of the direction of airflow to ensure they are closest to the clean air source, and that patients are closest to the air outlet. This involves arranging patients and staff so that contaminated air is not likely to cross directly into staff/patient spaces. The natural direction of air flow should be between patients and staff, and not across patients and staff. This is especially important for settings such as OPD, treatment centres, laboratories, radiology unit etc. This has been explained along with the administrative controls.

In Figure 6.23A, air supply is on one side, exhaust from the other, so IRPs are not dispersed to other patients or staff. In Figure 6.23B, air supply is from one side and the air outlets are on

either sides of the adjacent walls, for optimal direction.

Figure 6.23 A and B: Optimum air entry in wards



6.3.6 Short circuiting of air

Poor engineering design can increase the risk of contamination or produce short-circuiting of air. The pictures below are a few examples of short-circuiting of contaminated air and fresh air which should be avoided.

Figure 6.24 A: Short circuiting: Examples of poorly installed exhaust fan in an open window space, with "short-circuiting" of airflow. In this installation, the fan adds little to ventilation; removal of the fan was recommended, as natural ventilation was adequate.

Figure 6.24 B: The placement of air-exhaust fan right above the air inlet window. The fresh air coming in through the window is immediately exhausted through the fan.

6.4 Monitoring of ventilation

Ventilation of a room is variable except in the case of mechanical ventilation

- It can vary from time to time within a day
- It can vary from season to season
- Both the direction and velocity of airflow can vary
- Unintentional closing of air entry points can affect ventilation

IEC for prompting the opening of windows, turning on of exhaust fans etc. should be available. Please see Annexure 2 for Ventilation monitoring checklist.

6.5 Air changes per hour (ACPH)

Air Changes per Hour (ACPH) is a critical metric used to quantify the rate at which the entire volume of air within a specific space or room is exchanged or replaced with fresh, clean air in one hour. Low ACPH rates are associated with increased infection rates or outbreaks of airborne diseases.

Healthcare facilities should maintain a minimum amount of ventilation during all climatic conditions (Table 6.5). These recommendations are based on the minimum ventilation rate estimated to reduce the probability of infection up to 95% in an enclosed room with an hour of exposure to an infectious source.

6.5.1 Standards of minimum ventilation in healthcare settings

Table 6.5: Standards of Ventilation in Healthcare settings

Type of Healthcare Setting	Minimum ACPH
Registration areas	>6 ACPH
OPD and waiting area	>6 ACPH
Inpatients departments	>6 ACPH
High-risk area (TB wards, TB OPD, TB laboratories, bronchoscopy suites, ART Centres etc.) and their waiting sections	>12 ACPH
Sputum collection areas	> 20 ACPH

The following table explains the number of air changes per hour against the time and efficiency of particle removal.

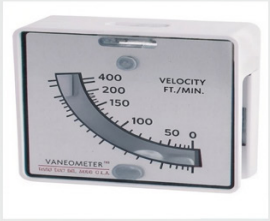
Table 6.6: Indicating the efficiency of particle clearing at different ACPH levels

ACPH	Time (mins.) required for removal 99% efficiency	Time (mins.) required for removal 99.9% efficiency
2	138	207
4	69	104
6+	46	69
8	35	52
10+	28	41
12+	23	35
15+	18	28
20	14	21
50	6	8

This table shows in the first column the ACPH number, in the second column time taken to remove 99% of the particles, and in the third column time taken to remove 99.9% of the particles. As the table shows 12 air exchanges in an hour will enable 99% of the particles removed in 23 minutes and 99.9% of the particles removed in 35 minutes.

6.5.2 Tools used to measure ACPH

Figure 6.25: The tools used to measure ACPH

Measuring tape	Laser Distance Meter	Vaneometer	Anemometer
			
Measures length, breadth and height **manually** (for windows, door measurements)	Measures **length, breadth and height digitally** (for measuring the dimensions of the room	Measures the **direction of airflow.** (It also measures velocity in cases of low values of air velocity)	Measures **air velocity** in feet per minute, meter per second etc (different units available)

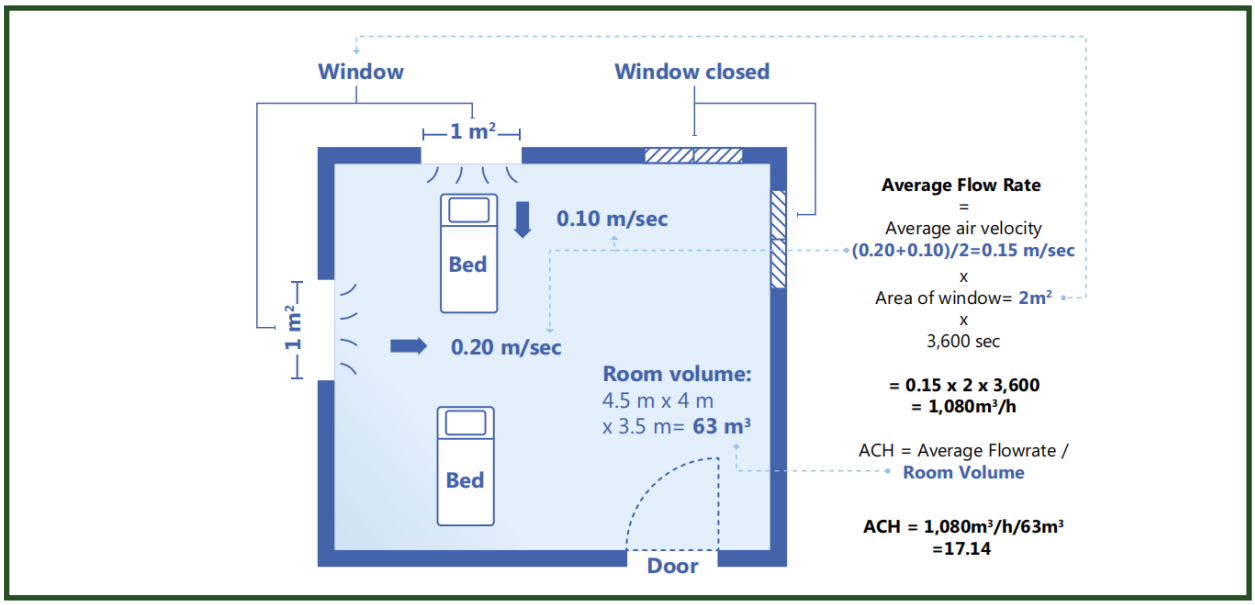
6.5.3 Formula to calculate ACPH

- ACPH = Q * 60 / volume of room in cubic feet
- Q = volumetric flow rate: average velocity across window or door * area of window and door (in cubic feet per minute)
- There are 6 steps (mentioned below) in calculating ACPH.

1. Calculate room volume using measuring tape or laser meter
2. Identifying door or window through which air comes in using vaneometer
3. Calculate total OPEN area of door and window using measuring tape or laser meter
4. Calculate velocity of supply air for all inlets using anemometer
5. Calculate total air supply volume (volumetric airflow or Q)
6. Calculate ACPH

The details of ACPH calculations and worksheet are given as Annexures 3a and 3b.

Figure 6.26: ACPH Measurement with example



- Calculate room volume: here, 4.5*4*3.5 m= 63 m^3
- Identifying door or window through which air comes in using vaneometer: here, the two windows, as indicated.
- Calculate total OPEN area of the air entry windows: here, $1m^2+1m^2= 2m^2$
- Calculate velocity of air for all inlets: here, (0.2 m/sec+0.10 m/sec)/ 2=0.15m/sec (for each window 3 to 5 points may be measured and the average taken)
- Calculate total air volume (volumetric airflow or Q): here, 0.15* 2*3600 = $1080m^3$/hr (where 0.15 is the velocity of air, 2m is the area of the windows, 3600 secs in one hour)
- Calculate ACPH: here 1080/63=17.14 (where 1080 is the volumetric airflow and 63 is the volume of the room)

6.6 GUV Systems

GUV (Germicidal Ultraviolet) is the current term for what used to be termed "Ultraviolet Germicidal Irradiation" (UVGI). The effectiveness of GUV systems depends on the specifications of the GUV fixtures installed, the place of installation, quality of maintenance, the duration of exposure of contaminated air to ultraviolet (UV) light (i.e. total exposure time) and the adequacy of air mixing to ensure exposure of all infectious particles to UV light. Upper-room GUV systems can be installed in both health facilities and congregate settings where there is a high risk of M.tb transmission. Priority should be given to achieving adequate air exchange using ventilation (natural or mechanical). However, in some settings it is not possible to achieve adequate ventilation; because of climatic changes (e.g in winter or during the night) or building structure. In addition, in settings such as DR-TB wards and ART centres transmission of TB poses a high risk of morbidity and mortality. In high-risk settings where adequate ventilation is not possible, a complementary option is to use ultraviolet germicidal disinfection devices.

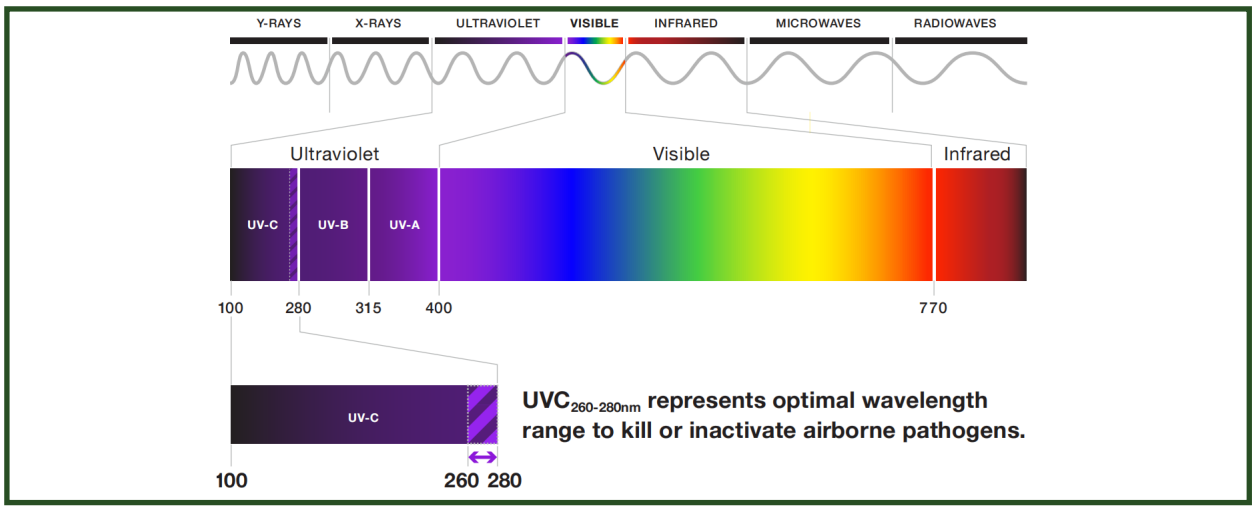
Key point: GUV systems should be installed as part of the package of IPC interventions, not as a standalone intervention, to avoid giving a false sense of security when administrative controls and respiratory protection measures are lacking, particularly in settings with high TB transmission.

6.6.1 GUV Mechanism of action

UVC and the Electromagnetic Spectrum

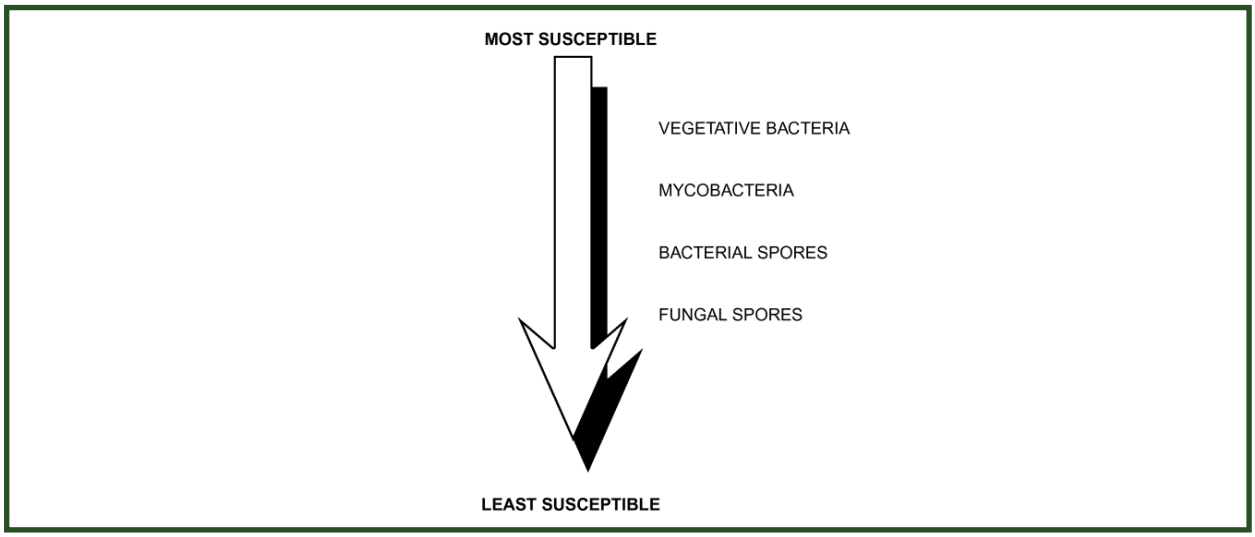
UV is the region of the electromagnetic spectrum from 100 to 400 nm, which is not visible to the human eye and is further split into subregions A, B and C. The visible light spectrum runs from about 400 to 700 nm whereas infrared waves may have wavelengths closer to visible light, but which are perceived more as heat. The UV light C (UVC), with wavelengths of 260–280 nm, is considered optimal for killing or inactivating most bacteria, viruses and fungi. It works by damaging DNA, RNA or proteins in the microorganism and interrupting cell replication. Commercially available germicidal lamps contain mercury vapours under low pressure that emit non-ionizing electromagnetic radiation in the UVC wavelength range with about 90% of the total spectral power emitted at 254 nm (UVC_{254}).

Figure 6.27: Electromagnetic spectrum from UV to infrared



6.6.2 Susceptibility of microorganisms to GUV

Figure 6.28: Susceptibility of inactivation of micro-organisms by groups. Viruses and vegetative bacteria are highly susceptible, whereas spores are least susceptible. Mycobacteria also have good susceptibility



6.6.3 Types of GUV systems

GUV are available in four forms:

1. Continuous upper air room disinfection by GUV, in which shielding placed below the GUV sources prevent injury to occupants. (This type of GUV system is discussed in detail further in this chapter)
2. High-intensity GUV in the ducts of a mechanical ventilation system (in-duct GUV). (This is discussed briefly in this chapter).
3. Portable GUV floor units.
4. Bare bulbs can be used to irradiate areas when not occupied, for example in biosafety cabinets. Bare bulbs should be avoided in patient care areas, as these are most likely to cause injury.

6.6.4 Most common applications of UVC_{254} as part of a TB environmental control strategy

Upper-room UVC_{254}

Upper-room UVC_{254} refers to the use of UVC_{254} fixtures with radiation directed in the upper portions of a room to disinfect the air while the room is occupied. UVC_{254} fixtures are mounted high on walls or suspended from the ceiling and positioned to avoid unsafe exposure to

occupants in the room. The ventilation system and/or auxiliary fans mix irradiated air with the air in the lower part of the room (breathing zone), resulting in reduction of viable airborne microbes. Upper-room UVC_{254} is a useful environmental control for congregate, healthcare, public, and other settings with inadequate ventilation airflow rate, where susceptible people may have prolonged exposure to a person with unidentified or infectious TB. These settings may include emergency departments, waiting rooms, airborne infection isolation rooms (AIIRs), isolation areas, congregate settings, or homeless shelters.

In-duct UVC_{254}

In-duct UVC_{254} is the installation of UVC_{254} lamps inside of a return or exhaust air duct to kill any M.tb that may be in the airstream. If air is recirculated, UVC_{254} may be installed before or after the cooling coil and is a useful supplemental environmental control in recirculating air systems. In-duct UVC_{254} is not recommended as an alternative for cleaning of exhaust air from airborne infection isolation rooms (AIIR). Better options would be direct exhaust to the outdoors or high-efficiency particulate air (HEPA) filtration for AIIR exhaust air.

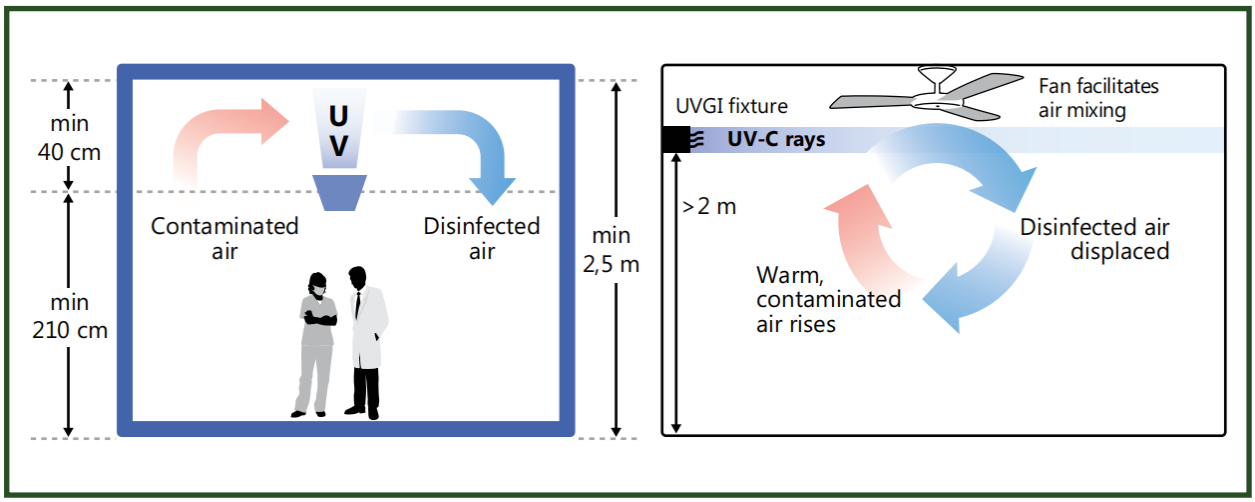
6.6.5 Upper room GUV fixtures

As with any light, the energy of UV light diminishes as the distance from the source increases. Therefore, the number of GUV fixtures required for a room depends on the size of the room. A room with GUV systems should have a ceiling that is high enough to prevent people looking into the lamp and to allow enough upper room unoccupied space for air disinfection; this is shown schematically in Fig.6.30 with a ceiling 2.5 m high, a shielded GUV device and a lamp that is oriented towards the roof. For the device to be effective, a "river" of circulating air needs to be created, to allow the "dirty" air to pass periodically through the space that has the UV radiation, to be "cleaned."

a) Effectiveness of Upper Room GUV

Upper room UVC GUV devices may be sometimes less expensive than structural alteration of the facility for ventilation purposes. Several studies have shown that a well-designed and maintained GUV upper room system can disinfect Mycobacterium (or surrogate test organisms), with an efficiency of 10–20 equivalent air changes per hour. WHO TB IPC Handbook 2023 indicates an equivalent ACPH of 24 with a properly installed GUV system. It has been estimated that when an average GUV intensity of 10 $\mu W/cm^2$ is present, 63% of airborne tuberculosis germs that arrive in that "kill zone" will be killed in 24 seconds, and 99% will be killed in 2 minutes. The degree of disinfection achievable using a GUV device also depends on the UVC dose. Pathogens must either receive a dose that is sufficient to inactivate them during one pass through the disinfection zone, or they must pass through the disinfection zone multiple times until they receive a sufficient cumulative UVC dose to be inactivated.

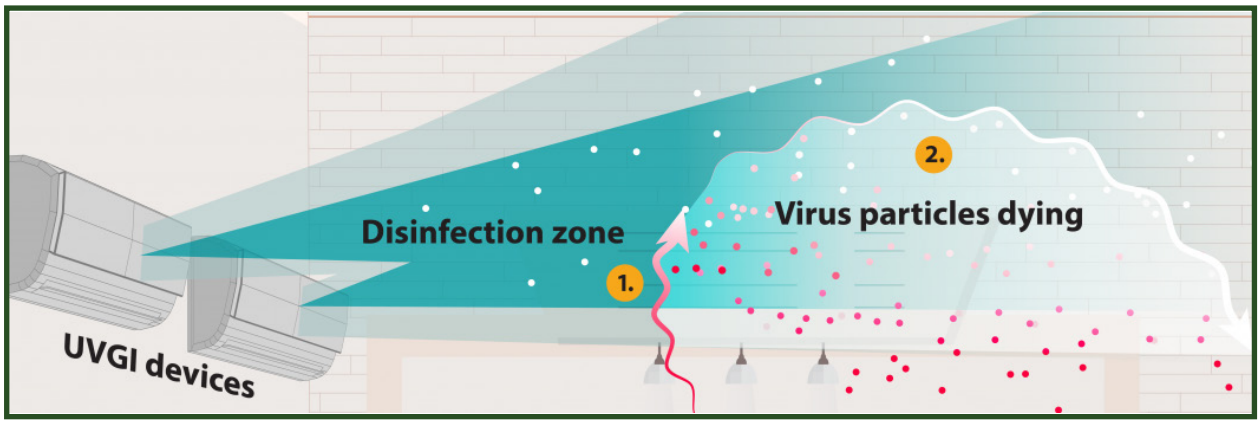
Figure 6.29: A "river of air" facilitates movement of contaminated air for exposure to GUV



Air rises to the disinfection zone, from fans or open windows. The airborne pathogens are killed once they receive an appropriate of UVC light dose. The particles remain in the air but are no longer infectious. For airborne organisms, correctly designed, installed and maintained upper-room GUV systems can provide an equivalent of 24 air changes per hour.

b) Use of Louvers in Upper Room GUV fixtures

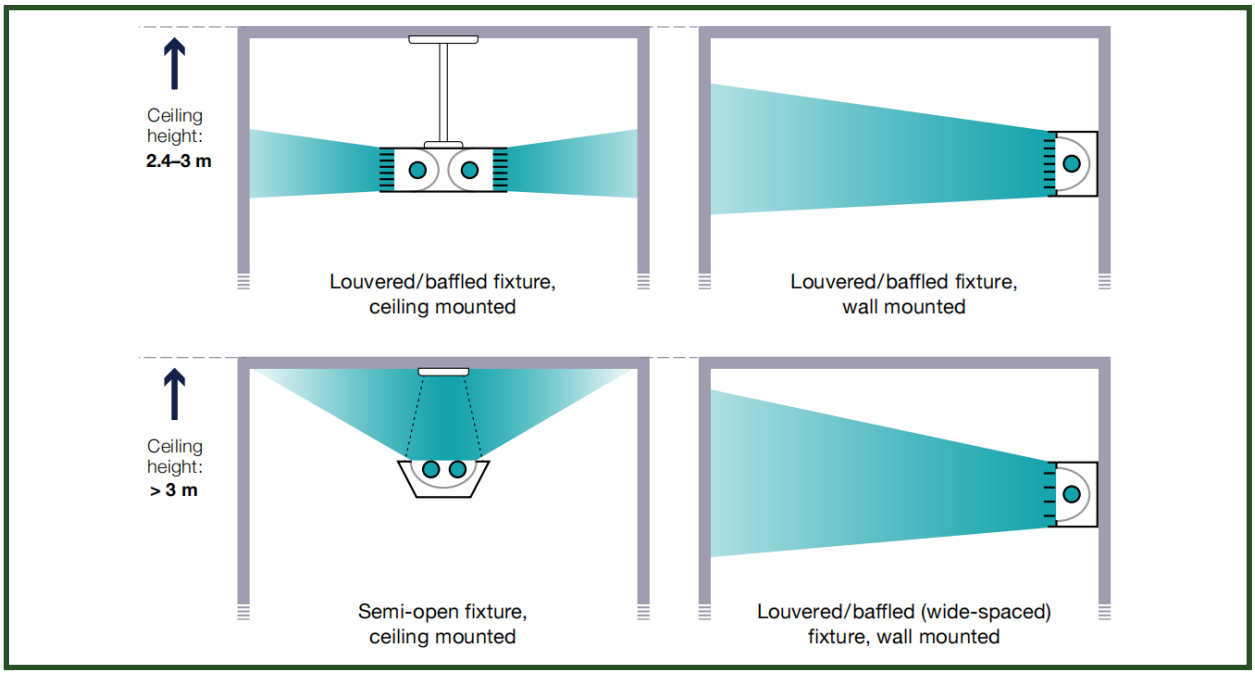
Figure 6.30: GUV device with louvers



Louvres are shutters with horizontal slats angled to allow UV light to be transmitted to the upper part of the room. The irradiance level in the upper air increased two to four times when the GUV devices were unshielded lamps (i.e., without louvers). Although louvers decrease the irradiance level in the upper room provided by the lamps, they also reduce exposure of room occupants to GUV. The louvers are coated with nonreflective material and are designed to be used in rooms with ceilings as low as 2.4 m (8 ft). In rooms with higher ceilings (e.g., 2.7 m [9 ft]) GUV may be used without louvers. These fixtures have upward-facing flanges (baffles), that deflect GUV upward. (Since this type of fixture radiates the UV rays upward, particular attention should be paid to potential reflection off the ceiling and other reflective surfaces)

c) Types of Upper Room GUV fixtures available

Figure 6.31: GUV Germicidal Ultraviolet Light



These are the common types of GUV fixtures available.

In rooms with lower ceilings (2.4–3.0 m), a louvered or baffled GUV fixture is needed to ensure that stray light does not overexpose occupants in the room or space; in rooms with higher ceilings (>3 m), GUV fixtures with wider spacing between the slats, or open GUV fixtures may be used.

The GUV fixtures may be suspended from the ceiling or attached to the walls. The bottom of the fixture is usually shielded or louvred to direct the radiation upward above a predetermined height. The aim is to inactivate airborne infectious agents in the upper part of the room, while minimizing the exposure of radiation to people in the room.

Figure 6.32A: Example of an open upper room GUV fixture for spaces of ceiling heights at least 2.7 meters	**Figure 6.32B:** Example of a Louvered upper room GUV fixtures for spaces of at least 2.4 meters in height
	

Figure 6.32C: Different types of ceiling, corner and upper room GUV fixtures

6.6.6 Different metrics and their units (for Irradiance, Dose and Output) used in defining safety and efficacy limits in Upper room GUV

Figure 6.33: Different units used for expressing irradiance dose and output

UVC Irradiance

flux of radiant energy per unit area

1 µW/cm² = 0.001 mW/cm²
= 0.01 W/m²
= 10 mW/m²

UVC Dose

UVC irradiation absorbed, Irradiance multiplied by exposure time

1, 000 µJ/cm² = 1 mJ/cm²
= 10 J/m²
= 10,000 mJ/m²

UVC Output

flux of radiant energy

1 Watt = 1 J per second

[Watt (W) = unit of power or radiant flux at rate of one joule per second; joule (J) = unit of energy]

Irradiance: Radiant energy per unit area

Dose Radiation absorbed (Irradiance * exposure time) expressed in Joules/ area

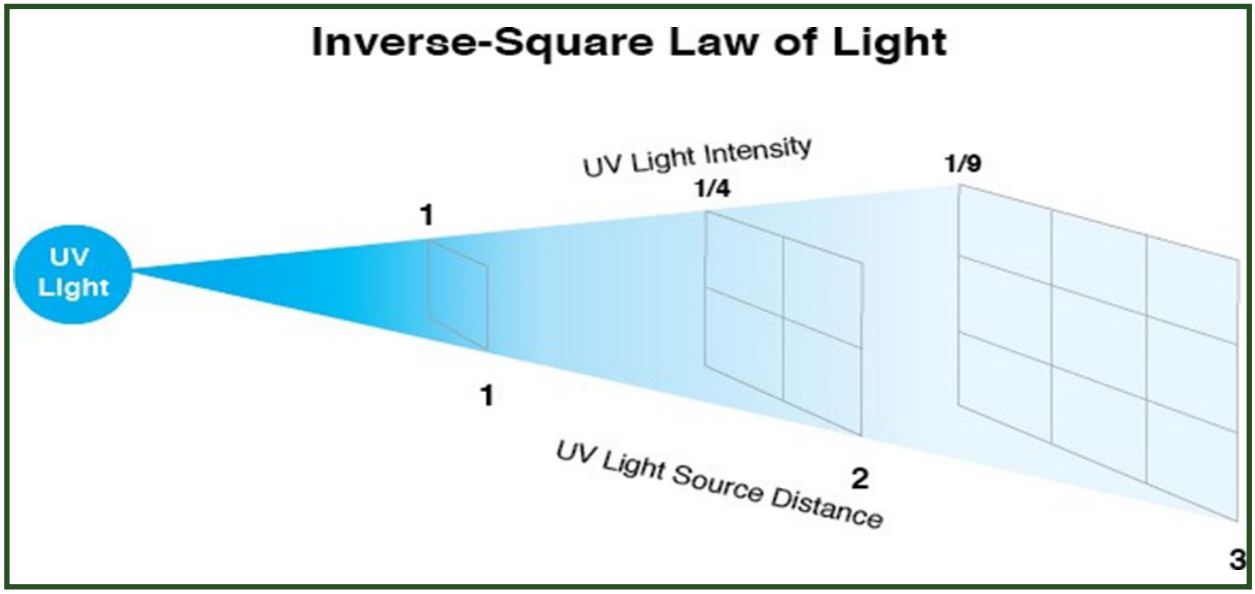
UVC Output: expressed in Watts

a) Irradiance

Irradiance: Is the flux of radiant energy per unit area and is expressed in W, mW or µW per m²,

cm^2 etc. This is the actual measurable parameter using a radiometer (discussed below)

Figure 6.34: Inverse square law. Diminishing intensity of energy, as the distance increases. In this case, the UV energy or Irradiance decreases with increase in distance.

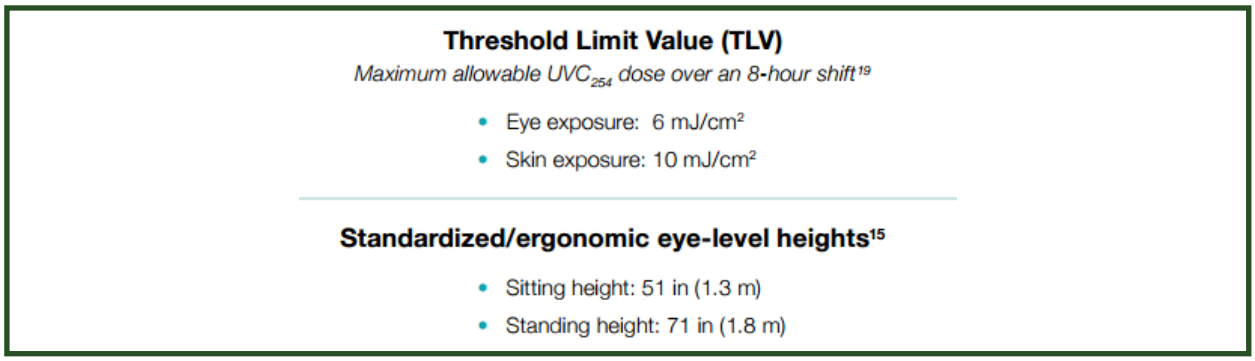


UV is a light wave which diminishes in intensity with distance from the source. At the time of installation and at 6 months, irradiance is measured at 1 meter (3.2 ft) in front of the fixture to ascertain the claims of the manufacturer is corroborated. Measuring irradiance in the safety zone is also very critical to ascertain the safety of the occupants. The maximum permissible irradiance in the safety zone is <0.2μW/cm^2.

b) Dosage

Dosage: The irradiance absorbed in unit time and is expressed in joules, microjoules, millijoules per area. This is an important parameter to understand the total exposed dosage per person. It is calculated by measuring the irradiance at all given spots an HCW/patient will occupy over a given time limit. The defined Threshold Limit Value (TLV) for eyes and skin is shown in the figure below. The eye-level heights in standing sitting and pillow level position are important.

Figure 6.35: Safety limits for Upper room GUV



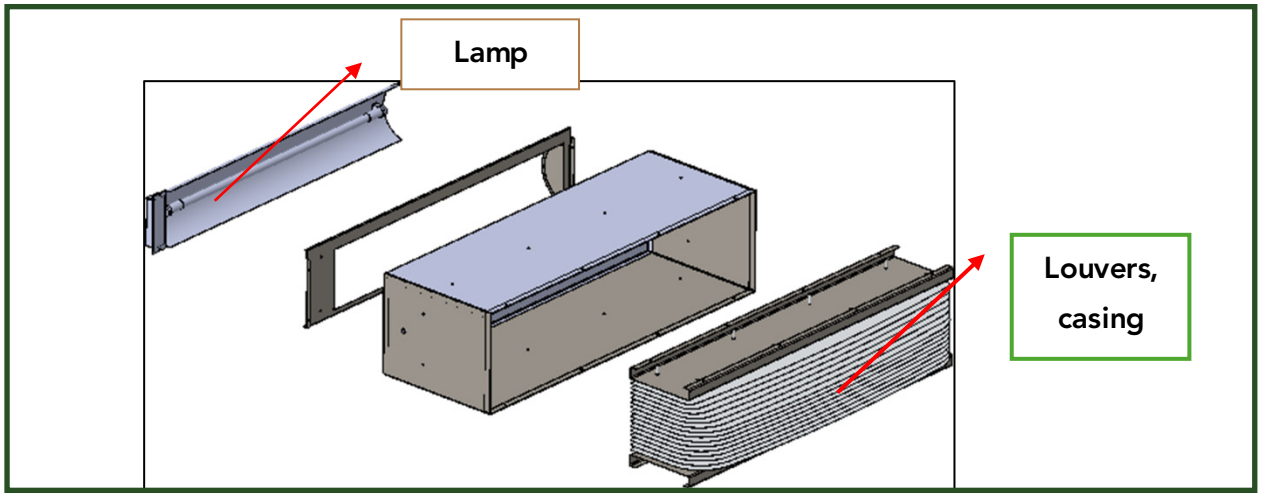
Dosage thus is:

- Calculated for each person
- Expressed in milli joules/sq^2
- Calculated by
    - ◊ Measuring the irradiance at all occupied zones
    - ◊ Mapping of all activities of HCW to understand the time spent in each zone
    - ◊ Comparing against the TLV limits for eye and skin
    - ◊ E.g., HCW XYZ spends 4 hours in zone A where the measured irradiance is 0.4 µW/cm^2 and 4 hours in Zone B where the measured irradiance is 0.2 µW/cm^2. Total exposure is = (0.4*4*60*60) +(0.2*4*60*60) = 5760+ 2280= 8040 µJ/cm^2 = 8.04 mJ/cm^2. TLV for eyes is 6 mJ/cm^2. Hence, we know that there is overexposure

c) Output

Output is the flux (flow) of radiant energy that is emitted by the UV lamp or the fixture. This can be the lamp output, which gets modified by the louvers and baffles on the fixture.

Figure 6.36: To show how the lamp output is modified using louvers. The final output is referred to as fixture output.



The minimum **fixture output** required will depend on the volume or area of the room as seen in the discussion below

Room/space dosing criteria for upper-room UVC_{254}

- Volumetric dosing criterion is 12 mW/m^3
- Area dosing criterion is 35 mW/m^2 assuming a maximum functional ceiling height of 10 ft (3 m) or less

An example for calculating the wattage (output) requirement

12 mW/m^3 is the minimum volumetric germicidal UVC_{254} output required.

- For a room of 2.6 m long, 3 m breadth and 3 m height,
- Volume=l*b*h= 2.6 m*2m *3m= 23.4m^3
- The required fixture UVC_{254} output in mW= 23.4 m^3 * 12 mW/m^3 = 280.8 mW= 0.28 W

6.6.7 Factors influencing the effectiveness of Upper room GUV

- Intensity of the radiation—depends on the wattage, condition, and age of the lamp. The intensity of radiation fades over time as the filament ages and drops sharply as dust accumulates on the lamp.
- Length of exposure time—depends on how quickly air containing the infectious particles moves past the lamp
- Proximity of infectious particles to the Upper room GUV lamp—the placement and number of lamps used should be sufficient to bring radiation of adequate intensity to enough air volume.
- Dose of UVC_{254} – a product of the irradiance (μW/cm^2) and length of exposure (seconds), expressed in microjoules per square centimeter (μJ/cm^2); effectiveness and safety criteria for UVC_{254} are based on the dose of UVC obtained.
- Mixing of air - inadequate air mixture has been shown to dramatically reduce the effectiveness of GUV. Without air mixture, in effect GUV will sterilize the same volume of air repeatedly and not dilute contaminated air with the sterilized air.
- Relative humidity—Upper room GUV effectiveness decreases with increasing humidity, as water vapor absorbs GUV at the germicidal wavelength of 254 nm. GUV is not recommended for rooms in which the relative humidity of the air is greater than 70%. The optimum humidity is 30-60%.

6.6.8 Exposure and safety of upper-room GUV fixtures

Safety is an important consideration when using UVC_{254}. Exposure to UVC_{254} radiation can occur directly or indirectly (e.g. while cleaning a fixture with the lamp turned on, or if UVC_{254} is unexpectedly reflected by a UV-reflective surface on the ceiling and down to occupied areas). Overexposure to UVC_{254}can cause temporary harm to the eyes (photokeratitis) and skin (erythema). UVC is a low-penetrating form of UV compared to UVA or UVB. UVC is absorbed in the first 2 μm of the stratum corneum (outer dead layer of human skin), thus minimizing the amount of UVC penetrating through the epidermis. Cutaneous damage consists of erythema, a reddening of the skin like sunburn (but without tanning). The maximum effect of erythema occurs at a wavelength of 296.7 nm in the UVB band.

Proper design, installation, and safety and maintenance protocols are essential to minimize the chances of overexposure. Systems must be monitored to ensure that optimal UV dose levels are achieved within a permissible limit of irradiance. People in the room that houses a GUV device should be shielded from excessive exposure by shields attached to the fixtures (in the form of louvres or baffles) to block the radiation and prevent it from descending below the horizontal plane of the fixture. Unshielded GUV lamps should be used only in areas that are not occupied.

The following safety features are ideally to be installed to avoid overexposure

- a power cut-off switch that automatically turns the system off when a service door is opened.
- motion detectors designed to automatically turn off the fixtures when something moves above a certain height above the floor.

Safety recommendations for UVC_{254} are based on dose of exposure (mJ/cm^2) for an individual; that is, the intensity of the radiation (irradiance, $\mu W/cm^2$) from the source that reaches the individual and the duration of exposure time. There are two sets of recommendations for exposure- the recommended exposure limit (REL) and the threshold limit value (TLV) – and they are not entirely consistent:

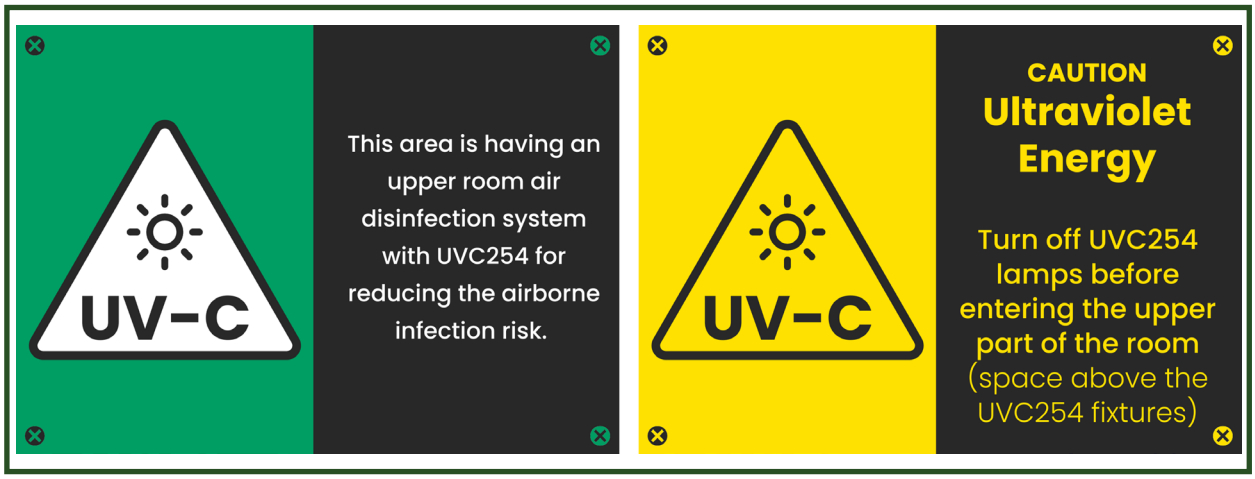
- The REL is 6 mJ/cm^2 for an 8-hour exposure for both the eyes and skin;(The 8-hour exposure dose limit (threshold limit value) for germicidal UV is 6.0 mJ/cm^2. This translates to 0.2 $\mu W/cm^2$ of measured UV irradiance at eye level for areas where exposure will be constant every day, such as the head of the patient's bed. In other areas where people would be present only transiently, such as hallways, the intensity could be up to 2.0 $\mu W/cm^2$)
- TLV for $UVC_{254}$for eye exposure is 6 mJ/cm^2 whereas for skin exposure it is 10 mJ/cm^2

a) UVC_{254} Safety education and signage

Staff and clients may have concerns about health hazards from UVC_{254}. To address these, facilities should provide simple education on purpose, benefits and risks associated with upper room UVC_{254}, for example, by:

- Posting a UVC_{254}information sheet on the wall of the room for occupants (staff and patients/ attendants).
- Developing written site-specific protocols for testing, cleaning, maintenance, repair and replacement of UVC_{254}fixtures and providing specialized training to appropriate staff.
- Ensuring that on and off switches for lamps are accessible to appropriate staff members but not located where patients/attendants may turn off the fixtures (it may be useful to consider lockable switches or placement of switches in areas restricted to staff).
- Posting warning signs, in all appropriate languages, on the GUV fixtures and other locations as appropriate (e.g. overhead storage areas), with an appropriate message, depending on the type of GUV system used; examples are shown in Figure 6.38.
- **Routine upkeep of GUV fixtures**
    - ◊ One member of staff should be designated as the in-house monitor for GUV fixtures. That person should be trained in the basic principles of GUV operation and safety.
    - ◊ The HICC is to designate appropriate functionaries for routine monitoring, performing routine checks by the institution, for monitoring scheduled maintenance by the vendors, and for the documentation of the required activities. Annexure 4- formats for maintenance of GUVs (installation and quarterly, half-yearly & yearly maintenance).

Figure 6.37: Safety communications



6.6.9 UVC_{254} Radiometers

UVC_{254} Radiometers are equipment calibrated at UVC_{254} nm to measure the irradiance in $\mu W/cm^2$ or mW/m^2. It is mandatory to measure the output of GUV systems at installation and periodically thereafter to ensure continuing efficacy and safety.

Radiometers are used to take measurements to confirm the following:

- Efficacy: The radiometer is used to check that the UVC_{254} source (the lamp) is working. When measured at 1 m in front of the fixture, the irradiance claims of the manufacturer should be achieved.
- Safety: The radiometer is used to check the level of irradiance at eye level or occupied level. (6, 4 and 3feet height, UVC_{254} irradiance should be ≤ 0.2 $\mu W/cm^2$ in constantly occupancy areas or <2.0 $\mu W/cm^2$ in transiently occupancy areas.)

The measuring range of the Radiometer should be 0.002 µW / cm^2 to 1000 mW / cm^2.

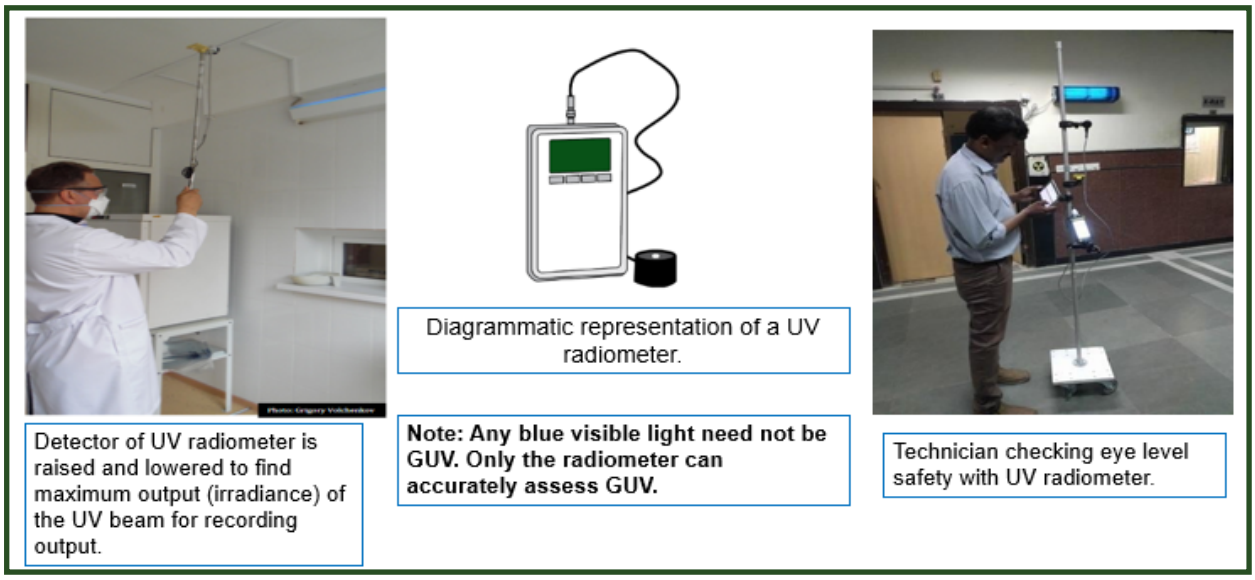
A broad range of possible irradiance levels (0.1–2000 $\mu W/cm^{2)}$ is needed to measure both the low end of the range (to gauge safety levels in the occupied zone of a room) and the upper end of the range (to check GUV fixture performance). Proper radiometer and detector selection is critical to verify the expected irradiance levels. Depending on the type of radiometer, two separate devices may be needed to accurately obtain both sets of measurements.

GUV lamp (bulbs) emits a visible blue light. However, all blue lights are not GUV or indicate that UVC is being emitted. UVC radiometer is needed to ensure efficient output of a GUV device.

GUV lamps can continue to emit blue light even after they are no longer effective. (The GUV lamp may look like it is working, but it may not be providing germicidal protection.)

Figure 6.38: Radiometer with sensor

Figure 6.39: Measurements taken in different parts of the room using a Radiometer



6.6.10 Suitability of a room for installation of upper room GUV fixture

In determining the suitability of a room for the installation of a GUV fixture, it is important to consider architectural details as well as utilities and other engineering features in the upper room that may affect UVC coverage. For example, ceilings and walls may need to be repainted to reduce reflection and improve UVC_{254} safety. Non reflective paints like those containing Titanium Oxide are preferred.

A room must meet the following criteria for upper-room UVC to be used:

- Ceiling height at least 2.4 m – for many commercially available GUV fixtures, a minimum ceiling height of 2.6–2.7 m (9 ft) is recommended.
- The GUV fixtures must be installed at a height of at least 2.1–2.3 m above the floor, to ensure that people cannot look directly into the lamps or accidently bump into the

fixtures.

- In rooms with lower ceilings (2.4–3.0 m), a louvred or baffled GUV fixture is needed to ensure that stray light does not overexpose occupants in the room or space; in rooms with higher ceilings (>3 m), GUV fixtures with wider spacing between the slats, or open GUV fixtures may be used.
- Larger rooms or spaces may require more than one GUV fixture. The dosage calculation for each room is to be decided as explained earlier.
- In congregate settings, the use of bunk beds should be avoided unless the rooms have very high ceilings, and the GUV fixtures are placed high enough above the bunk beds to avoid overexposure.
- Fans for mixing the room air or appropriate ventilation diffusers are recommended to help increase airflow from the occupied space to the upper room and from the upper room back to the occupied space. The room-air fans or HVAC system fans should operate continuously while the building is occupied.
- Placement and number of fixtures: GUV fixtures should be placed such that radiation in the upper room is relatively uniform, continuous and complete. The number of fixtures needed to reach the target effective dose depends on the room volume, area and shape, and the UVC_{254} output of the fixtures.

6.6.11 The Importance of Air Mixing

For upper-room UVC_{254}systems to optimally disinfect the air, the air from the breathing zone must pass through the disinfection zone or upper room before returning to the breathing zone. Adequate "air mixing" is a key component of an upper-room GUV system design plan. Existing ventilation systems may need to be supplemented with ceiling or wall fans, or different supply-air diffusers, to accomplish adequate airflow patterns for this purpose. In the latter case, it may be necessary to keep the ventilation system fan operating (i.e. constant air volume setting) during building occupancy, to ensure adequate air mixing. The simplest way to check airflow patterns is with ventilation "smoke tubes" that can be used to show the air movement. The goal is to see the smoke moving up to the disinfection zone and back to the breathing zone in several locations. The critical criterion is the direction rather than the speed of the smoke movement.

6.6.12 Planning a Upper room GUV installation

Deciding on the number of fixtures, outputs and the placement of the fixtures:

- The configuration of the room as well as the purpose (waiting area/ OPD/ ward) should be taken into consideration. In waiting areas and OPDs, etc. the time of exposure is limited to a maximum of 4-6 hours, whereas in the wards there will be prolonged exposure.
- The number of fixtures needed to reach the target effective dose depends on the size of the room based on room volume (ft^3 or m^3), area (ft^2 or m^2), room shape, ceiling height, type of fixtures available, initial purchase as well as maintenance costs, how occupants will utilize the space and the total UVC_{254}output of the fixtures.

- The volumetric dosage for each room or area is 10 to 12 mW/m^3. An area dosing of 35mW/m^2 may also be employed if the room's height is 3 m or less.
- Locate upper room UVC_{254}fixtures so that irradiance in the upper room is relatively uniform, continuous, and complete. To ensure safe levels of UVC irradiance in the occupied areas, choose optimal fixture location(s) considering overlapping irradiance from several fixtures, possible UVC reflection from low and reflective ceiling, walls, objects suspended to the ceiling, metal objects or reflective paints.
- Principles for commissioning and installation should be based on a combination of fixtures. Combination of low and medium UVC output fixtures are to be used for smaller rooms, while high UVC output fixtures to be considered for larger rooms.
- Some examples are as follows.
    - ◊ Suppose a room/facility is 4.5 m long, 4.5 m wide and 3 m high. The total volume of the room is 4.5*4.5*3 = 60.75 m^3. With volumetric dose of 10 to 12 mw/m^3 requirement, the total UVC output required for this facility here will be 607 to 729 mW or 0.6 to 0.72 watts.
    - ◊ One can use a fixture with an output of one medium UVC output: one fixture with a total UVC output of 0.7 watt meets the dosing requirement for such a room.
    - ◊ Suppose a room/facility is 5.7 m long, 6.5 m wide and 3.4 m high. The total volume of the room is 5.7 *6.5*3.4 = 126 m^3. With volumetric dose of 10 to 12 mw/m^3 requirement, the total UVC output required for this facility here will be 1260 to 1512 mW or 1.26 to 1.51 watts. In such a case, one can use a fixture with an output of one large UVC output fixture of 1.2 watt and one small UVC output fixture of 0.3 watt, or two fixtures with total UVC output of 0.7 W (whichever will allow more uniform irradiance in the upper room space and lower levels of UVC irradiance in the occupied space) to meet the dosing and safety requirements.

6.6.13 Installation and maintenance requirements

General Instructions

- Power supply 230 ± 15%, 50 Hz single phase AC, must be made available.
- Proper and suitable earthing connections are to be made for GUV devices.
- Installation is to be carried out by certified engineers only.
- No direct human eye contact with the UV should occur during installation and regular operation.
- All physical structures (fans, light panes, panels etc.) falling under UV radiation zone must be anti-UV reflective painted.
- Ensure that the on-off switches for lamps are accessible to appropriate staff members only.
- Accuracy for measurements of UV irradiance of more than 1 to 2000 μW/cm^2 should be ±10% of the reading, to measure irradiance and confirm performance of the source or lamp.
- Accuracy for measurements of UV irradiance of 0.05–1 μW/cm^2 should be ±0.05 μW/cm^2 to

measure safety levels for occupants.

- Safety test including irradiance at 6, 4, & 3 feet height ≤0.2 μW/cm² must be ensured.
- Efficacy test should verify that the claimed irradiance is available at 1 m in front of the fixture as per the manufacturer's claims. This is at the time of installation or lamp change. During the 6 monthly maintenance, if the irradiance measurement has fallen >30% (after proper lamp cleaning), the lamp change should be done.
- Documentation requirements-
    - ◊ Manufacturer catalogues, Operator's manuals, Maintenance manuals etc. should be provided
    - ◊ Installation certificates to be provided.
- Proper safety and operational training must be provided by the vendor and availed by the institution.
- The performance of GUV fixtures should be measured 3–4 days after initial installation and then every 6 months until replacement. Before measuring the output, the fixtures should be cleaned, and potential interferences (e.g. fluorescent lights or sunlight) should be blocked. Radiometers should be held 1 m away from the geometric centre of the fixture, with the face of the sensor parallel to the fixture's louvres. Additional measurements should be taken slightly above, below, to the left and to the right of the geometric centre.

6.6.14 Maintenance of Upper room GUVs (Standard Operating Procedure)

Routine checks and monitoring activities for the healthcare facility

- There should be authorized personnel (preferably Duty Nurses) who are responsible for switching On or Off the Upper room GUV.
- The UVC_{254} output should be verified visually. It is important to ensure that the lamps are clean, not burnt out or broken. If the tubes are working, they will emit a violet-blue glow (note: this is not an indicator of the lamp's effectiveness, which can only be confirmed by measuring output with a calibrated radiometer).
- Monitor and document for any adverse effect caused due to UV.
- Check for the incoming voltage and earthing at the AC power socket using multimeter once in a quarter.
- Check the safety signages are in place.
- Any breakdown or equipment malfunction should be recorded and notified to the Infection Control Officer, engineering department and the vendor immediately.

a) Maintenance steps done by the vendor

Quarterly maintenance

- Certified engineers must carry out preventive maintenance as per the SOPs once in three

months.

- Clean and disinfect the Upper room GUV fixture and GUV lamp using 70% to 100% alcohol and a soft cloth. Dust can reduce the efficacy of GUV lamps:
    - ◊ The Upper room GUV fixtures should therefore be cleaned at least once every 3 months (or more frequently, depending on local conditions).
    - ◊ Before cleaning, the Upper room GUV fixtures should be turned off to avoid contact of the light with the skin and eyes and prevent heat burn.
    - ◊ Cleaning should be undertaken using a solution of 70–100% alcohol and a clean, soft cloth, such as a microfiber cloth
    - ◊ The bulb and fixture should be wiped clean of dust; also, in a louvred fixture, all louvres should be cleaned.
- Fill and hand over the log sheet to the site in-charge/ designated person.
- If any breakdown observed/ spare part is replaced during periodic maintenance, it is the responsibility of the agency to dispose the part as per the safety guidelines.

Half yearly maintenance by vendor

- Certified engineers must carry out preventive maintenance as per SOPs.
- Performance testing (efficacy and safety tests) to be carried out.
- If a fixture with cleaned lamps has a 30% or more decline in the rays it emits, its lamps should be replaced even if it is before the scheduled replacement date.
- Handover the test certificates to the site in-charge/ designated person.
- If any breakdown observed/ spare part is replaced during PM, it is the responsibility of the agency to dispose the part as per the safety guidelines.

Annual Maintenance by vendor

- Certified engineers must carry out preventive maintenance as per SOPs.
- UVC_{254}lamps to be replaced by the agency. Old lamps are to be disposed by the agency as per the guidelines. Lamp life is approximately 9000 hours or as a rule of the thumb, one year if switched on continuously. However, if the intensity of lamp has a 30% or more decline during performance testing, it should be replaced even if it is before the scheduled replacement date.
- Performance testing (efficacy and safety tests) to be carried out.
- Handover the test certificates to the site in-charge/ designated person.

Responsibilities of Staff at Site for the maintenance steps:

- For dusty places, the outside cleaning of the louvers and outer body of the fixtures may be done twice a month using 70% alcohol.
- Ensure that the engineer is performing the maintenance as per the supplied SOPs.
- Verify the calibration status of all equipment used by vendor to carry out performance testing and safety testing.
- Ensure engineer is conducting the required performance testing (safety and efficacy test) at time of installation/ reinstallation/ lamp change/ 6-monthly maintenance.
- Do actual verifications of the equipment readings of the radiometer before accepting the

verification certificates.

- Ensure UVC_{254} lamps are replaced every year.
- Ensure that the vendor handles mercury waste as per the safety guidelines of the state.
- Monitor and document for any adverse effect caused due to UV.

Disposal of GUV lamps

- GUV lamps contain mercury which is safe when enclosed inside the lamp.
- Mercury is dangerous to humans and the surroundings.
- GUV lamps should be disposed off by the vendor following state/national environmental guidelines.
- In the case of lamp breakage, guidance for mercury spills as discussed on page no. 67-70 of Guidelines For Implementation Of "KAYAKALP" Initiative may be followed.(https://qps.nhsrcindia.org/sites/default/files/2022-03/Implementation%20Guidebook%20for%20Kayakalp%20.pdf)

6.6.15 Limitations of Upper room GUV

There are several limitations to GUV.

- GUV only provides an equivalent to air exchange and does not provide fresh air or directional airflow.
- Climatic conditions like temperature and high humidity affect the performance of GUV systems
- If the GUV is not installed and maintained properly, it may be ineffective at inactivating M. tb and provide a false sense of security.
- Poorly designed or installed GUV may cause overexposure injuries to HCWs and patients.
- The actual irradiance levels of an upper-room GUV installation are difficult to predict and therefore should be verified with UVC_{254} radiometer. For a given fixture, final irradiance levels will vary for every room and for different parts of the same room.
- Physical factors that affect each installation include:
    - ◊ Type of lamps used
    - ◊ Age of lamps
    - ◊ Effectiveness of the fixture baffles at preventing radiation from reaching occupied areas.
    - ◊ Locations of the fixtures
    - ◊ Reflectivity of the walls and ceilings

6.6.16 Need assessment for installation of Upper room GUV (with reference to programmatic setting of NTEP)

- ACPH < 12 and there is no scope to increase the ventilation by natural or mixed mode ventilation.
- Minimum room area of > 100 square feet.
- Minimum height of room being at least 9 feet.
- Priority for installation of GUV should be given to DR-TB ward, crowded registration or waiting area, crowded OPD and waiting area and bronchoscopy suite.
- DSTB wards in TB Hospitals if bed occupancy is high and ACPH is compromised
- In case of ACPH could be > 12, in crowded wards, but windows/ doors are kept closed due to climatic conditions or at night to avoid insects, or when the mixing fans and exhaust fans are switched off.

Details of need assessment is provided in annexure 5

6.6.17 Cost consideration for installation of Upper room GUV

In a usual setting with appropriate maintenance, life of GUV fixture is around 15 years. The cost of GUV (table 6.6) should be considered in that context. Annual maintenance cost of GUV would be around 10% of installation cost.

Table 6.6: Initial and recurring cost of GUV

Initial Cost	Recurring maintenance cost
Type of UVC_{254} Fixture or fixtures	Quarterly maintenance
Shipping, customs, and taxes	Biannual maintenance
Air-mixing systems (e.g. diffusers and fans	Annual maintenance with lamp change
Layout Design	Annual electricity
Installation (e.g. fixtures, fans and electricals)	Annual Calibration of Radiometer (primarily the responsibility of the vendor)
Acceptance testing (Upper-room UVC_{254} performance for inactivation and safety	

6.6.18 In-duct UVC_{254}

In-duct GUVs are high-intensity GUV in the ducts of a mechanical ventilation system

The principal design objective for an in-duct UVC air disinfection system is to distribute UV

energy uniformly in all directions throughout the length of the duct or air-handling unit (AHU) to deliver the appropriate UV dose to air moving through the irradiated zone with minimum system power. Enhancing the overall reflectivity of the inside of the air handler can improve UVC system performance by reflecting UVC energy back into the irradiated zone.

Installation, start-up, and commissioning of in-duct GUV systems are straightforward. Those responsible for installation should ensure that the system is installed as designed and that all lamps, ballasts, and/or fixtures are the same as included in the final design. Take care to ensure that all safety interlocks and view ports are installed in appropriate positions and functional. Once the UV lamps are powered on, ensure that all lamps are burning. Since there are no good methods for in situ testing of in-duct system performance, so relying on final design parameters is essential to ultimate system performance.

Advantages and disadvantages of in-duct UVC

Table 6.7: Advantages and disadvantages of in-duct UVC

Advantages	Disadvantages
In-duct UVC lamps, unlike HEPA or other filters, do not cause a significant resistance to airflow in the system. Therefore, they can inactivate most infectious particles in the air but do not significantly reduce the amount of airflow.	UVC lamps are a more specialized type of equipment than almost all other components of a mechanical HVAC system and require specialized expertise to install and maintain.
In-duct UVC_{254} is usually less expensive to install and operate than a 100% outside air supply system.	Higher output of UVC_{254} lamps (than those used for upper-room UVC_{254} systems) places greater potential risk to maintenance staff if safety measures are not followed, not operational, or inadequate.

6.6.19 UVC in Air Conditioners

One must be cautious of in-room, stand-alone heating or cooling units (window, wall, or ductless units) that claim to use UVC_{254} for air disinfection. UVC within these units can be less efficient at disinfecting air because of the limited UVC_{254} dose received by the airborne pathogens while passing through the unit (i.e., the airborne pathogens are not exposed to the UVC long enough to inactivate them).

7 STANDARD PRECAUTIONS INCLUDING SANITATION

Standard Precautions are essential infection control practices to protect healthcare workers and patients from spread of infection. These are based on the principle that all blood, body fluids, secretions, excretions except sweat, non-intact skin, and mucous membranes may contain transmissible infectious agents. These precautions are applicable to all patients, regardless of presence of infection.

Standard precautions combine the major features of universal precautions, body substance isolation, and airborne precautions. Elements of standard precautions are summarized in table 7.1; these are important to include while doing risk assessment of healthcare facility.

Table 7.1: Elements of standard precautions

Sr. No.	Standard precautions
1	Hand hygiene
2	Selection of personal protective equipment (PPE) based on assessment of risk
3	Respiratory hygiene and cough etiquette
4	Prevention of injury from needles and other sharp objects
5	Cleaning and disinfection of patient-care equipment
6	Cleaning of the patient care environment
7	Disposal of sputum and other biological sample in wards, labs, households
8	Linen management
9	Bio-Medical Waste management
10	Spill Management

7.1 Hand hygiene

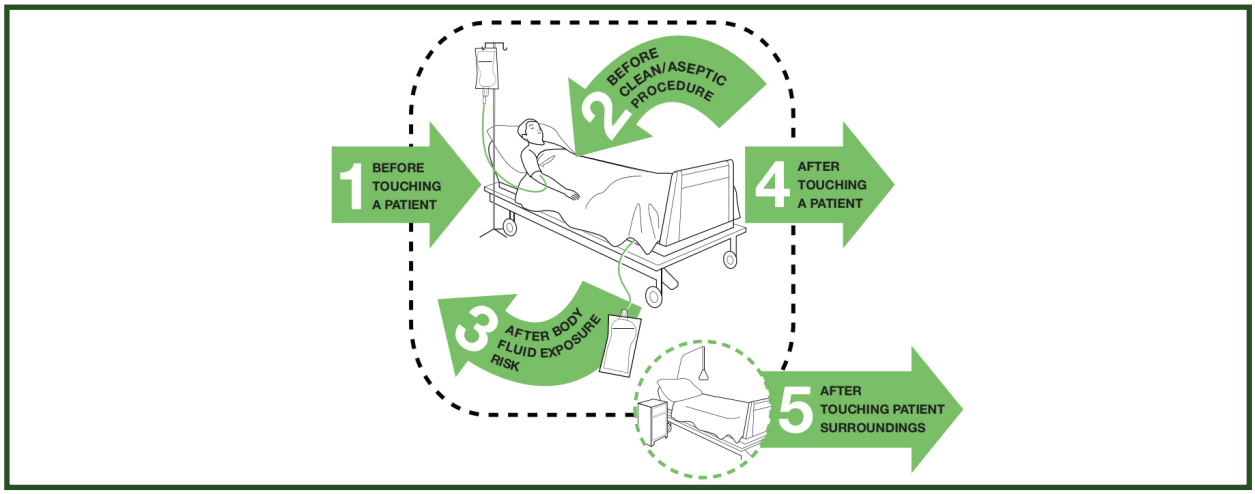
The WHO guidelines on hand hygiene in healthcare (2009) suggest that hand hygiene is the single most important measure for prevention of infection. Hands can become contaminated with infectious agents during contact with a patient, patient surroundings, the environment, or other HCWs. Hand hygiene removes dust/soil, organic material and transient microorganisms. Evidence suggests that the hands of the HCWs are the most common vehicle for the transmission of healthcare-associated pathogens from patient to patient and within the healthcare environment.

Studies show a direct correlation between an increase in adherence to hand hygiene with decrease in healthcare associated infections (HAI).

7.1.1 Moments of hand hygiene

Hand hygiene is the most necessary during any of 5 moments presented in figure 7.1

Figure 7.1: Moments of hand hygiene in clinical settings



7.1.2 Hand decontamination

Hand washing using soap and water or use of alcohol rub are two main methods of hand decontamination. Hand washing with soap and water is preferred when hands are visibly dirty or soiled with blood or other body fluids or after using toilet. Both the methods of hand decontamination are detailed out in figures and 7.2 and 7.3.

Figure 7.2: Steps of hand washing using soap and water

Figure 7.3: Steps of hand rubbing using alcohol based hand rub for hand decontamination

It should be noted that alcohol rub has no activity against protozoan cysts, bacterial spores (e.g. clostridium difficile) and less or variable activity against non-enveloped viruses.

Surgical hand scrub: Hand scrubbing with an antiseptic agent before beginning a surgical procedure reduces the number of microorganisms and inhibits their growth on hands under the gloves. Chlorhexidine or povidone-iodine-containing soaps are the most used products for surgical hand scrub. The antimicrobial efficacy of alcohol-based formulations is superior to that of all other currently available methods of preoperative surgical hand preparation.

7.2 Selection of personal protective equipment (PPE) based on assessment of risk

Personal protective equipment (PPE) refers to physical barriers, which are used alone or in combination, to protect mucous membranes, airways, skin and clothing from contact with infectious agents. PPE includes masks, gloves, aprons and gowns, facial protection, footwear and hair cover or cap. The type of PPE should be selected on the basis of estimated risk of contamination of the HCW's hands, clothing or other areas of the body by blood, body fluid, excretions or secretions of the patient. The route of transmission of the infectious agent is an important factor in selecting the PPE. The health personnel to use PPEs includes -

- HCWs, who provide direct care to patients and who may come in contact with blood, body fluids, excretions, and secretions.
- Support staff including cleaners, and laundry staff in situations where they may have contact with blood, body fluids, secretions, and excretions.
- Laboratory staff handling patient specimens.
- Family members, who provide care to patients, where they may have contact with blood, body fluids, secretions and excretions.
- HCWs and patients in a haemodialysis unit, because of the high risk of transmission of blood-borne infections during activities associated with haemodialysis.

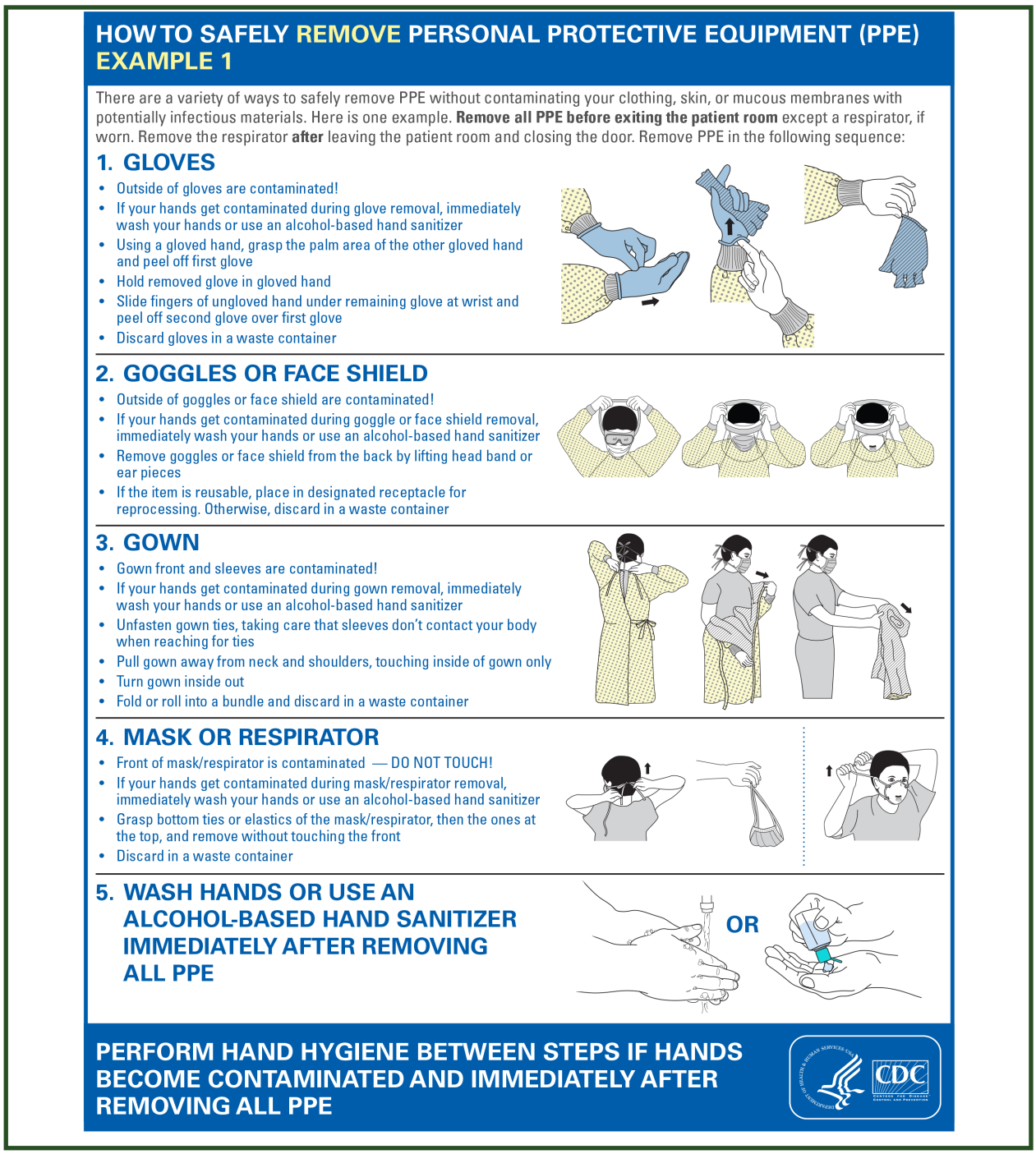
General considerations for use of PPE:

- HCWs should be trained in the use of PPE as part of the IPC training, including practicing both putting on and taking off process and giving care to patient.
- The training should address the protocols adopted by a specific facility and competency of the HCWs in using PPE should be assessed, tested and documented.
- Adequate stock of different sizes and shapes of PPE, placing for easy access, quality of items purchased and timely management for reporting shortages should be made available.
- The type of PPE should be selected as per estimated risk of contamination and the route of transmission of the infectious agent.
- Written protocols should be in place for stepwise procedures in putting on and taking off PPE (donning and doffing) and appropriate spaces should be designated for the same.
- Any protective clothing worn by HCWs in an area with high risk of contamination such as laboratory or OT must be removed before leaving that area.

- PPE which has been in contact with patients should not be worn outside the patient-care area.
- PPE must be put on in the proper order (figure 7.4) and an observer should check the integrity of the PPE, making sure it is well adjusted, and write the name and role of the person as well as the time of entry into the high-risk zone on the apron.
- The sequence of removal of PPE should be as given in the figure7.4.
- Information and posters about PPE, demonstrating the sequence for wearing and removing PPE should be posted in all patient-care areas.
- Discarding of the PPE should be in accordance with the bio-medical waste management guidelines.

Figure 7.4: Sequence of putting on PPE

Figure 7.5: How to remove PPE



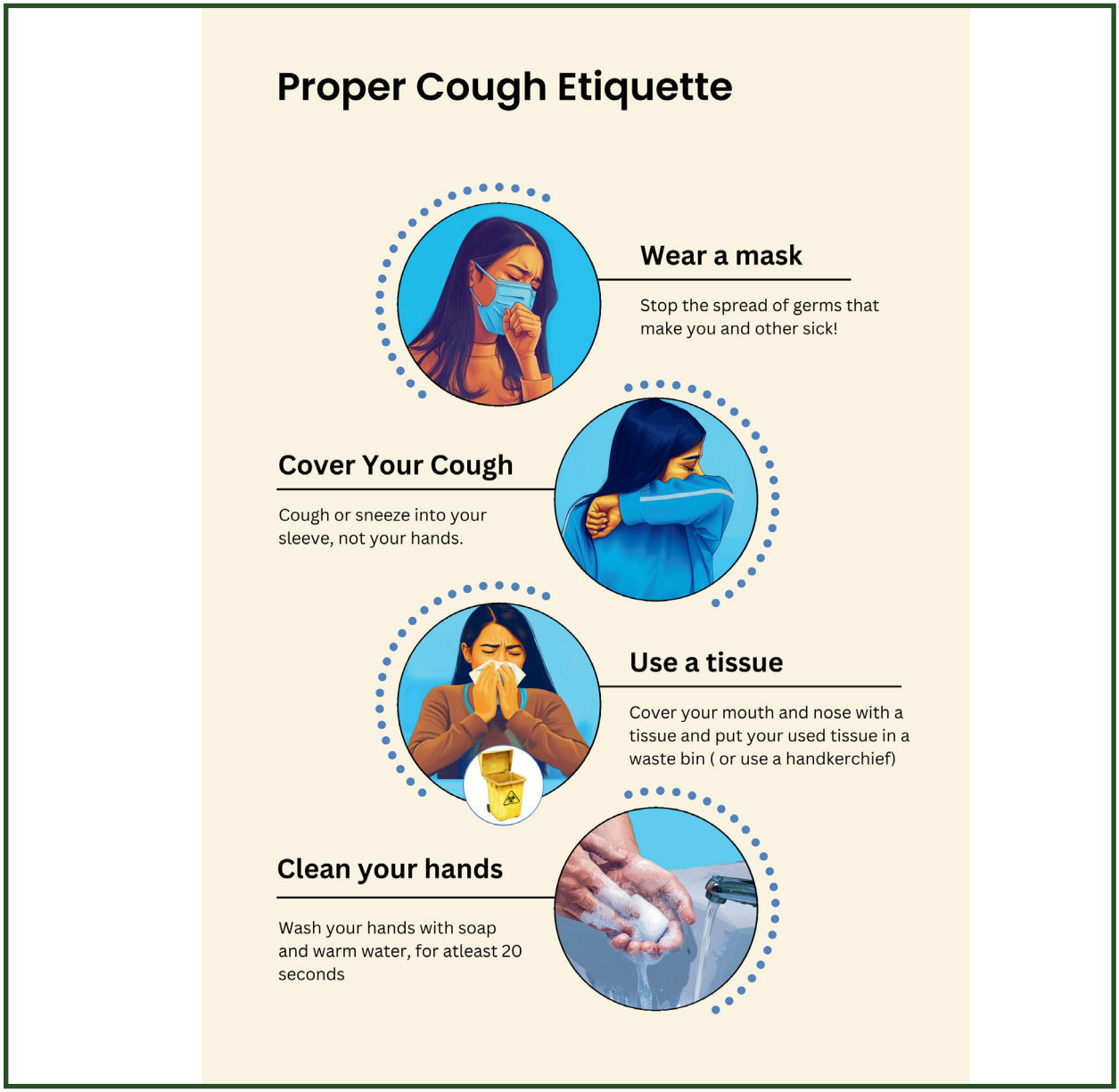
7.3 Respiratory hygiene and cough etiquette

IRPs are formed during breathing, talking, coughing or sneezing and during certain procedures like diagnostic sputum induction, bronchoscopy, airway suctioning etc. Respiratory hygiene and cough etiquette (figure 7.6) refers to the practice of covering the mouth and nose during coughing or sneezing (e.g. by wearing a medical mask or cloth mask, or covering the mouth with a tissue paper or handkerchief, sleeve, flexed elbow or hand) to reduce the dispersal of respiratory secretions.

Elements of respiratory hygiene and cough etiquette:

- Cover mouth and nose with a tissue paper or handkerchief when coughing or sneezing.
- Dispose the tissue after use in the nearest waste container.
- Perform hand hygiene after contact with secretions and contaminated objects or materials.
- If resources permit, healthcare facility (HCF) should ensure the availability of tissues and foot-operated waste bins for patients and visitors in waiting areas.
- People should be instructed to cover their nose and mouth with their arm during coughing and sneezing in case of no tissue/handkerchief.
- Provide conveniently located dispensers of alcohol rub.
- Where sinks are available, ensure that water and soap for hand washing are available.
- Posters elaborating cough etiquette and hand hygiene (in local language) must be displayed at appropriate locations.

Figure 7.6: Cough etiquette



7.4 Prevention of injury from needles and other sharp objects

Precautions should be taken while handling needles and sharps to protect the healthcare worker from needle stick injuries, which may lead to risk of transmission of blood borne infections.

- Used needles must not be recapped by hand or be bent or broken after use.
- Used sharps should be disposed of immediately in designated puncture-proof containers (labelled with a biohazard symbol) as per the bio-medical waste management rules.
- These containers must not be in publicly accessible areas.
- While handling sharps, the sharp end of instruments shall be positioned away from oneself and others.
- If injured by sharps, contact the ward, clinic or unit supervisor immediately for further management.

7.5 Cleaning and disinfection of patient-care equipment

Proper handling of instruments and equipment which are in contact with the patient excretions or secretions ensure that there is no transmission of patient infection to the staff or visitors, nor any new infection is transmitted to the patient. The following measures should be taken for safe handling of patient care equipment.

- Equipment that has been in contact with a patient should be disinfected or sterilized by a team of dedicated personnel trained in the appropriate cleaning procedures.
- Ensure all reusable equipment is cleaned and reprocessed appropriately before being used on another patient.
- Soiled patient-care equipment should be handled in a manner to prevent exposure of skin and mucous membranes and contamination of clothing and environment (E.g.-Use of heavy-duty gloves).
- Responsibility and accountability for cleaning should be assigned.
- A hospital disinfection policy should be prepared for appropriate cleaning, disinfection and sterilization of patient-care devices which are strictly followed and monitored.
- All disposable units (or patient care equipment) to be discarded in appropriate color-coded biomedical waste bags according to the BMWM rules.

Cleaning and disinfection of bronchoscopes:

- Wash in ample water.
- Disinfect with glutaraldehyde (2%) or orthopthaldehyde (OPA, 0.5%) with contact time of 20 and 5 minutes respectively.
- Wash in deionized water.

Figure 7.7: Automated Bronchoscope Washing Unit at GMC Kozhikode

Cleaning and disinfection of humidifiers

- Humidifiers must be washed, rinsed, and disinfected daily.
- It can be done using warm water and mild detergent. Rinse the humidifier and allow it to air dry completely.
- Chlorine based disinfectants like Sodium hypochlorite can also be used for disinfection of humidifiers.
- Oxygen bubble humidifier (non-heated bottle) must be washed, rinsed, and disinfected daily when used for the same patient and disposed of after use.

Alternatively

- Empty the water from the humidifier.
- Rinse the humidifier flask under running water.
- Fill in with proper distilled water or boiled and cooled water within the scale between the top scale line and the lowest one.
- Do not use tap water or bottled/ distilled water stored in warm conditions. These conditions allow bacterial growth in the water and increase the risk of patient infection.

7.6 Cleaning and disinfection of environment

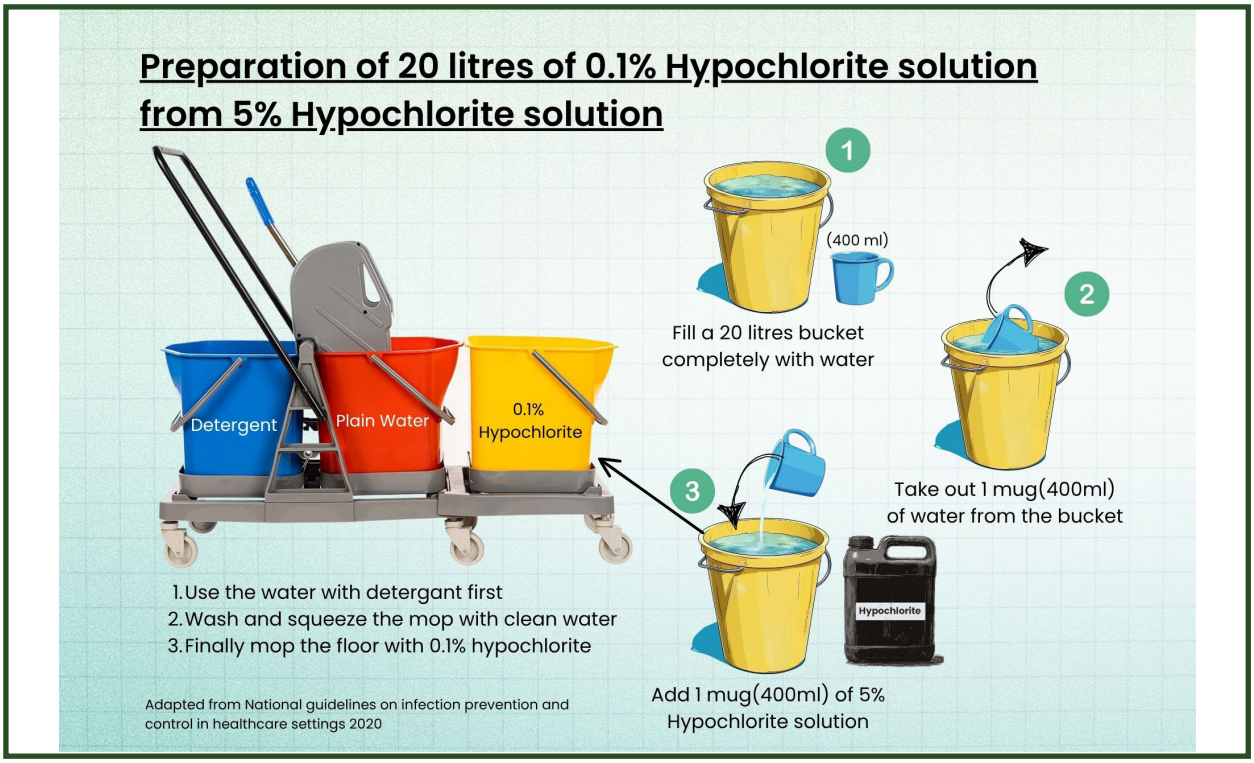
IRPs are primarily generated from infectious person (i.e. source) during coughing, sneezing or talking and may remain in the environment for longer period and could settle over the surface. Proper cleaning and disinfection of the environment reduces the risk of spread of an infectious agent.

7.6.1 Triple bucket system for floor cleaning

For floor mopping, three bucket system should be used. This includes as shown below in figure .

- 1st bucket: detergent and warm water solution
- 2nd bucket: plain water
- 3rd bucket: hypochlorite (0.1% dilution) solution

Figure 7.8: Triple bucket system for floor cleaning



Steps of cleaning

- Prepare cleaning solution using detergent/ sanitizer with warm water.
- First mop the area with detergent solution.
- After mopping clean the mop in plain water and squeeze it.
- Repeat this procedure for the remaining area.
- Mop area again using hypochlorite 0.1% dilution after drying the area.
- In between mopping if solution or water is dirty change it frequently. Between every dip 120 sqft area can be mopped. Change cleaning solutions after mopping 240sqft area.
- Mop the floor starting at the far corner of the room and work towards the door.
- Clean mops with hot water and detergent solution, disinfect it with hypochlorite and keep for drying upside down.
- Bed side tables and lockers are to be cleaned with warm water and detergent solution.
- Avoid dry sweeping with brooms, as this generates dust aerosols

Figure 7.9: Mopping of large area by using figure of 8 technique

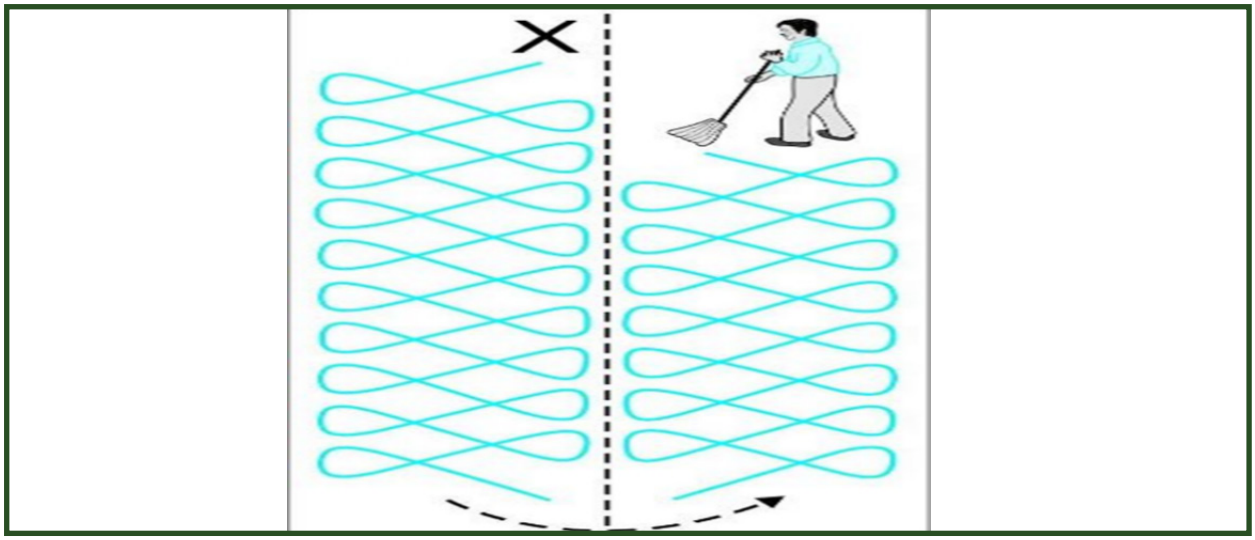
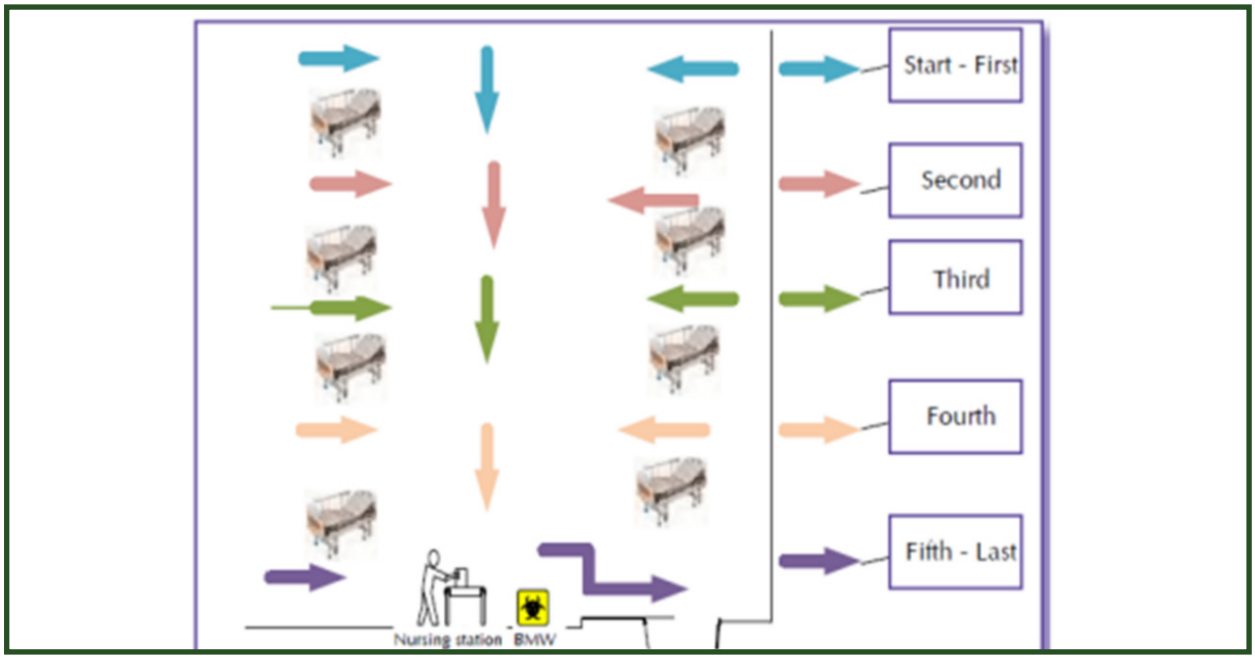


Figure 7.10: Mopping of ward

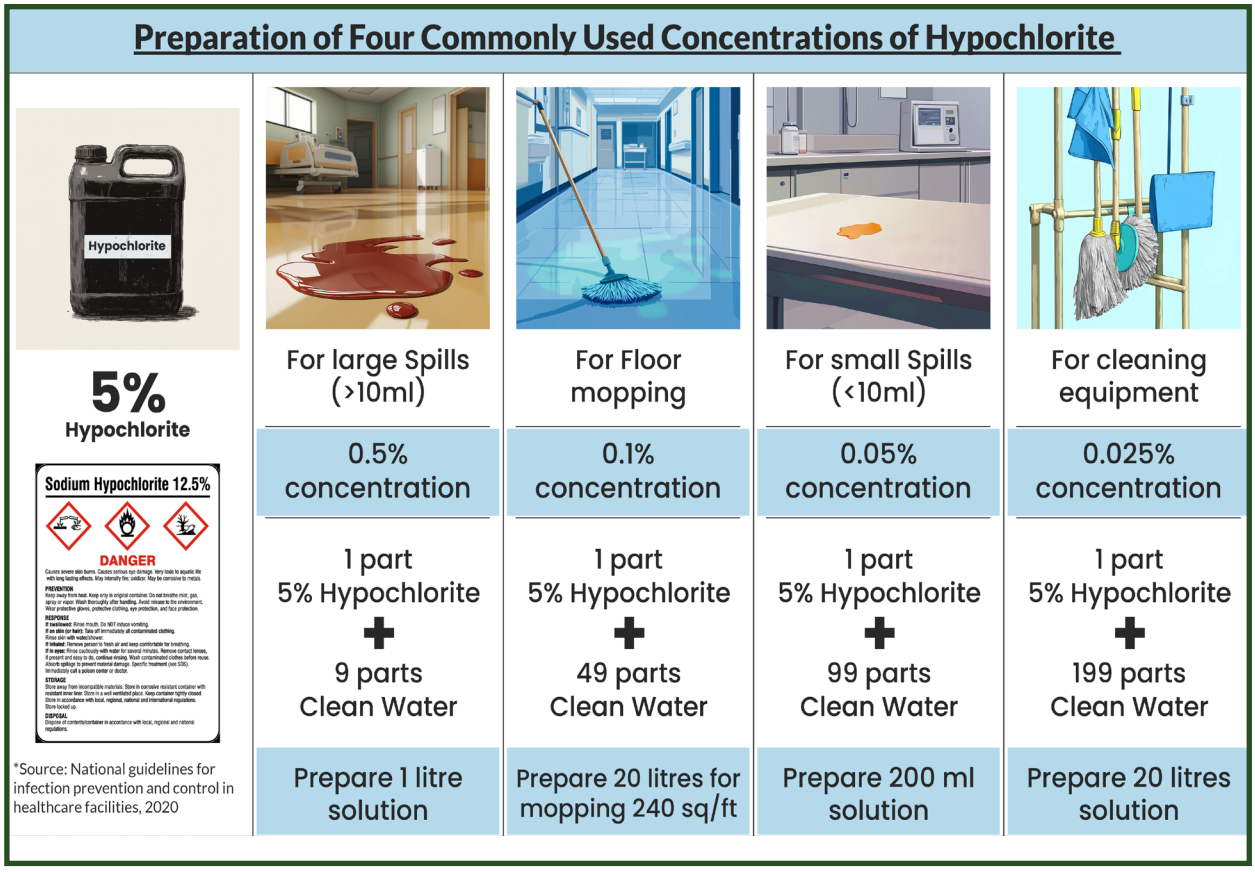


As indicated in figures , mopping process in open areas, using the figure of 8 technique. A figure eight stroke in open and wide spaces allows overlapping each stroke with the mop head turned over every five or six strokes; the mopping of ward should start from innermost part to the outside and around each bed.

7.6.2 Hypochlorite

The original bleach or hypochlorite should contain a minimum of 5% sodium hypochlorite (i.e. 50,000 ppm available chlorine). The recommended dilution of 5% hypochlorite for various uses is prescribed in figure 7.11.

Figure 7.11: Dilution to prepare hypochlorite solution for various purposes



For decontamination of laboratory floors and work benches, NTEP recommends 1 % Hypochlorite.

Hypochlorite solutions are unstable and tend to lose 40-50% of free available chlorine over one month even when stored in an opaque plastic container. Hence the expiry dates mentioned by the manufacturer should be strictly followed.

Disadvantages of hypochlorite include corrosiveness to metals in high concentrations (>500 ppm), inactivation by organic matter, discoloration or bleaching of fabrics, release of toxic chlorine gas when mixed with ammonia or acid (e.g., household cleaning agents, urine), and relative stability.

7.6.3 Use of bleaching powder (available chlorine 25-30%)

As a principle, use of bleaching powder for disinfection should be avoided as it leaves powder residues on the surfaces. However, it can be used by making effective disinfectant solution by dilution of 4 grams of bleaching powder in one litre water may be considered as mopping disinfectant (i.e. approximate 70-80 gms in 20 litre bucket) and 40 grams in one litre of water disinfection of TB lab work benches.

Table 7.2: Preparing 0.1% Hypochlorite using bleaching powder (Chloramine powder)

Product	Chlorine available	0.5%	1%	2%
Chloramine - powder	25%	20 g to 1 litre water	40 g to 1 litre water	80 g to 1 litre water

7.6.4 Discarding chemical waste

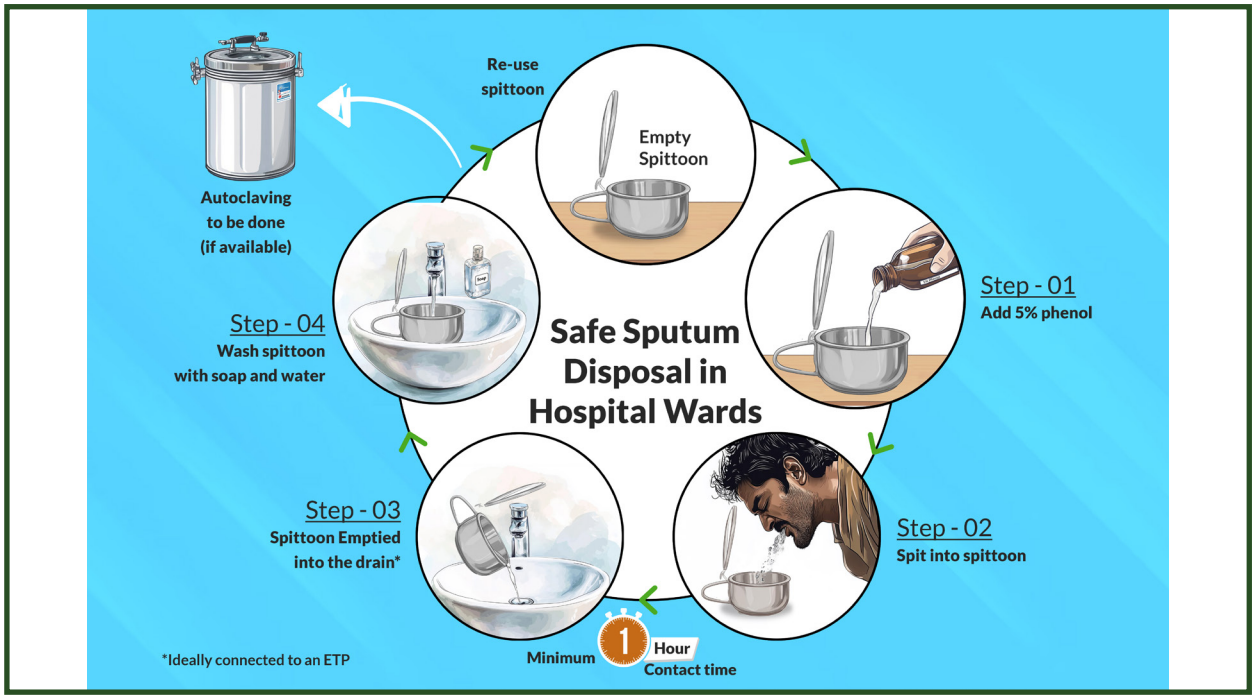
Liquid waste generated through use of chemicals or discarded disinfectants, and floor washings, cleaning, housekeeping and disinfecting activities should be collected separately and pre-treated prior to mixing with rest of the wastewater from health facility. Wastewater generated from the HCF is treated in the Effluent Treatment Plant (ETP) and shall be disposed into drain / sewer. If there is no ETP, such effluents should be discarded into the municipal drain by flushing with ample amount of water.

7.7 Disposal of sputum or biological sample

Disposal of sputum sample produced in wards: Patients and relatives should be educated on safe sputum disposal practices in wards as well as at home.

- The patient is asked to spit in a covered spittoon containing 5% phenol and after a contact time of 1 hour, the spittoon is emptied and drained into routine drain. It is preferable to have an effluent treatment plant in the facility, if not, ensure abundant running tap water (figure 7.12).
- Wash the spittoon under running water and reuse, preferably after autoclaving.

Figure 7.12: Safe disposal of sputum in hospital wards



Disposal of sputum sample produced at home:

Disposal of sputum at home can be done two ways-

- Add 5% phenol to the spittoon, collect sputum, give 1 hour contact time, dispose in the contents in drain, wash the spittoon and boil it in a bigger vessel and re-use. (Figure 7.13)
- Collect sputum in paper/ tissue paper and collect in a bag and burn (Figure 7.14) or bury it in the evening or dispose in a pot with ash or lime.

Figure 7.13: Steps to dispose sputum in at home

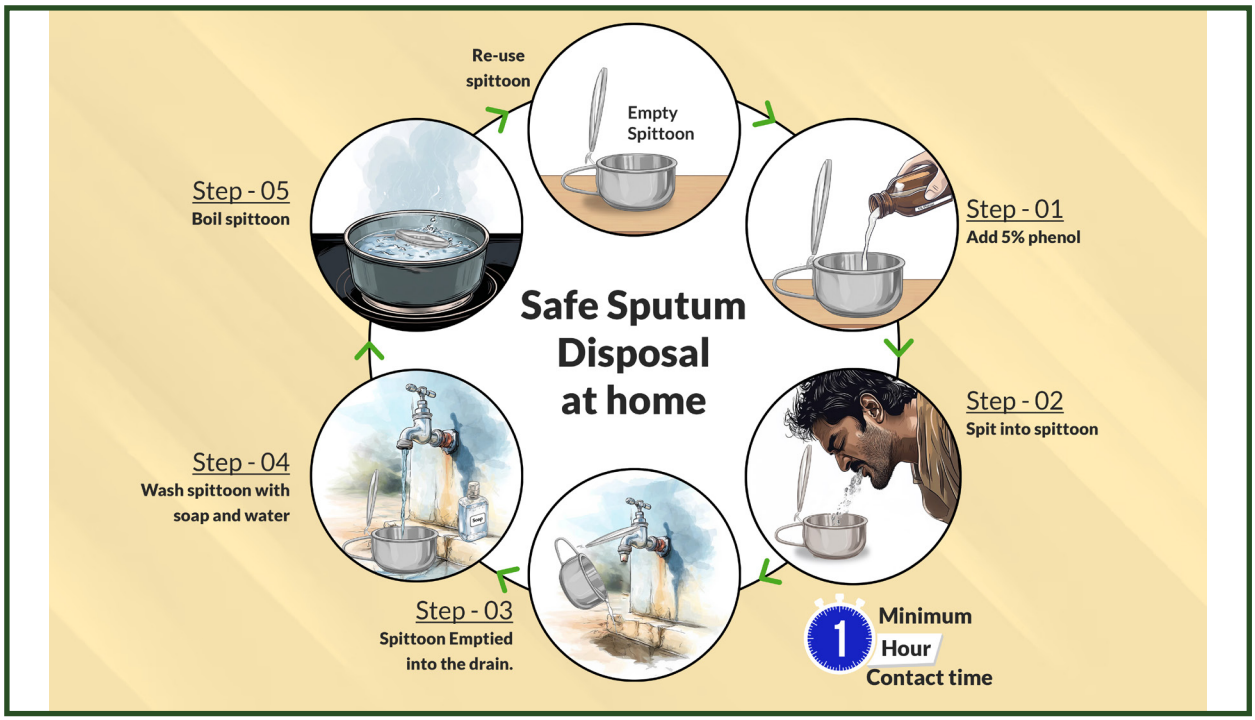
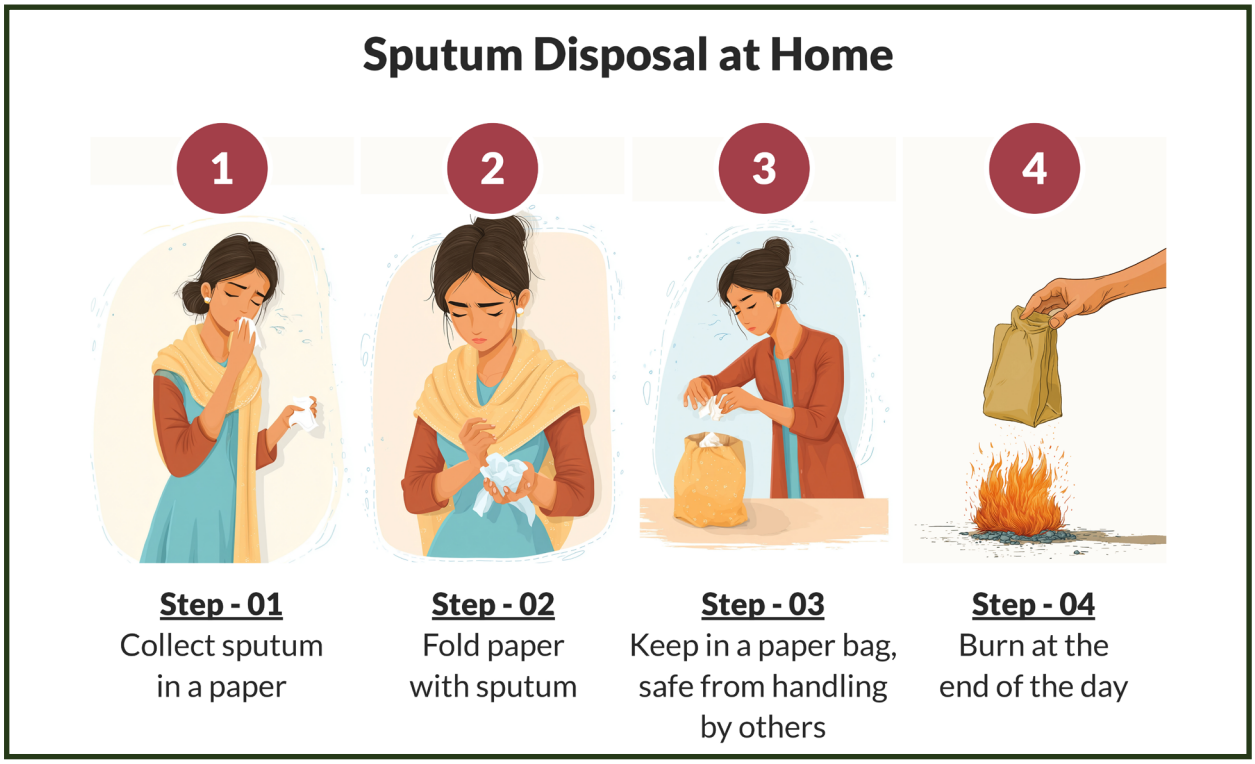


Figure 7.14: Steps to dispose of sputum in a paper



Disposal of sputum sample at OPD:

- All follow up patients should carry spittoons with 5% phenol.
- OPD settings should make tissue papers available and make bins with disinfectants accessible to patients for disposal of sputum/tissues.
- Handouts should be available at the NTEP IEC resource centre.

Disposal of sputum or biological sample in the laboratory:

- After the smears are examined, remove the lids from all the sputum cups.
- Put the sputum cups, left over specimen, lids and wooden sticks in a foot operated plastic red bucket/bin with 5% phenol or phenolic compound diluted to 5%.
- The cups and lids should be fully immersed in the solution. Keep it overnight/ for about 12 hours.
- Next day/ at the end of the day, drain off the phenol solution into the drain.
- Take out the sputum cup/lid/wooden sticks and put them into a reusable metal or autoclavable plastic container or red bag. (with biohazard symbol, adequate load bearing strength and be made of non-PVC plastic material).
- Autoclave at 121°C at 15 psi pressure for 45-60 minutes. The autoclave shall comply with the standards stipulated in the rules.
- Under certain circumstances, if autoclaving is not possible, boil such waste in a pressure cooker of approximately 7 litres capacity containing adequate amount of water to submerge the contents and boiled for at least 20 minutes.
- After adequate cooling, the material can be safely transported to a common waste treatment facility for mutilation / shredding / disposal.

It is suggested that red waste disposal bags be employed in the collection and decontamination of the lab waste. One such bag may be perforated at the bottom and then lined in the red bin. Add 5% phenol to this bag and immerse the waste as described above. After ensuring enough contact time, lift the bag and ensure that the phenol solution is drained out through the perforations. Seal the bag and pack it in another red bag and hand over the bio-medical waste management facility. Steps to dispose biological materials, sputum sample, cups, falcon tube, NAAT cartridges/ chips and other waste generated in the laboratory can also be done in the same manner as described in figure 7.15

Figure 7.15: Steps to dispose biological waste generated in laboratory

Table 7.3: Methods to prepare 5% phenol from phenol crystal (100%) and phenolic compound (40%)

Preparation of working solution of 5% phenol from phenol crystals	Preparation of working solution of 5% phenol from 40% phenolic compound
Preparation of TB Lab Disinfectants - 5% Phenol ▪ Use commercially available phenol crystal (100% pure) ▪ Use water bath to melt Phenol crystal before preparation ▪ Prepare required amount of 5% Phenol using appropriate amount of distilled water Distilled Water (ml) + Phenol crystal (ml) = Working Solution - 5% phenol (ml) 95ml + 5ml = 100ml 475ml + 25ml = 500ml 950ml + 50ml = 1000ml **Caution:** Phenol is highly corrosive, handle with extreme care	**Preparation of TB Lab Disinfectants - 5% Phenol** ▪ Use commercially available phenolic compound (phenyl) (40% pure) ▪ Prepare required amount of 5% Phenol using appropriate amount of distilled water Distilled Water (ml) + Phenyl (ml) = Working Solution - 5% phenol (ml) 70ml + 10ml = 80ml 350ml + 50ml = 400ml 700ml + 100ml = 800ml **Caution:** Phenol is highly corrosive, handle with extreme care

When purchasing 40% phenolic compound commercially, it should be ascertained that product is hospital grade and not for domestic use.

Concentration of 40% phenol: It can be determined by use ultraviolet-visible spectrophotometry (270nm) and this certification may be looked for while procuring 40% phenolic compounds for decontamination and sanitation. Ideally the labels should indicate the concentration and details about tuberculocidal activity. Phenol solutions are to be stored in a cool, dark place and tightly sealed in amber coloured bottles.

7.8 Linen management

Hospitals need to ensure that they have at least 4 sets of linen (6 sets are preferable) as it is required for-

- One already in use (on bed)
- One ready to use (in sub store)
- One in transit-route to laundry or to the ward
- One in washing cycle in laundry

It is ideal to have a colour coded system for every day of the week.

Figure 7.16 & 7.17: Linen management systems ANMCH Gaya, Bihar and IDH Guntur Andhra Pradesh.

7.9 Waste management

- Waste to be segregated at the point of generation and is the responsibility of the waste generator.
- Segregation to be done as per the colour coding provided in the bio-medical waste management rules, 2016 and amended in 2018.
- The non-medical waste generated should not be mixed with bio-medical waste.
- Work instructions are to be displayed at appropriate areas along with bio-medical waste bins.
- All the bags/ containers/ bins used for collection and storage of bio-medical waste, must be labelled with the symbol of Biohazard or Cytotoxic Hazard.
- Bio-medical waste bags / containers are required to be provided with bar code labels in accordance with CPCB guidelines.
- Laboratory waste, microbiological waste, blood samples and blood bags must be pre-treated through disinfection or sterilization on site in the manner as prescribed by the CPCB rules on safe management of wastes from healthcare activities and then sent to a common biomedical waste treatment facility for final disposal.
- On-site biomedical waste treatment and disposal facilities are not to be established unless a common biomedical waste treatment facility is not available within 75 km.

7.10 Spill Management

Spillage of blood, body fluids or chemicals can pose risk to the staff, visitors and patients. It is therefore essential for the hospital to have the right material and well-trained staff to deal with any spill immediately. Steps for spill management is described in table 7.4 and figure 7.18.

Table 7.4: Steps for spill management

Management of small (<10ml) volume of spill	Management of large (>10ml) volume of spill
Wear workman's gloves and other PPE appropriate to the task.	Confine the contaminated area.
When sharps are involved use forceps to pick up sharps and discard these items in a puncture resistant container.	Wear workman's gloves and other PPE appropriate to the task.
Wipe the spill with a newspaper moistened with 0.05% hypochlorite solution.	Cover the spill with newspaper or appropriate absorbent material to prevent it from spreading.
Discard the paper as infected waste.	Flood the spill with 0.5% hypochlorite solution ensuring that both the spill and absorbent material is thoroughly wet.

Repeat until all visible soiling is removed.	Alternatively, chlorine granules can be sprinkled on the spill first and then the paper put over it.
Wipe the area with a cloth mop moistened with 0.05% hypochlorite solution and allow drying naturally.	Wait for five minutes.
All contaminated items used in the clean-up should be placed in a bio-hazardous bag for disposal.	Remove and discard the paper as infected waste.

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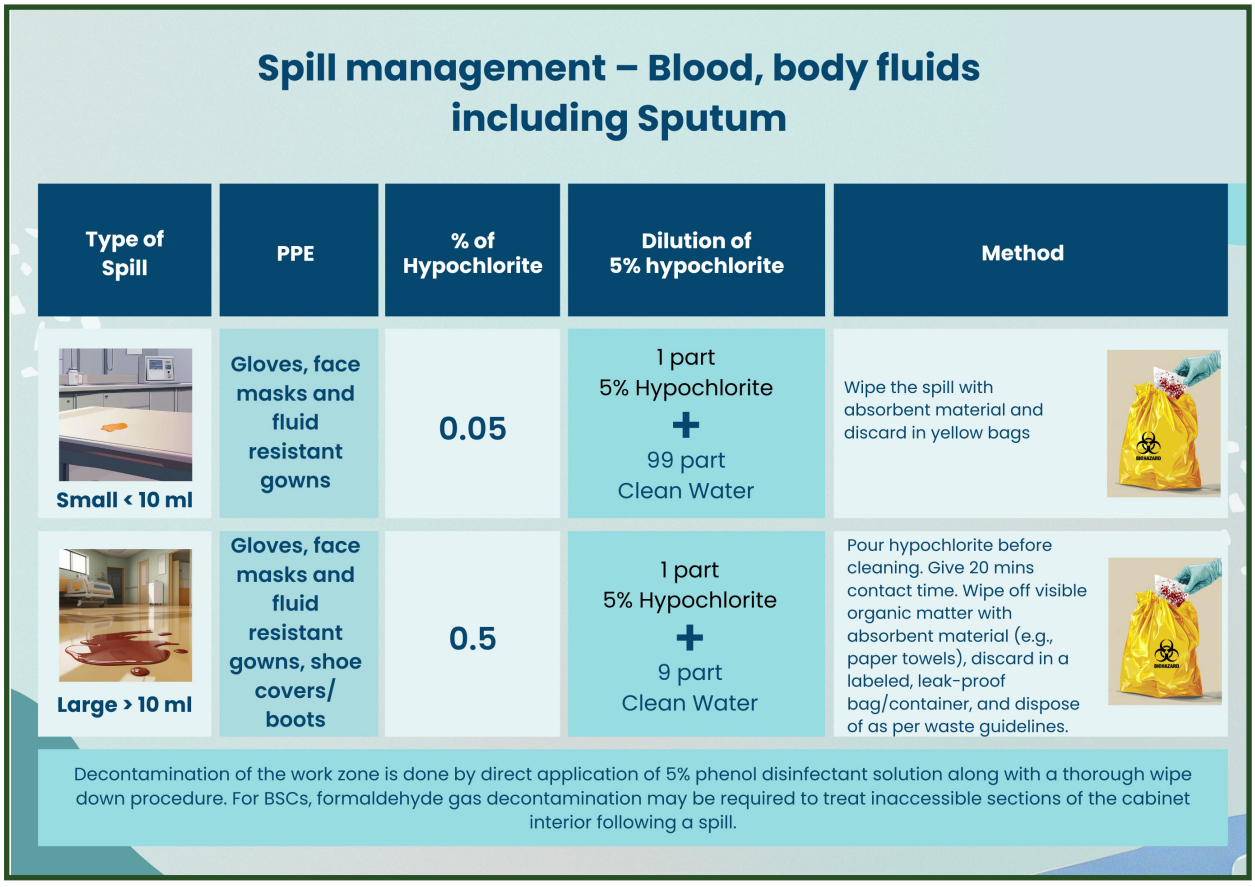
Figure 7.18: Spill management



Spill Kit: blood and body fluid spill kit contains-

- Workman's gloves x 2 pairs
- Apron
- Mask
- Shoe over or plastic bag to cover the shoes
- Absorbent material like newspaper or blotting paper
- Waste collection bag
- Cleaning equipment – bucket, mop, cloths, and hypochlorite solution can be obtained from housekeeping and must be washed and disinfected appropriately after use.

- If chlorine solution is not prepared fresh daily, it can be stored at room temperature for up to 30 days in a capped, opaque plastic bottle with a 50% reduction in chlorine concentration after 30 days of storage (e.g., 1000 ppm chlorine [approximately a 1:50 dilution] at day 0 decreases to 500 ppm chlorine by day 30).

The spill kits must be readily available especially in areas where risk of spill is more, like laboratory, sample collection room, wards, bronchoscopy units, etc.

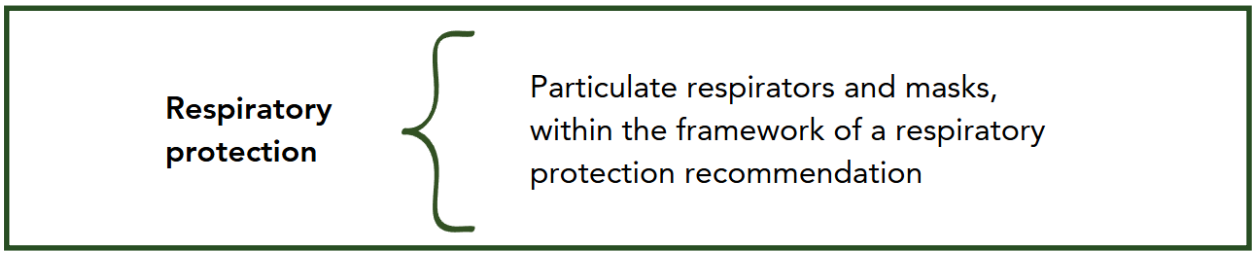
Spill kit must be immediately replenished after use and stored at the original location after every use.

Figure 7.19: Contents required in a spill kit

8 RESPIRATORY PROTECTION

Respiratory protection in healthcare settings in India is a critical concern, especially with the rise of infectious diseases and the ongoing challenges posed by respiratory infections such as tuberculosis (TB), COVID-19, and seasonal influenza. Healthcare workers are at a higher risk of exposure to airborne infectious agents, which makes proper respiratory protection essential. Respiratory protection is at the third level of the hierarchy of controls. It refers to the use of personal protective equipment over the nose and mouth in situations that pose a high risk of exposure to infectious particles. The HCWs should be sensitized and appropriate training on use and maintenance of respirator.

Figure 8.1: Key strategies under respiratory protection



8.1 Respiratory protection programme

Particulate respirators are the key strategies (figure 8.1) under respiratory protection and should be used within the framework of a respiratory protection recommendations programme. This aims at reducing the M.Tuberculosis and other airborne infections transmission to HCWs and non-health congregate settings with presumed and confirmed TB cases (e.g. correctional facilities, refugee and asylum centres). Respiratory protection should be offered to all entering high-risk areas. Respirators may also be used by community workers or family members taking care of patients with TB.

8.1.1 Component of respiratory protection programme

- A TB IPC focal person at the health facility or congregate setting is required to coordinate the implementation of the respiratory protection programme.
- Allocation of dedicated funding and human resources to ensure availability of commodities such as medical masks and respirators.
- Funds for the development of educational material and training of staff in appropriate application, use and disposal of respirators.

- A choice of appropriate respirators that meet global standards for protection (e.g., N95, FFP2 or FFP3) in different settings.
- The procurement team should consider different sizes to fit the range of staff members in the facility (based on respirator fit testing results).
- Written SOPs and signage to be made available to all users and displayed at strategic locations.
- A plan for respirator fit-testing for all users, including fit-testing after every change of brand or make of the respirators.
- All HCWs must do a seal check before wearing a respirator, and systematic records of fit-testing must be maintained.
- Mechanisms to ensure that respirators are used by all personnel entering high-risk areas, HCWs, people living with HIV and care providers for infectious TB patients.
- General health screening of those using respirators should be done, to assess whether they can perform duties for long hours wearing a respirator – those with impaired lung function (e.g., asthma or chronic obstructive pulmonary disease) may be unable to perform duties with respirators and should be assigned to different tasks.

8.2 Particulate respirators

Particulate respirators provide additional protection to user against airborne infection if properly certified, fitted and correctly used. Particulate respirators effective against airborne pathogens include those certified as N95, as FFP2, or greater protection ratings.

The performance of N95 respirators is approved by the National Institute for Occupational Safety and Health (NIOSH) of the United States Centers for Disease Control and Prevention. The performance of FFP2 respirators must comply with the essential health and safety requirements set out in European directives; that is, with "Conformité européenne" (CE). Either of 2 types of particulate respirators are widely used (table 8.1).

Table 8.1: Types and use of particulate respirators

N95 respirators	Filtering Face Piece (FFP)
• 'N' refer to respirator class for use against non-oil aerosols and '95' refers to filter material that is 95% efficient to remove particles of 0.3 µm. • Other marking are 'R' refers to resistant to oil for 8 hour and 'P' refer to oil proof.	• It is further available as FFP2 and FFP3. • FFP2 and FFP3 filters out >94% and 98% of particles of 0.4 µm, respectively. • It is used by HCW when undertaking aerosol generating procedure[1] on infectious PwTB.

1. Aerosol generating procedures: tracheal intubation, non-invasive ventilation (e.g., bilevel positive airway pressure and continuous positive airway pressure), tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy, sputum induction by using nebulized hypertonic saline, dentistry, and autopsy

- Particulate respirator is recommended for use in TB laboratory, bronchoscopy, DR-TB wards and other public health important and under transmission (e.g. H1N1, SARS, COVID-19).
- Everyone provided with a respirator should be given training on how to use it.

Figure 8.2: Use of particulate respirator in a high-risk setting

8.2.1 Fit testing of respirator

Fit testing is a critical process to ensure that a respirator forms a proper seal on the user's face, thereby providing the intended level of protection from infectious respiratory particles. The purpose of fit testing is to confirm that the respirator, typically a tight-fitting model like an N95 or other similar types, fits the wearer's face securely without any gaps that could allow air to bypass the filter.

Fit testing ensures that a respirator will provide adequate protection, comfort and is compliant with health and safety standards.

Fit testing should be offered to all new employees and repeated annually for all HCWs. However, the frequency of fit test is determined by working in high-risk settings, changes of facial feature and medical condition and type of respirator.

Fit testing may be carried out in two ways using either qualitative or quantitative method.

a) Qualitative Fit Testing

This method relies on the wearer's sense of taste or smell to detect leakage of a test agent around the respirator's seal. The user wears the respirator while a test agent (such as saccharin or bitter aerosol) is introduced into the environment. If the wearer can taste or smell the agent, the respirator doesn't fit properly, and the test is failed. The most common qualitative fit tests include Saccharin and Bitrex test and are generally used for respirators that have a negative pressure seal, like N95 masks. It is often used in less critical or lower-risk environments because it is subjective and relies on the wearer's senses.

b) Quantitative Fit Testing

This method uses instruments to measure the actual amount of leakage into the respirator, providing an objective result. An instrument measures the concentration of a test substance inside and outside the respirator. The ratio of these concentrations helps determine the fit. The wearer is subjected to different movements (e.g., head shaking, jogging, non-stop talking) to simulate real-life conditions. Quantitative fit testing is recommended in high-risk environments (e.g., healthcare workers exposed to airborne pathogens like tuberculosis or COVID-19) because it provides objective, more reliable data about the effectiveness of the respirator.

Fit Test Procedure

The basic steps for a respirator fit test, whether qualitative or quantitative, are generally similar:

i) Pre-test Check: Ensure proper respirator selection for the correct model and size for the wearer, check for facial hair which can prevent a good seal and should be removed before testing and also check the respirator for any damage before the fit test.

ii) Performing the Test: The person being tested should wear the respirator with the appropriate fit. For qualitative tests, the test agent (e.g., saccharin or Bitrex) is introduced, and the wearer must indicate if they can taste or smell the substance. For quantitative tests, a specialized machine is used to measure the particulate concentration inside and outside the mask while the wearer performs various movements to simulate normal activities.

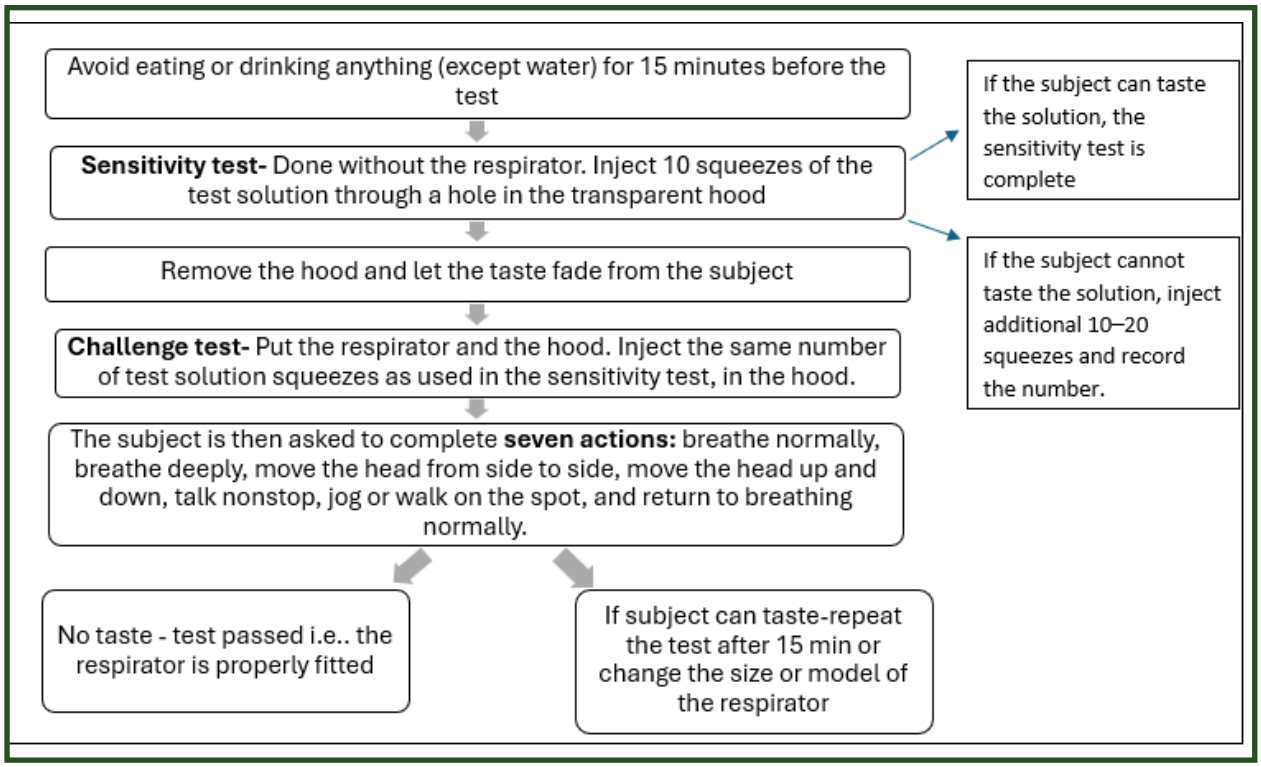
iii) **Result Interpretation:** If the respirator forms a proper seal, and there is no detectable leakage the result is interpreted as "Pass". If a leakage is detected, the respirator needs adjustment or replacement, the result is interpreted as "Fail" and the fit test should be repeated with a different size or adjusting the straps or use of different model if needed.

iv) Frequency of Fit Testing: An initial fit test should be performed when the user/ worker is first required to wear a respirator and should be repeated annually if there is change in the worker's face shape, weight, or facial hair (such as beards or moustaches) as that can affect the fit.

v) Training and Record Keeping: Workers should receive training on how to properly wear, adjust, and maintain their respirators, as this will affect the fit and performance. Employers are required to maintain records of the fit test results for each worker, including the type of test performed (qualitative or quantitative), the specific respirator used and its size, whether the fit test was passed or failed and the date of the fit test done. These records ensure compliance with regulations and help track the proper use of respiratory protection.

Figure 8.3: Demonstration of fit testing of a respirator using a test hood/ test kit Lab Biosafety training at NTI Bangalore, 2015

Figure 8.4: Steps of performing the fit test



8.2.2 Seal check of respirator

A seal check is a critical step in ensuring that a respirator provides the intended level of protection. It ensures that the respirator fits properly, creating a tight seal around the face to prevent air from leaking in around the edges.

A proper seal check is a simple but critical part of respiratory protection. By confirming that a respirator is properly sealed, the user can ensure that it will function as intended, providing the necessary protection from infectious respiratory particles. The seal check can be performed either using a positive pressure or a negative pressure check.

How to Perform a Positive Pressure Seal Check

- Wear a respirator and place your palms over the respirator.
- Exhale sharply.
- If the respirator expands and you feel pressure inside without air escaping from the edges, the seal is good.
- If air escapes, the seal is inadequate, and the respirator must be adjusted or replaced.
- This is known as a positive pressure seal check.

How to Perform a Negative Pressure Seal Check

- Wear a respirator and place your palms over the respirator.
- Inhale deeply.
- The respirator should collapse slightly as it draws air through the filter.
- If air leaks around the edges or if you cannot feel the respirator collapsing, the seal is not proper, and the fit must be adjusted or the respirator replaced.
- This is known as a negative pressure seal check.

A user seal check should be performed each time the respirator is worn/ put on (donned).

The steps for seal check are presented in figure 8.5.

Figure 8.5: Steps for seal check of respirator

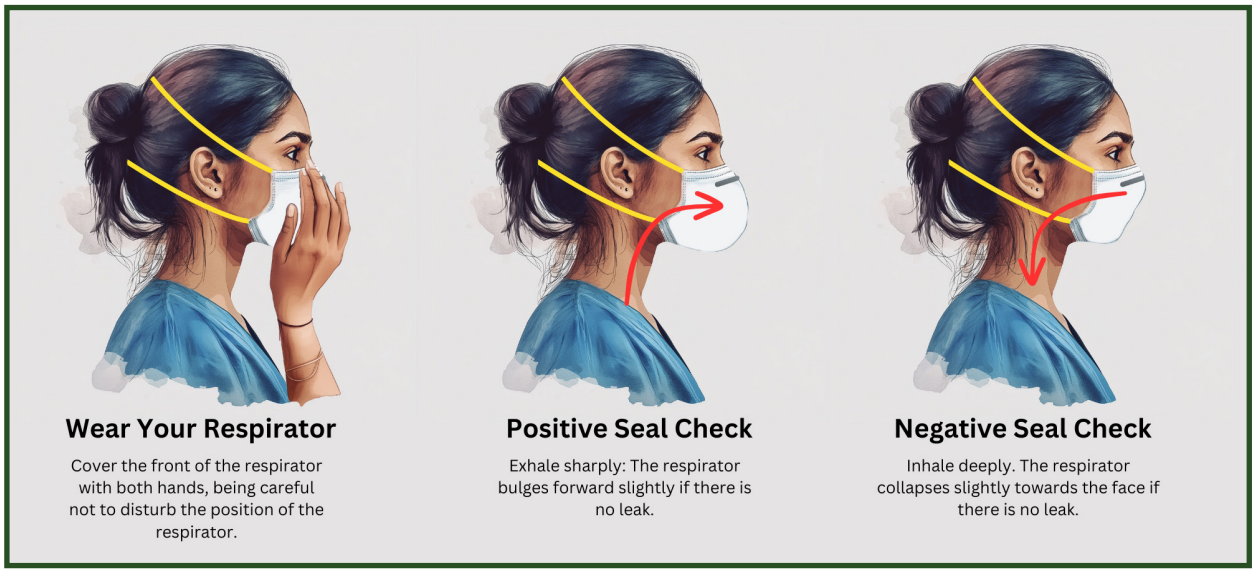


Figure 8.6: Procedure for donning and doffing of a respirator

8.3 Medical/ surgical mask

Masks, meaning facial coverings without certification against 0.3micron particles (including typical 3-layer medical masks) are effective in source control for patients, i.e. to reduce the dispersion of infectious respiratory particles of all sizes.

Medical masks are used to reduce the release of IRPs and provide minimal protection against M.tuberculosis and other airborne infections. It is recommended for individual and PwTB, particularly when coming in contact with other individuals and poorly ventilated areas to prevent the spread of TB.

- The mask is flat or pleated with nasal bar and is affixed to the head with straps around the

ears, and it should completely cover their nose and mouth (i.e. 3-layer medical masks).

- Their performance standards are tested using a set of standardized test methods – American Society for Testing Materials (ASTM) ASTM F2100, EN 14683 or equivalent – that aim to balance high filtration, adequate breathability and (optionally) fluid penetration resistance.
- The mask must be replaced at least once a day, or if it becomes wet or damaged.
- The individual may be able to remove the medical mask for large portions of the day (e.g., when they are alone, outside or sleeping); this is important because the mask restricts air movement and is often not comfortable.

8.4 Personal respiratory protection measures (Do's and Don'ts)

- Individual with respiratory symptoms or PwTB should be instructed to wear disposable face masks when in healthcare and community settings.
- Cough etiquette must be enforced.
- Healthcare workers in the high-risk settings should use respiratory protection like N95 particulate respirators.
- Simple medical face masks may be insufficient to ensure protection against IRPs hence it should be used for source control in the patients.
- The respirator selected should be well-fitting. A quick positive and/or negative pressure seal check must be conducted each time the respirator is donned.
- Manufacturer recommendations must be strictly adhered to for all aspects of respirator use.
- Hand hygiene should be conducted before donning and after removal of respirator.
- The respirators should not be touched while being worn.
- Users should not try to clean, chemically disinfect, decontaminate or autoclave a disposable respirator, as it may affect the efficiency of respirator.

9 RECOMMENDATIONS FOR HIGH-RISK SETTINGS FOR TB IN HEALTH FACILITY

Healthcare facilities are more prone to infection transmission. Some areas in the healthcare settings deserve special attention where AIC is concerned. These are:

1. Airborne Precaution Rooms
2. OPD and waiting areas
3. DR TB wards
4. ART Centers
5. Bronchoscopy and Procedure Rooms
6. Intensive Care Units
7. Radiology Areas
8. Autopsy Suites
9. TB Labs
10. Biomedical Waste Management areas

The aspects of AIC-IPC of these areas with reference to Administrative, Environmental and Respiratory Protection are outlined in this chapter.

9.1 Airborne isolation rooms (AIIRs) or Negative pressure rooms

These rooms are specifically designed rooms to confine airborne infectious agents, such as those causing tuberculosis (TB), and other infectious agents, within the room. In some hospitals airborne precaution rooms are available for patient segregation. Airborne precaution rooms can be naturally ventilated or mechanically ventilated.

Specifications for these rooms are suggested below.

Room layout

- Ensure signage on the door.
- Ensure appropriate hand-washing facilities.
- Ensure appropriate room ventilation (> 12 ACH, or >80 l/s/patient average ventilation rate).
- Ensure unidirectional control of airflow, with air flow only entering the room when the door is open, and exhausted outside safely. This enables air flow from non-infectious area to infectious area.

- Naturally ventilated airborne precaution rooms: the air flow should be directed to areas free of transit, or safely outside where it may be diluted.
- Airborne Isolation Rooms with Mechanical Ventilation:
    - ◊ These rooms use "negative pressure," meaning the air pressure inside is slightly lower than outside.
    - ◊ This setup makes air flow into the room when the door is open, preventing germs from escaping.
    - ◊ It ensures that air moves from clean (non-infectious) areas into infected areas.
    - ◊ A pressure difference of more than 2.5 Pascals is needed.
    - ◊ The air leaving the room should be stronger by more than 125 cubic feet per minute than the air entering.
    - ◊ The room must be sealed tightly, with only a small amount (about 0.5 square feet) of air leakage allowed.
    - ◊ The used air should be sent outside or cleaned using a HEPA filter before being reused

Room Setup

- Remove all non-essential furniture; the remaining furniture should be easy to clean, and should not conceal or retain dirt or moisture within or around it.
- Set up a trolley outside the door to hold PPE. A checklist may be useful to ensure that all equipment is available (see sample checklist). And stock PPE supply and linen outside the precaution room/area (e.g. in the change room).
- Maintain regular supplies for hand washing, and with alcohol-based hand rub near the point-of-care and room door.
- Place appropriate waste bags in a bin. If possible, use a touch-free bin. Dirty bins should remain inside the precaution rooms.
- Place a puncture-proof container for sharps disposal inside the precaution room/area.
- Place an appropriate container with a lid outside the door for equipment that requires disinfection or sterilization.

Procedures

- Before being allowed into the airborne isolation rooms areas, visitors should consult the nurse in charge, who is also responsible for keeping a visitor record. A roster of all staff working in the airborne precaution areas should also be kept for possible outbreak investigation and contact tracing.
- Patient-care equipment that is required for use by other patients should be thoroughly cleaned and disinfected before use.
- Ensure scrupulous daily cleaning like wet mopping with appropriate disinfectants, of the airborne precaution room/area.

9.2 OPD & Waiting Areas

OPD waiting areas are one of the crowded areas of the institute. The institute should ensure that these areas are well-ventilated and adequate in size based on the daily footfalls at these places.

Respiratory symptomatic patients must be fast tracked from the long queues (Triaging, as explained in the administrative control chapter). Cough symptomatic patients should be isolated in the cough corners (separation). They should be provided with masks (Respiratory hygiene) and prioritized for quick services (early treatment initiation). All these will enable reduced contact time with other patients.

- OPD seating should be arranged such that air flows from clean areas to unclean ones, with optimum air changes per hour (ACPH) to keep ventilation effective.
- All furniture obstructing the windows and doors should be removed to ensure adequate ventilation
- All windows and doors must be kept open to maintain adequate Air Changes Per Hour (ACPH).
- There should be signages to educate the staff regarding keeping air entry and exit points open.
- In adverse climatic conditions where ACPH cannot be maintained, alternate mechanisms like GUV may be employed to maintain indoor air quality.
- Ideally respiratory OPD should be away from other OPDs, especially those of immunocompromised departments like Oncology, NCD and Pediatrics.
- Waiting areas should be spacious with regulated patient flow.
- The Infection control team needs to evaluate the OPD load and IPC measures once quarterly.
- Appropriate BMW receptacles should be available in OPD settings
- Regular cleaning of OPD floor with appropriate disinfectant and using triple bucket system is recommended (Minimum twice a day).
- Patients with respiratory symptoms should be provided with masks.
- HCWs are recommended to use N95 respirators for their safety.

9.3 DR-TB Wards

DR-TB wards are inpatient facilities for admitting DR TB patients for initiation of treatment and managing clinical complications during treatment.

Location and Design:

- The facility should be located away from the other wards with preferably a separate passage for the patients to access the toilets.
- Preferably, there should be separate passage for the patients to access the toilets.

- The facility should have adequate ventilation (natural and/or assisted ventilated) to ensure >12 ACPH at all times, preferably >15 ACPH. This would be possible only if adequate fixed unrestricted openings, e.g. ventilator windows, are open at all times during the day and night in all seasons. Similarly, if assisted ventilation is being used (e.g. exhausts) to maintain the adequate ACPH it should be ensured that these are kept switched on at all times.
- Use of upper room GUV devices may be considered for such facilities as an alternative, if ventilation standards cannot be achieved at all times of the day and seasons.
- In the event of frequent power cuts in a setting requiring mechanical or GUV devices to maintain safety, a power back-up facility (i.e. generator set) is recommended along with adequate provision for fuel and maintenance.
- The distance between 2 adjacent beds should be optimal (at least 6 feet).
- Visitors should be restricted to the greatest extent practical.
- Admission should be limited to confirmed DR TB patients which are infectious and/or need intensive care.

General Hygiene:

- Hand washing facility (Universal Precaution) shall be in appropriate place for doctors, Healthcare workers and patients.
- Running water, soap and alcohol hand rub solutions supplies shall be maintained.
- Frequent wet mopping of the ward shall be undertaken.
- The lavatory shall be kept clean.

Patient education

Patient education/counselling should be conducted on the following at each admission, and reinforced frequently by staff. This should include

- Cough hygiene
- Cough etiquettes
- Safe sputum disposal
- Proper use of medical masks.
- Limited entry of visitors

Cough Hygiene

- Display IEC sign boards in the ward demonstrating cough hygiene.
- All patients admitted in the ward should be issued face/medical masks.

Sputum Disposal

- Patients should be provided with individual kits consisting of container with lid, containing 5% phenol, for collection of sputum.
- Patients should be instructed to spit the sputum directly in the container.
- The container should be emptied daily, and the sputum should be disposed of as per the infection control guidelines mentioned in chapter 7.

HCW with health conditions having immuno-compromised state or who are on immuno-suppressants should not be posted for work in DR TB ward.

Training of DR-TB Ward staff

All the staff of the DR TB ward shall be trained in Standard Workplace Precaution, Waste segregation and disposal and Air borne Infection Control Practices, with special reference to tuberculosis. The sanitation staff should be trained on mopping the floors, safety precautions, use of PPEs, and they should be instructed not to use brooms.

Respiratory Protection – i.e. N95 particulate respirators – It must be made available for use by any staff working in the DR-TB ward area. All staff should be provided with appropriate training on how to choose, use, and maintain the respirator. The details are explained in Respiratory Protection chapter 8.

9.4 ART centers

Location and design

- ART centers should be preferably located away from TB Detection Centers (TDC) (erstwhile called Designated Microscopy Centre/DMC) and TB Treatment and Support Center (Previously called DOT Centers).
- There should be well-ventilated waiting & seating area. Separate, well-ventilated waiting area for respiratory symptomatic should be made available wherever possible (larger ART centers).
- Adherence to ventilation standards for airborne infection control (>12-15 ACH throughout during all hours of operation, in all seasons) should be ensured.
- Covered outdoor waiting areas and use token systems are encouraged to reduce crowding.
- As far as possible, the use of air conditioners with closed air circulation in the waiting area should be avoided as these do not facilitate air exchange.
- Where natural ventilation is of concern, adequate ventilation can be achieved by augmented ventilation through exhaust fans may be considered, if installations are properly designed and maintained, and electrical power is consistently available.
- Use of GUV may be considered for such facilities as an alternative, if ventilation standards could not be achieved at all times of the day and seasons

General Hygiene

- Hand washing facility shall be in place for doctors, Healthcare workers and patients
- Running water, soap and alcohol hand rub solution supplies shall be maintained.
- Regular frequent wet mopping of the patient floor area shall be practiced.
- Lavatory shall be kept clean
- An appropriate waste segregation and disposal system shall be in place

Cough Hygiene for people with respiratory infection

- The patients should cover their mouths and nose with tissue when coughing and dispose of used tissue in waste containers. Use a tissue to cover the mouth and nose while coughing and promptly discard it in a designated waste bin.
- Medical masks may be issued to coughing patients
- Perform hand hygiene (use an alcohol-based hand rub or wash hands with soap and water) after contact with respiratory secretions; and
- Display sign boards for patients and family members on acute febrile respiratory illness, using respiratory hygiene/cough etiquette and limit their time spent in healthcare facility.
- Train and educate HCWs, patients, family members, and visitors on the importance of containing IRPs to help prevent the transmission of TB and other respiratory pathogens.
- Posting signs requesting that people with acute febrile respiratory illness refrain from visiting the Healthcare facility.

Fast Tracking of persons with respiratory symptoms/known pulmonary TB patients and persons with respiratory infection

- The nurses or care coordinators of the ART Centre shall streamline the entire Fast Tracking of the patients at the ART Centers. More personnel may be involved to manage larger / crowded ART centers
- Known pulmonary TB patients and people with respiratory infections shall be identified at the registration area for fast tracking.
- They will be helped by the nurse to get them counseled by the counselors, examined by the doctors and provided with the services quickly, without making them wait in the regular queue. Fast-tracking of chest symptomatic will ensure that there are minimum chances of contact of these patients with healthy ones.
- Presumptive TB shall be referred to the TB Detection and treatment centers for their sputum examination as a part of Intensified TB Case finding.
- Public announcements or display of the Fast-tracking system are to be used within the ART center to dispel any confusion among waiting patients

Training of ART staff:

- All the team members of ART Centre shall be trained in standard workplace precaution, waste segregation and disposal and AIC practices, with special reference to tuberculosis.

9.5 Bronchoscopy/Respiratory procedure rooms

Diagnostic procedures such as bronchoscopy, gastric lavage and induced sputum collection are extremely hazardous with refence to the generation of large numbers of respiratory aerosols. Bronchoscopy procedures have high risk of pathogen transmission if the bronchoscope or accessories are not adequately disinfected. Airborne infection control in such a high-risk setting

must also follow the standard hierarchy of control measures:

- Administrative measures to reduce risk of exposure to healthcare personnel and other patients inside or close to bronchoscopy room
- Environmental controls to prevent spread and reduce concentration of infective aerosols within and around the bronchoscopy room, and
- Judicious use of respiratory protective equipment by healthcare personnel involved in bronchoscopy and specimen handling.

For optimal results, good control at a previous level must be ensured before proceeding to the next level.

Administrative measures

- Strong commitment is needed from the hospital administrators for providing infrastructure, facilities and funds for implementing implementing airborne infection control measures for bronchoscopy/procedure rooms. This should include necessary renovation/relocation of the procedure room, installation of necessary equipment, along with periodic maintenance and replacement.
- A comprehensive airborne infection control plan written specifically for the bronchoscopy room should be in place and must be periodically updated based on past performance and new scientific evidence.
- Staff in the bronchoscopy room should have training regarding both tuberculosis transmission and airborne infection control guidelines for bronchoscopy. Compliance should be assessed routinely as part of performance evaluation.
- Appropriate signage for advising need and techniques of cough etiquette and sputum disposal must be prominently placed in the area. Healthcare workers or volunteers in the bronchoscopy room can utilize the opportunity for additional emphasis on these measures and further train patients.
- In general, bronchoscopy should be avoided unless the desired clinical information cannot be obtained through other less invasive procedures. If the bronchoalveolar lavage is planned for diagnostic purposes, the patient should have at least two negative sputum smear results and/or negative NAAT results before the procedure.
- Patient's with bronchoscopy procedure schedule should be structured to minimize exposure to other people. Presumptive TB patients should be brought to the bronchoscopy room / waiting area without any waiting time. The general policy of asking patients to report at a fixed time and wait for their procedure should be avoided. If possible, a separate time, or day of the week, could be assigned for these patients to limit the time of potential spread of infection in the bronchoscopy room.

Environmental controls

- The bronchoscopy room must exceed 15 air exchanges per hour. The air flow should be uni-directional, from room entrance to the back and outside.
- The room should have local exhaust ventilation that vents the room air to the outside, and not into the corridor or waiting area. The air exhaust should be at least 2 meters away

from any open window.

- The resources may be made available, specific air cleaning methods such as upper room germicidal ultraviolet (GUV) or HEPA filtration. These methods complement, and are not a substitute for, the measures listed above. They may prove especially useful in closed air-conditioned suites, or if the exhausted air cannot be vented outside or it is discharged into a general ventilation system. These measures can also be used to further clean air that is exhausted outside. These systems must be carefully installed and meticulously maintained to ensure optimum function.
- Adequacy of ventilation, and the number of air exchanges, should be objectively assessed at periodic intervals.
- Periodic fumigation may be undertaken in Bronchoscopy suites.

Respiratory protection measures

- Patients should be instructed to wear disposable face masks while waiting for the procedure or immediately after the procedure. Cough etiquette must be enforced.
- Healthcare workers in the bronchoscopy room should use respiratory protection using N95 particulate respirators. Simple medical face masks will be insufficient to ensure protection against IRPs. Healthcare workers must be given time and training to adjust to these infection control measures. Disposable N95 respirator masks may be an economically suitable option; these may be reused by the same person till they lose fit or get soiled. The selected mask should be well-fitting. A seal check must be conducted each time the respirator is donned. The respirator should be continuously used both during the bronchoscopy procedure as well as during specimen handling. Manufacturer instructions must be strictly adhered to for all aspects of respirator use.

9.6 Intensive Care Units

Closed Healthcare areas such as intensive care unit (ICU) pose specific challenges in ensuring airborne infection control. It is therefore imperative that these necessary infection control procedures remain in place and are used routinely. As in other areas, a comprehensive and hierarchical approach using administrative control measures, environmental controls, and personal protective measures (in that order) is necessary to achieve this objective.

These measures below are recommended in addition to Standard Precautions and infection control measures for inpatients

Administrative controls

- ICUs should develop airborne precaution rooms or areas.
- It is important to have a detailed infection control protocol in place.
- The clinical and nursing staff should receive training on Standard Precautions, general hygiene, and specific infection control measures in the ICU.
- Sufficient material should be available to (a) ensure general hygiene (e.g. soap and running water, alcohol-based hand rubs, disposable towels, etc.), and (b) perform cleaning and

disinfection of patient bed and other material at periodic intervals. (c) Adequate supply of personal protective equipment should also be ensured.

- Segregation of patients with known or suspected respiratory infections should be practiced in ICUs.
- Proper disposal of respiratory secretions generated through suctioning in mechanically ventilated patients, as well as used personal protection equipment, is mandatory.
- Visitor entry should be restricted to the minimum possible number. The visitors should also be advised to take necessary precautions, in line with the general hygiene practices followed in the ICU.

Environmental controls

The necessary environmental controls are most important in two aspects: (a) engineering aspects related to the distribution of space for patients and healthcare workers in the designated ICU area, and (b) controlled ventilation.

Required

- Regular cleaning and disinfection activities should be conducted. Surface cleaning (using cloth or mop moistened with water or a liquid detergent) should precede disinfection, taking care to minimize aerosolization.
- At least 12 air exchanges are recommended hourly, though more may be preferred. Alternatively, 80 l/sec/patient ventilation rate should be achieved.
- Ventilation should be controlled (i.e. mixed-mode or mechanical ventilation). It is ideal not to use split or window ACs as there will be recirculation of contaminated air.
- 100% fresh air HVAC systems are ideal in ICUs as it prevents recirculation of contaminated air.

While using mechanical ventilators for intubated patients with conditions of potential concern regarding airborne transmission, bacterial/viral filters should be used on exhalation valves. Exhalation valves are crucial components in mechanical ventilation systems for intubated patients. These valves control the release of exhaled air and help maintain proper pressure during the breathing cycle.

These should be regularly changed as per manufacturer guidelines, and used filters judiciously disposed off. Ventilator tubing, etc. should also be disinfected as per manufacturer recommendations.

Other Precautions:

- It is ideal to have individual cubicles for each patient with sufficient space for patient bed and other equipment necessary for providing critical and respiratory care. This not only prevents HAI transmission to other patients and staff in the ICU but also makes the disinfection process easier after the patient leaves the ICU. If this is not feasible due to space or financial constraints, then two or three patient beds may be grouped in a single cubicle, with wide separation between beds.
- Have separate airborne isolation rooms for patients having respiratory infections having a high potential for airborne spread that has a significant clinical and/or public health impact. If feasible these should be designed for uni-directional control of airflow. Air

should flow into the airborne precaution area and be exhausted out without recirculation.

- Use non-recirculating ventilation, which will exhaust air to the atmosphere outside well away from any habited area, air intake, or open windows. If air is either being re-circulated back into the ICU or to other areas in the Healthcare facility, then the air flowing into the ICU or the other areas must be decontaminated of (for instance using HEPA filters, or passing the exhaust through a duct with in-line UV treatment).

Personal and Respiratory protection

- Healthcare workers should take adequate precautions (including general hygiene measures like hand disinfection) while providing care to patients in the ICU.
- If aerosol generating procedures (especially nebulization, cardiopulmonary resuscitation, endotracheal intubation, manual ventilation, oral/airway suctioning, or bronchoscopy) are performed, in addition to other personal protective equipment like gloves, gowns, and goggles, N95 particulate respirators should be used. The standard guidelines for donning and doffing must be followed.
- Each time personal protective equipment is removed, hand hygiene should be performed immediately thereafter.

9.7 Radiology Areas

The general administrative, environmental and personal protective measures applicable to a general outpatient setting are also relevant to the radiology department.

In addition, radiology departments should attempt to routinely practice the following principles because many smear-positive patients also are referred routinely to X rays.

- Patients who are coughing, or who are known to have TB or other infectious diseases with high potential of airborne transmission, should be provided with disposable face masks and cloth/tissue for covering their mouth while coughing.
- Provide priority to potentially respiratory infectious patients sent for chest radiography, to minimize their stay in the department.
- Schedule inpatient chest radiographs on respiratory symptoms and other infectious patients for non- busy times (for instance in the afternoon, or towards the end of the routine morning schedule).
- Ensure that the room where chest radiographs are taken is adequately ventilated; if multiple rooms are used for radiography, the room with the best ventilation should be assigned to potentially infectious patients.

These administrative procedures for safer radiology areas should be posted on the walls in all radiology suites.

9.8 Autopsy Suites

- The dead bodies must be completely sealed in impermeable cadaver bags prior to transfer to a mortuary or autopsy room. This transfer should be made as early as possible after death.
- If autopsy cannot be performed immediately, the cadaver must be maintained under refrigeration at the mortuary till autopsy.
- Mortuary staff and the autopsy team must be alerted prior to transportation of any cadaver that possesses infective risk.
- Entry to and exit from the autopsy suite should be into separate non-connected areas. The former should be used to dress in, and the latter to dress out and to dispose used personal protective equipment.
- Autopsies should be conducted in well-ventilated suites with at least 12 air exchanges per hour. Exhaust systems around the autopsy table should direct air and aerosols away from personnel conducting the autopsy.
- Auxiliary and staff areas should be isolated from the autopsy room.
- Wherever possible, avoid splashes during removing, handling and/or washing organs.
- Avoid aerosol generation by procedures, such as avoiding high pressure water sprays, opening intestines and other hollow viscera under water, and avoiding use of power-saws as far as possible.
- Wherever possible containment devices should be used (e.g. bio-safety cabinets for handling and examining individual organs).
- After autopsy, all contaminated surfaces and used instruments should be cleaned with water and detergent, and then disinfected using chemicals with sufficiently long contact time.
- Personnel handling the dead bodies, prior to and during autopsy, should wear disposable waterproof gowns, gloves, medical masks, and face-shields. If aerosol generation during autopsy is contemplated or the patient is known or suspected to have had TB, persons involved in autopsy should use a particulate respirator (N95).
- After removal of personal protective equipment, all personnel should follow hand hygiene before returning to subsequent duties.

9.9 TB laboratories

This document outlines the AIC-IPC precautions for TB Detection Centers only. For the AIC-IPC guidelines for other laboratories, the reader is directed to Biosafety Manual for Tuberculosis Laboratories under NTEP, 2023.

TB Diagnostic Centers (TDC) (Previously called Designated Microscopy Centers)

Direct sputum microscopy is a relatively low-risk activity if safe work practices are implemented properly. The following work practices are recommended to ensure that microscopy laboratory technicians are not exposed to aerosols from sputum specimens.

- **Sputum collection:** Sputum must be collected in a well-ventilated area (more than 20 ACPH) with direct sunlight. It should not be collected in laboratories, toilets, waiting rooms, reception rooms, or any other enclosed space.
- **Smear preparation:** Smears should be prepared in a well-ventilated environment, near an open flame.
- **Work bench:** Work Benches should be cleaned daily with 70% Alcohol.
- **Sputum container/applicator sticks/slides:** Sputum containers, applicator sticks and slides should be disinfected with 5% Phenol overnight before discarding. They may be discarded in deep burial pits or may be tagged for appropriate disposal via the hospital biomedical waste management system.
- **Ventilation:** Natural or mechanical ventilation at a rate of more than 12 ACPH should be provided in order to minimize the concentration of airborne particles.
- **Protective Gear:** The laboratory staff to be provided with appropriate PPE, including N95 respirators, gloves etc.

10 FAMILY COUNSELLING AND HOUSEHOLD PRECAUTIONS

Early detection (through active or passive case finding) and prompt initiation of treatment for TB infection (TB Preventive Treatment (TPT)) or TB disease (anti-TB treatment for drug sensitive or resistant) are critical for reducing the transmission of TB.

- **Counselling:** Patients with respiratory infections are potentially infectious.
    - ◊ All patients attending clinics and their family members should also be educated on the importance of hand washing, following cough etiquettes, proper sputum disposal and taking other respiratory precautions and respiratory precautions along with importance of completing the treatment
    - ◊ Importance of cough etiquette and sputum disposal should be discussed with anyone with respiratory symptoms and not just PwTB.
    - ◊ Counselling for family members to ensure that patient is not unnecessarily stigmatized, and on proper anti-TB treatment and good nutrition for complete recovery.
    - ◊ Emphasis on cough etiquette for the TB patient at the beginning of treatment should be made.
    - ◊ Clear guidance on safe disposal of used tissues, masks, and sputum containers in sealed bags before disposal, should be given.
    - ◊ Abstinence from smoking should be advocated as it aggravates cough.
- **Household precautions for PwTB:** It is suggested specific measures to reduce exposure in households as below-

Precautions for patients:

- ◊ Houses/ room should be adequately ventilated, particularly where person with TB spend considerable time. Natural ventilation is mostly sufficient. Windows should be kept open as much as possible.
- ◊ Infectious TB patients should spend as little time as possible in crowded and congregated settings.
- ◊ Patients and family members should be educated on collection and safe disposal of sputum.
- ◊ Patient should be encouraged to use a cloth or medical mask when with other individuals, particularly children. This is further important for DR-TB patients.
- ◊ DR-TB patients require more frequent support & counselling because of longer duration of treatment, underlying infective status and toxic medicines.

Precautions for family member of PwTB and Healthcare providers:

- ◊ Family members of people living with HIV should not be directly involved in the care

of infectious TB or DR-TB patients, but if there is no alternative, HIV-positive family members should wear respirators.

- ◊ Children aged below 5 years and pregnant women should spend as little time as possible in the same living spaces as patients with bacteriologically positive TB or DR-TB.
- ◊ Recommend frequent cleaning and disinfection of surfaces (e.g., tables, doorknobs, and shared spaces).
- ◊ All family contacts, and particularly children, should be screened regularly for TB disease and TB infection; if they test positive for TB disease, they should be offered DST and TB treatment. All contacts of patients with bacteriologically positive TB should be put on TPT once TB is ruled out.
- ◊ Healthcare providers should wear respirators when attending bacteriologically positive TB patients in enclosed spaces. Once the patient is bacteriologically negative, respirators are no longer necessary.

Implementation responsibility or role of health system: Key stakeholders who could support effective implementation of AIC-IPC in households include staff at the Healthcare facility, members of community-based organizations providing health services, community health workers or volunteers, as well as TB patients themselves and their close contacts.

- NTEP staff like TB Health Visitors (TBHV), Senior Treatment Supervisor (STS), PMDT DRTB HIV Coordinator and DRTB Counsellor should do frequent house visits to educate and counsel the TB patients and household members. Health education should start even before the patient is discharged from the hospital or referred to TB treatment after TB diagnosis and should continue during treatment and follow-up.
- TPT should be advocated to all household contacts.
- Use of Digital Tools: Recommend Nikshay App for remote counselling, adherence monitoring, and household contact screening.
- **Ni-kshay Setu:** It is an innovative digital platform designed to empower healthcare providers with the knowledge and tools necessary for effective Tuberculosis (TB) care and management. The app offers a robust and user-friendly interface, enabling informed decision-making, capacity building, and adherence to the latest guidelines.
- **TB Aarogya Sathi App:** TB Aarogya Sathi empowers citizens (including TB Patients under NTEP) and to serve as a direct interface with the healthcare system. The App is aimed at augmenting the initiatives of the Central TB Division, Government of India in proactively increasing awareness among the citizens and ensuring availability of free and quality assured drugs and diagnostics to all citizens in the country.
- Community health workers and volunteers like TB Champions and Nikshay Mitra should be trained on how to implement AIC-IPC when a patient is discharged from the hospital, or referred for TB treatment, or during patient home visits.
- HIV testing and counselling should be offered to all household members, and TB screening and TPT to all contacts of the TB patient.
- Community leaders and representatives should be engaged to implement risk reduction strategies in communities with a high TB burden; such strategies include keeping windows open and providing TPT for contacts, particularly children and people living with HIV.

11 HEALTHCARE WORKER (HCW) SAFETY AND SURVEILLANCE

Healthcare Associated Infection (HAI) surveillance is a vital component of Healthcare Workers (HCW) safety. For acute HAIs, HICCs are already well equipped for surveillance and reporting to the National HAI network. However, for chronic infections like TB, which can also be healthcare associated, surveillance of HCWs is essential in the fight against TB. Not only do HCWs have an important role in providing a safe environment for their patients, but also for themselves and others working in healthcare settings. Staff working in congregate settings (a mix of institutional settings where people live in proximity) such as prisons, military barracks, homeless shelters, refugee camps, dormitories, nursing homes, etc. are also at increased risk and need to be protected as well.

Getting infected may be an occupational hazard, but implementation of AIC-IPC measures and strict adherence to guidance for personal protection can minimize the risk. The risk to staff will never be zero.

Surveillance for TB disease among staff can provide data that is essential for informing the program the implementation of TB infection control measures.

Routine reporting of instances of TB disease among healthcare workers is a recommended activity for all Healthcare facilities. The Healthcare facilities should have a policy on healthcare worker surveillance for TB Administrators should be aware of instances of TB disease among staff, perhaps through inclusion of questions regarding TB in periodic health checks. Regardless, this information should be compiled at the facility level on a routine, annual basis.

11.1 HCWs surveillance

11.1.1 Definition of HCW

According to WHO (Working Together for Health, WHO 2006), the definition of Healthcare workers (HCWs) is "People primarily engaged in actions with the primary intent of enhancing health".

HCWs are at an increased risk of acquiring TB compared to the general population, regardless of economic setting and local TB incidence. However, the risk is higher in low-resource, high-TB-burden settings, where HCWs are in more close and prolonged contact with people in an infectious stage of active TB.

HCWs – Who Should Be Included in a TB screening?

All paid and unpaid persons working in healthcare settings/ facilities which includes all part time, temporary, regular, contractual, and full-time health staff. All HCWs who have duties that involve

close contact with patients with presumptive TB or PwTB (i.e. medical doctor, nursing staff, laboratory technician, health attendant, janitor etc.) or presumed to be come in contact with infectious person (i.e. financial officer, administration staff, cook, cleaner, driver, security guard) should be included in a TB screening program.

11.1.2 Areas with higher risk of transmission:

Inpatient settings, outpatient settings, and non-traditional facility-based settings, where undiagnosed and diagnosed TB patients seek care are areas for high risk for transmission of TB to HCWs

- **Inpatient settings** include patient rooms, TB wards, medical wards, DR TB wards, HIV care facilities, emergency departments (EDs), intensive care units (ICUs) where TB patients may receive treatment, surgical suites, laboratories, laboratory procedure areas, bronchoscopy suites and sputum induction rooms etc.
- **Outpatient settings** include chest clinics, other TB treatment facilities, medical OPDs, ambulatory-care settings, emergency rooms, laboratories and radiology departments etc.
- **Non-traditional facility-based settings** include emergency medical service (EMS), medical settings in correctional facilities (e.g., prisons, jails), homebased healthcare and outreach settings, and homeless shelters etc.

11.1.3 TB prevention among healthcare workers

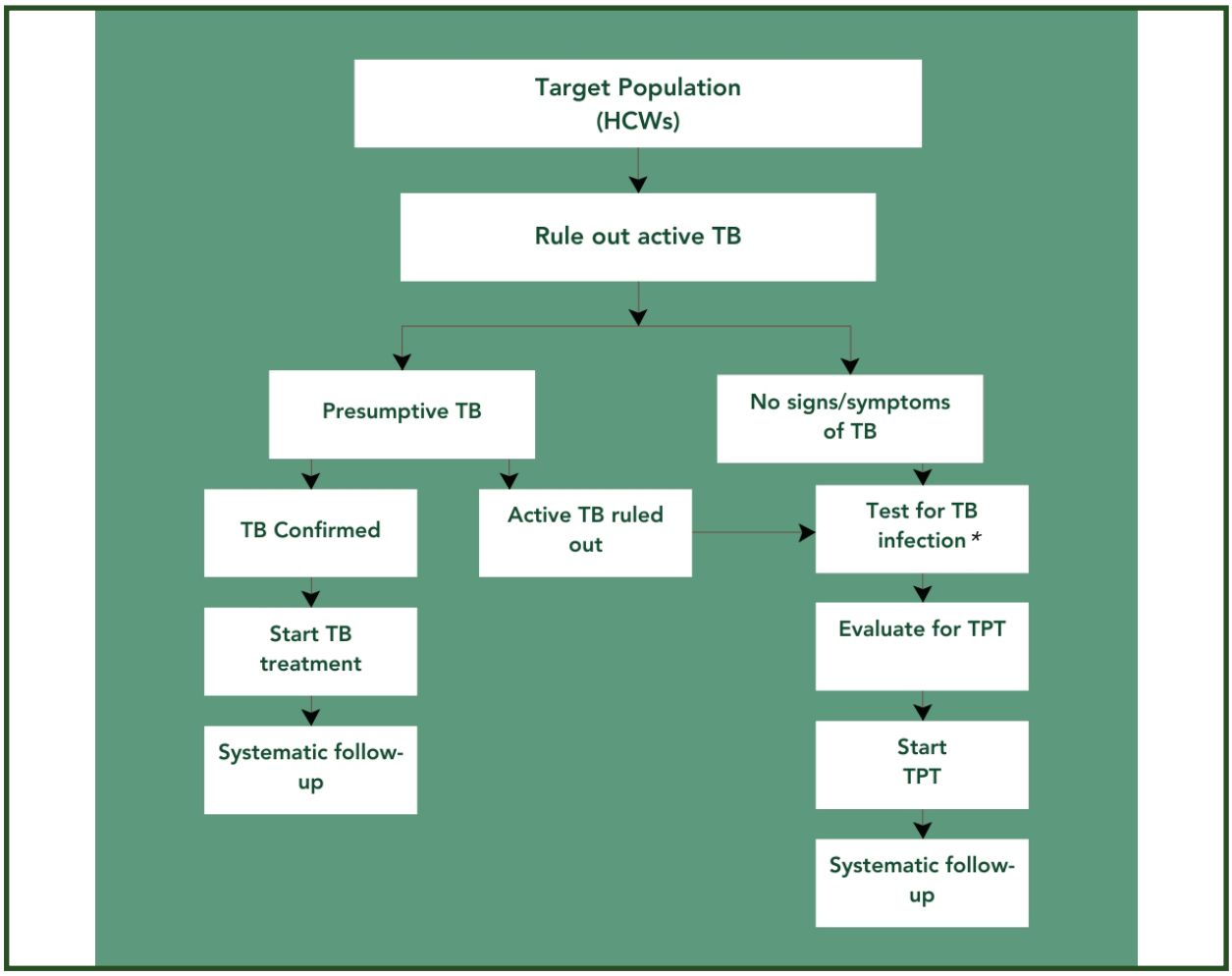
- As per 'WHO operational handbook on tuberculosis, Module 1: Prevention – tuberculosis infection prevention and control, 2023' healthcare workers are at increased risk of acquiring TB infection and disease when IPC measures are not effective.
- These workers have the right to work in a safe environment, and a professional obligation to act in a way that minimizes the risk of harm to those under their care. Governments and programmes should therefore strengthen measures to reduce these risks, as follows:
    - ◊ Uninterrupted access to particulate respirators, appropriately fitting, should be ensured for healthcare workers, particularly those engaged in TB patient care.
    - ◊ All Healthcare workers should receive appropriate information and rapid TB diagnostic testing if they have signs and symptoms suggestive of TB.
    - ◊ All Healthcare workers (including those newly recruited) and other staff engaged in direct patient care should receive periodic screening for TB symptoms, chest X-rays and testing for TB infection.
    - ◊ Based on the results of the evaluation, Healthcare workers should receive, free of charge, either TPT or a full course of TB treatment.
    - ◊ All Healthcare workers should be given information about HIV and access to HIV testing and counselling – if diagnosed with HIV, they should be offered a package of HIV prevention
    - ◊ Treatment and care that includes regular screening for TB disease and access to ART and TPT.

◊ HIV postive HCWs may be avoided being posted in areas with presumed TB or DRTB patients.

11.1.4 Types of screening for HCW for TB disease:

- **Passive screening**-When HCWs present themselves to the doctors for examination if symptomatic. However, stigma, incorrect perception of risk or health seeking behaviour lead to delay in passive reporting of symptomatic HCWs to the doctors.
- **Active screening-** Institute should have a policy on annual or bi-annual screening and surveillance of HCWs. All the HCWs involved in direct and indirect patient care should be mandated to get themselves screened. HCWs may also be screened for other non-communicable diseases (i.e. diabetes, hypertension, undernutrition) during the annual/ biannual screening. Flow of TB screening and care cascade is presented in figure 11.1 as below.

Figure 11.1: Algorithm for screening of TB disease and infection



**Non availablity of TBI testing should not be a roadblock to initiate TPT after ruling out active TB disease.*

- Ruling out TB disease is the most critical step during screening. All HCWs should be actively asked about the following symptoms for TB (viz. cough >2 weeks, fever, weight

loss, night sweat, fatigue, chest pain, breathlessness, haemoptysis, loss of appetite, swelling in neck) and undergo CXR.

- Affirmative for any of the symptoms or any abnormality on CXR should be further evaluated through rapid molecular testing (i.e. CBNAAT or Truenat).
- All the diagnosed patients should be treated with appropriate DS or DR TB treatment regimens.
- Those HCWs in whom TB disease has been ruled out should be screened for TB infection.
- TB Preventive Treatment (TPT) should be offered to eligible HCWs (i.e. ruled out TB disease and positive for TB infection).
- All HCWs screened should be enrolled in Ni-kshay and data entry should be completed on the same day.

Other considerations:

- HICC should ensure uninterrupted access to particulate respirators, appropriately fitting, should be ensured for healthcare workers, particularly those engaged in TB patient care.
- HCWs should receive appropriate information and rapid TB diagnostic testing if they have signs and symptoms suggestive of TB.
- HCWs including new recruits and other staff engaged in direct or indirect patient care should receive periodic screening for TB symptoms, chest X-rays and testing for TB infection.

Table 11.1: Guidance on active screening of TB disease among HCWs; Risk categorization matrix

Risk of TB Disease =>	+	++	+++	++++
HCW Type	Minimal contact with patients, e.g., storekeeper	Treatment support officers	**DMC/ NAAT LT, ARTC staff, TB/Chest OPD/ IPD: doctors / nurses/ class 4**	**CDST Lab, DR TB ward: doctors / nurses/ class 4**
Screening type and frequency	Entry and annual Symptom screening	Entry and biannual symptom screening	**Entry and Biannual screening (symptom + CXR)**	**Entry and biannual screening (symptom + CXR)**
Diagnostic Algorithm	NTEP diagnostic algorithm (CXR+ NAAT)	NTEP diagnostic algorithm (CXR+ NAAT)	**NTEP diagnostic algorithm (CXR+ NAAT)**	**NTEP diagnostic algorithm (CXR+ NAAT)**
Notification	Each screening to be entered into National TB Notification system (Ni-kshay)			
Treatment	Complete and regular treatment with appropriate regimens			

Screening frequency: It will be based on risk assessment such as low risk, medium risk and potential ongoing transmission. Chest X-ray screening along with symptoms screening is to be done periodically, atleast annually. However, in settings of great risk such as DR-TB ward, TB culture and drug susceptibility testing laboratories (CDST labs), ART Centres, the frequency may be bi-annual or as and when a HCW reports with symptoms or sickness. It should provide general guidance on risk category, tools for screening, and frequency of screening. Details on HCW surveillance is provided in table 11.1

11.1.5 Screening for TB infection (TBI)

Screening HCWs at high risk of TB is likely to reduce transmission; and with earlier diagnosis and treatment, prevent serious illness and disability. HCW can be prioritized for specific TPT interventions. A system should be established for baseline and periodic TB screening and evaluation of staff based on their risk of TB exposure, and free TB treatment and TB preventive treatment (TPT) should be provided. For it, a schedule for TB screening and evaluation of healthcare workers and other staff, including TB treatment and provision of TPT should be prepared.

a) Testing for TB Infection

The currently recommended and available tests for TB Infection are Tuberculin Skin Test (TST) and Interferon-Gamma Release Assay (IGRA). The newer Antigen based skin tests are based on combination of two recombinant proteins, which are specific to M.tb. Some of these tests are Cy-Tb, Diaskintest and CTB. In NTEP, currently Cy-Tb is being used.

All these tests measure immune sensitization (type IV or delayed-type II hypersensitivity) to mycobacterial protein antigens that occurs following infection by M.tb. IGRAs measure the amount of interferon-gamma released in vitro by white blood cells when mixed with M. tuberculosis antigens or the number of T-lymphocytes producing interferon-gamma.

As an alternative to IGRA- QuantiFERON TB Gold Plus and TST, a novel skin test for detection of TB infection, Antigen based skin test can be used (for individuals above 5 years of age). Antigen based test is a highly specific skin test for the diagnosis of TB Infection designed to address some of the drawbacks of TST and IGRAs. Cy-Tb is applied and read in the same way as TST but is based on the antigens ESAT-6 and CFP-10 that are also included in the IGRAs. Due to high specificity, Cy-Tb uses a universal 5 mm cut-point induration irrespective of the status of BCG, HIV, or both. This is important to potentially reduce false positive diagnosis of TB infection in settings using TST. It is also cost-saving relative to TST and IGRA. The only contraindication is allergy to products from Lactobacillus lactis. Refer to Table no 11.2 for details.

Table 11.2: Shows currently recommended and available tests for TB Infection

Criteria	TST	IGRA	Cy-Tb
Sensitivity	High	High	High
Specificity	Low in BCG vaccinated	High even in BCG vaccinated	High even in BCG vaccinated

Ease of use	Field friendly, complex test interpretation	Requires lab and infrastructure	Field friendly, single cut-off allows simple test interpretation
Cost of test	Low	High	Low
Children	Affected by young age	Affected by young age	More robust
PLHIV	Requires info on HIV status	Affected by HIV and low CD4 count	More robust with low CD4

PLHIV and Household Contacts < 5 years old are offered TPT directly without testing

Format for recording the status of HCW surveillance and screening for TB disease is given in Annexure 6a

11.2 Vaccination of HCWs

HCWs can be protected from vaccine preventable diseases by appropriate immunization of Hepatitis B and Tetanus toxoid as recommended by National guidelines for Infection Prevention and Control in Healthcare Facilities 2020.

Adult BCG vaccination is implemented as a study in different states for selected high- risk population. Under program implementation study it is given to sub cohort of the adult i.e 18 years plus population in selected geographies. One of the modelling studies showed that besides accelerating current tools and practices, 17% decline per year in TB incidence can be achieved by introducing vaccine and new treatment regimens.[World Health Organization. Regional Office for South-East Asia. Bending the curve. Annual report 2017]

The target population for adults BCG is individuals aged 18 years and above, meeting any of the following criteria: (single criterion or multiple criteria):

- History of TB disease
- Close contacts of TB patients
- Individuals aged 60 years or above
- Individuals with history of Diabetes
- Individuals with a history of smoking tobacco
- Individuals with a Body Mass Index of less than 18 kg per sq.mts.

Recording and reporting of vaccination status: HICC should maintain records of screening results and immunizations provided, including history of vaccine-preventable disease, date and results of serology, record of vaccine refusal, date of giving the vaccine and batch number, type and brand name of vaccine. Records need to be secure and maintained in accordance with confidentiality. Format for recording the vaccination status of HCWs is given in Annexure 6b.

12 TRAINING AND CAPACITY BUILDING

Training and capacity building of HCWs on IPC and AIC is an essential component in healthcare setting. Both pre-service and in-service training plans are required.

- State should ensure adequate budgetary provision for induction and refresher training needs in programme implementation plan (PIP).
- The State TB Cell and State TB Training and Demonstration Centre (STDC) along with State Quality Assurance Committee (SQAC) should play a crucial role in providing the necessary technical support for these trainings.

12.1 Developing a facility level training program

Two mechanisms for training are described in parallel, a Learning Management System (LMS) Training for NTEP staff and in person training, where LMS is unavailable

12.1.1 Resources

Resource material on all aspects of AIC-IPC provided by CTD may be utilized for these trainings. These include PPTs with speakers' notes, indication of relevant handouts for each session and quizzes that may be employed for pre and post training evaluation.

The LMS will be equipped with resources in modular forms, for different cadres.

12.1.2 Responsibilities

The chairperson of the HICC (head of the institution) is responsible for supporting all training for all categories of staff. The Infection Control Officer (ICO) or the nodal officer is responsible for the organization and conduct of these training. The Infection Control Nurses (ICN) will support the ICO in all IPC training courses. The following table illustrates the roles and responsibilities as per the National Guidelines for Infection Prevention and Control in Healthcare Facilities, 2020.

While using an LMS, the ICO or designee will be provided with access to the system and will be responsible for the operations.

Table 12.1: Roles and responsibilities of the HICC

Chairperson of HICC: Head of the institute	Member-secretary HICC/ infection control officer / DR TB Nodal Officer	Infection Control Nurses
Support educational and training activities for all categories of staff.	Organize and conduct regular TB IPC educational and training activities for HCWs	Organize and conduct regular IPC educational and training activities for HCWs.

12.1.3 Responsibilities of Master Trainers

The master trainers are those technical experts trained in the National, regional or state level Training of Trainers. They may be doctors, engineers, administrators, staff nurses etc. Once the training of trainers is completed, these staff become Master Trainers. The following are the responsibilities of master trainers-

- Master trainers should sensitize the HICC of the parent institution on AIC, surveillance, reporting and other key points.
- Master trainers must understand the scope and content of all national guidelines applicable to AIC- IPC, as discussed in the ToT.
- Master trainers must conduct cadre wise training using the resource material supplied by CTD and/or developed by the institute in compliance with the guidelines. Any customization required at the site level may be done.
- Local languages may be used as required.
- Sharing of best practices and cross learning is encouraged.
- While using the LMS, the master trainers will follow the instructions of the ICO and complete the modules assigned to them.

12.1.4 Training Methodology

- Training calendars may be developed for each quarter and communicated to all, for effective planning and participation
- Different topics may be assigned for each session.
- Trainers to be identified
- The staff may be categorized into 4 groups as follows
    - ◊ Group 1: MS, HICC members
    - ◊ Group 2: Bio Medical engineers, doctors and nurses
    - ◊ Group 3: Class 3 staff
    - ◊ Group 4: Class 4 staff

- Additional trainings for district and state levels may be planned.
- All necessary handouts and training materials must be made available as required
- All activities including pre and post training quizzes, group activities must be conducted for effective training outcome.

The assigning of cadres and courses will be done centrally in the case of LMS

12.1.5 Assigning contents for each cadre

Different cadres may be trained in different topics as per their relevance to their job descriptions. An indicative list of topics for some cadres is suggested in Table 12.2 below

Table 12.2: Indicative topics on AIC-IPC for HCWs to be covered in facility level trainings

Topic from national AIC guidelines	Programme managers and administrator - HICC	Doctors	Nurses, laboratory and X-ray technician	Paramedical staff	Janitor, clerical and other assistant staff	Bio medical engineer
Managerial activities and components of AIC	√					
Administrative controls	√	√	√			
Environmental controls	√	√	√	√ (BMW management)	√ (BMW management)	√ (air flow ventilation, GUV, ACPH etc.)
Respiratory protection	√	√	√	√ (PPE)	√	
Sanitation and hygiene	√	√	√	√ (hand hygiene)	√	
HCW safety and surveillance including vaccination	√	√	√	√	√	
Supervision and monitoring including risk assessment	√	√	√	√ (support in risk assessment)	√ (support in risk assessment)	
Facility infection control plan	√					

12.1.6 Preparing Training Calendars

Preparation of quarterly training calendars upfront will ensure smooth training covering all topics. The topics, the trainer and the target audience may be decided and announced well ahead of time to ensure participation and adequate preparation.

Calendars of similar types may be prepared by the ICN and circulated by the ICO.

ICN under the guidance of ICO should prepare quarterly training calendar for IPC and AIC. Prototype of IPC training calendar is given in table 12.3.

Table 12.3: Prototype of IPC training calendar for two months

Month	Topic	Cadre	No. of Participants	Trainer	Month	Topic	Cadre	No. of Participants	Trainer
Jan 26					**Feb 26**				
Week 1	BMWM	Class 4		ICN	Week 1	BMWM	Class 3		ICN
Week 2	Sanitation	Staff Nurses		ICN	Week 2	Sanita-tion	Class 4		ICN
Week 3	Facility Infection Control Plan	Doctors		Member Sec/ des-ignee	Week 3	Facility Infection Control Plan	Nurses		Member Sec/ desig-nee
Week 4	Risk as-sessment	Doctors		DR TB Nodal Officer/ DTO	Week 4	Risk Assess-ment	Nurses		DT TB Nodal Officer/ DTO

Calendar development each quarter will ensure all required topics are covered for each cadre. It will also enable HICC to identify the trainer upfront who can prepare the resources required for the training adequately. Moreover, it will enable the trainees to organize their schedules optimally, rearrange duties and participate in the training. Developing calendars thus will give sufficient notice to trainees and trainers.

Such a calendaring system is easily possible through the training tool in the LMS.

12.1.7 Training Evaluation

- Evaluate each training by pre- and post-training quizzes.
- Honor the participants with the training certificate on successfully completing training, wherever applicable.
- HICC should maintain the record of training of HCWs. The template of training register is given in table 12.4.
- In written or oral tests, a score of > 70% may be considered satisfactory.
- Training evaluation can also be done through LMS, when available.

Table 12.4: Template of training register to be maintained by HICC

Sr. No.	Name	Designation	Department	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5
1								
2								
3								
4								
5								

12.1.8 Competency evaluation

All training should be followed up for on-ground skill changes. Competency assessments should be done regularly through direct observation of work practices. If found lacking, re-training should be done for such HCW. The specific pre and post questionnaires may be given to each cadre. The question bank provided may be utilized for this purpose. For cadres who cannot read and write, this process may be done orally, and evaluation done in an objective way. All filled forms, and documents of oral evaluation must be collected and scored. This should be tabulated and submitted to the designated person in HICC for further remedial actions as required.

13 MONITORING AND EVALUATION

Well-structured monitoring and evaluation systems at all levels, provide policy makers, decision makers, programme managers and hospital administration with relevant information for the purposes of guidelines, advocacy and program design. The information generated is also used to ensure the most efficient use of resources and serves to demonstrate the impact of efforts and resources on achieving program goals and objectives. Monitoring and evaluation are particularly relevant for a new strategy for which experience is limited, such as in IPC and AIC.

Establishing the system for monitoring and evaluation, including supportive supervision, for IPC-AIC measures should involve collaboration and sharing of indicators between healthcare facilities, the general health system and health programmes (e.g. programmes related to TB, HIV, occupational health, District and State Quality Assurance Committees and IPC).

Monitoring: is the routine tracking of service and programme performance using input, process and outcome information collected on a regular and ongoing basis from policy guidelines, routine record-keeping, regular reporting and surveillance systems, and occasional health facility observations and client surveys. This information is used to assess the extent to which a policy or programme is achieving its intended activity targets on time. In a well-designed M&E system, monitoring will contribute greatly to evaluation.

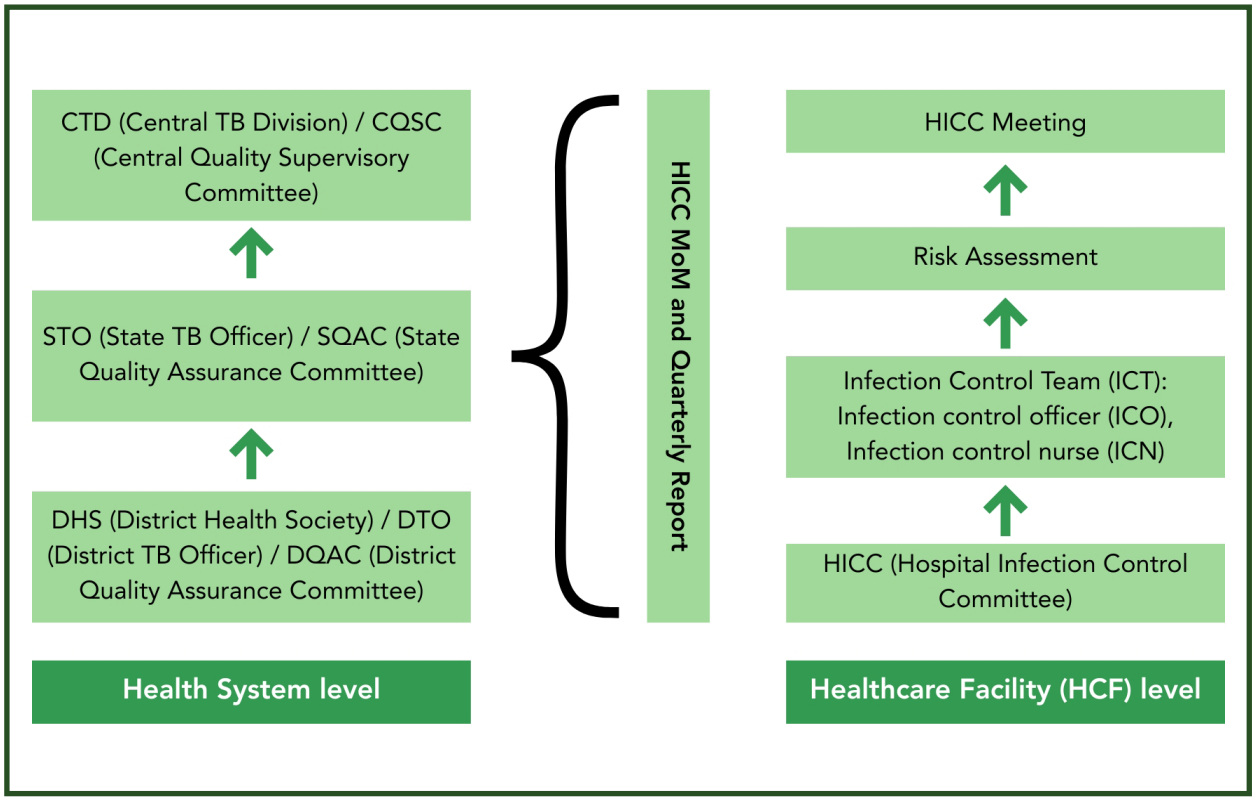
Evaluation: is the episodic assessment of results that can be attributed to programme activities; it uses monitoring data and often indicators that are not collected through routine information systems. Evaluation allows the causes of failure to achieve expected results on schedule to be explored and any necessary mid-course corrections to be applied. Process evaluation assesses progress in programme implementation and coverage. Outcome and impact evaluation measures the effect of programme activities on the target population.

Key components of monitoring and evaluation of IPC including AIC implementation at facility level are:

- Facility risk assessment using a tool (self-assessments/ external validation) in relevant sections and submitting to HICC.
- Identification of strengths, weaknesses, and opportunities for improvement.
- Reviewing and reporting by HICC, to the program, through quarterly report that includes monitoring indicators.

The process of flow for conducting risk assessments under the direction of HICC is presented in figure 13.1 and further elaborated in detail under this section.

Figure 13.1: Flow of process for conducting risk assessments in the facility



The right-hand side flow chart shows the activities within the healthcare facility and left hand side shows the information flowing into the health system. The healthcare facility appoints the HICC with the head of the institution as the chairperson. Infection Control Team is formed within the HICC for day-to-day activities. The process for M&E of AIC-IPC is implemented through HICC in following way:

Head of the institute and HICC deputes ICO and ICN for risk assessment

ICO and ICN evaluate all relevant sections of the facility using the risk assessment tool once every quarter: Standardised tool / checklist is given in annexure 7. It should be used by the ICO and ICN to evaluate all the sections in the facility at least once in every quarter. ICN can take help of link nurses in completing the assessments.

ICO will submit the filled risk assessment formats to HICC with a brief report recommending measures to be undertaken: The report should contain key observations and gaps in implementation of IPC-AIC measures.

HICC meeting: HICC deliberates on compliance of previous meeting, and also makes recommendations for the present assessment. HICC should conduct a detailed review of observations and recommendations submitted by the ICO. The HICC should also verify that all points relevant to AIC and IPC are discussed adequately. HICC should also monitor the adequacy and adherence to the previous quarter's recommendations by examining the action taken report (ATR) submitted by the ICO.

HICC prepares the minutes of the meeting and quarterly report: HICC will compile the data from the minutes of the meeting and other relevant sources and complete the quarterly report. This report should capture relevant indicators for informing the program. The template for

preparing the minutes of the HICC meeting is given in annexure 8. The template for quarterly reporting format is given in annexure 9.

The head of the institute authenticates the report and shares with the programme on quarterly basis: HICC chairperson/ head of the institute is to share the quarterly report to the relevant state/ district programme managers (District Health Society, District TB Officer, District Quality Assurance Officer and Copy to State TB Officer and State Quality Assurance Officer) for perusal and necessary support.

The state or district programme managers should also supervise AIC-IPC implementation at the institute during routine supervisory visit and brief head of the institute about the observations. Annexure 10 outlines a checklist for program review.

14 HOSPITAL INFECTION CONTROL COMMITTEE: THE ROLE OF HICC IN AIC-IPC IN TB SETTINGS

Infection Prevention and Control, and quality standards of healthcare are essential for well-being and safety of patients, their families, health workers and the community. A well-organized IPC program is a basic requirement in every Healthcare facility (HCF) to assist HCWs in the provision of quality healthcare. In 2016, WHO issued evidence-based guidelines incorporated in the implementation manual on the core components of IPC. The first step towards implementation is the establishment of an IPC program at the HCF level. It is thus very critical to include TB focal persons in the existing institutional HICCs and discuss TB IPC especially with reference to AIC routinely in the HICC meetings. The reader is advised to read the chapter on HICC in the National Guidelines for Infection Prevention and Control in Healthcare Facilities-2020. A few additional points with reference to TB IPC has been included alongside relevant excerpts from the above mentioned guidelines.

14.1 Hospital Infection Control Committee (HICC)

HICC is an integral component of the IPC program of the HCF. It is responsible for establishing and maintaining the IPC program and its various functions of monitoring, surveillance, reporting, research and education. The HICC should have wide representation from all relevant disciplines or departments in the facility. The head of the HCF or lead administrator should establish a hospital infection control committee (HICC) with well-defined composition, roles and responsibilities; and provide adequate resources for the effective functioning of the IPC program.

14.2 Structure of HICC

The proposed structure and responsibilities of the HICC are given below.

Chairperson: Head of the institute

Member-secretary/ Infection Control Officer

Members

- Representation from management/ administration: Dean/ Director of hospital; nursing services; medical services; operations.
- Representation from relevant medical and surgical disciplines.
- Representation from support services: laboratory, operation theatre (OT), central sterile supply department (CSSD), housekeeping/ sanitation, laundry, engineering, pharmacology/ pharmacy, stores/ materials department.

- Infection control nurse (ICN).
- Representation of TB facilities if co-located in the same institution.
- Standalone TB Centers may have independent HICCs, but these must come under the supervision of the HICC of the parent institution.
- District TB Officers may be invitees to the committee.

14.3 HICC Responsibilities

- Establish the IPC program in the HCF and develop a facility infection control plan with appropriate budget. This should be reviewed annually.
- Appoint an IPC team responsible for day-to-day activities and implementation of the facility infection control plan.
- Conduct HCW surveillance for TB disease and infection, along with other HAI surveillance.
- Institute and occupational safety program with vaccination for all vaccine preventable diseases.
- Provide training to all categories of staff.
- Conduct risk assessments periodically in all risk areas with special emphasis on AIC.
- Organize periodic (monthly/ quarterly) meetings of HICC and take minutes with clear action points to delegate responsibilities for implementation.
- Report to district, state, and national levels for the program to take informed decisions.

14.3.1 Establishing the IPC Program

- Develop an action plan for strengthening IPC measures for the facility, and individual units within the facility, with priorities based on the risk matrix for that unit and appropriate review.
- Allocation of adequate budget for all proposed activities.
- Constitute an infection control team.
- Develop a Facility Infection Control plan with special emphasis on AIC.
    - ◊ Crowd control measures, triaging and fast tracking of respiratory patients, monitoring of ventilation (keeping all windows and doors open, exhaust fans switched on, wire meshes cleaned), provision of respiratory protection to both HCWs and patients, display of IEC material related to AIC-IPC etc to be coordinated by the HICC.
    - ◊ Technology driven ventilation interventions like HVAC, GUV etc must be monitored by HICC.
    - ◊ Periodic air flow audits must be enabled by HICC in all risk areas.
    - ◊ Ensure environmental sanitation activities including mopping, sputum decontamination and disposal in wards and labs, linen management, continuous availability of disinfectants and ensuring appropriate dilutions.
- Review and revise annually, the infection control guidelines with policies, recommendations and working protocols.

- Organize training programs on recommendations of the guidelines and IPC practices for staff and other HCWs.

14.3.2 Appointing an IPC team

- The IPC team will be responsible for day-to-day activities. It should have the following members
    - ◊ Infection control officer: usually a clinical microbiologist/ clinical epidemiologist
    - ◊ Infectious disease physician, who is the team leader
    - ◊ ICN(s): a minimum ratio of one full-time ICN per 250 beds
    - ◊ One link-nurse from every unit

14.3.3 Analyse the surveillance data for HAI

- Conduct HCW surveillance as per NTEP guidelines for TB disease and TB infection. Refer to chapter HCW Surveillance and safety for details.
- Monitor the trends of HAI regularly and compare the rates of infections within the HCF and with other facilities wherever feasible.
- Investigate outbreaks of HAIs in collaboration with medical, nursing and other staff.
- Help control environmental risks for infection by liaising with appropriate departments such as healthcare waste management, CSSD, provision of safe water (testing of water sources), pharmacy, housekeeping services, engineering department, laundry and kitchen services.
- Refer to Chapter 4 on Policy level interventions- Managerial activities for details.

14.3.4 Implement an occupational safety program

- All vaccine preventable diseases for HCWs is explained in the chapter on HCW safety and surveillance

14.3.5 Provide training to all categories of staff

- All categories of staff should be trained in all relevant aspects of AIC IPC
- The training plan should be made in advance and informed to the trainees
- Training evaluation and if required, retraining must be done
- Refer to Chapter 12 on Capacity Building for details

14.3.6 Conduct risk assessments periodically in all risk areas

- All risk areas are to be assessed using the checklist provided.
- All the gaps identified in the high risk area should be addressed.
  For further details, please refer the chapter 13 on Monitoring and Evaluation

14.3.7 Organize periodic (monthly/ quarterly) meetings of HICC

Document minutes of the meeting with clear action points to delegate responsibilities for implementation. The following documents may be considered

- Meeting notice (Prepared by ICO in consensus with all members and issued by the Chairperson)
- Agenda (Prepared by ICO in consensus with all members and issued by the Chairperson)
- Report on action taken from the challenges in the previous meeting (ICO)
- Meeting minutes (prepared by ICO, with action points, responsibilities, and timelines, signed by the chairman)
- Developing quarterly report with composite score for program reporting

14.3.8 Report to district, state, and national levels

- Quarterly reports are to be submitted to the district and state levels
- The basic indicators defined in quarterly report format (annexure 8) must be reported for the program to make informed decisions

14.4 Details about committees at peripheral facilities

As per 'Kayakalp- Rejuvenating the Public Healthcare Facilities 2024', the Infection Control & Cleanliness committee should be constituted at all the facilities- District Hospitals, Sub-divisional Hospital (SDH), Community Health Centre (CHC), Primary Health Centre (PHC)/ Ayushman Arogya Mandir (AAM)- PHC and Urban Primary Health Centre (UPHC/AAM -UPHC) or equivalent.

Following will be the composition of Infection Control and Cleanliness committee at the facility level:

- Medical Superintendent/Medical Officer In charge – Chairperson
- Nursing in charge/Infection control nurse – Convener
- Pathologist/Microbiologist

- Blood bank in charge
- In charge of OT
- Lab technician
- Hospital Manager/Quality Manager/Health Manager
- Chief pharmacist
- Housekeeping in charge.

RKS will be responsible for monitoring the functioning of Infection Control and Cleanliness committee at the level of DH, SDH and CHC.

Rogi Kalyan Samiti (RKS) or Patient Welfare Committee / Hospital Management Society is a registered society and acts as a group of trustees for the hospitals to manage the affairs of the hospital. It consists of members from local Panchayati Raj Institutions (PRIs), NGOs, local elected representatives and officials from Government sector who are responsible for proper functioning and management of the hospital / Community Health Centre / First Referral Units (FRUs).

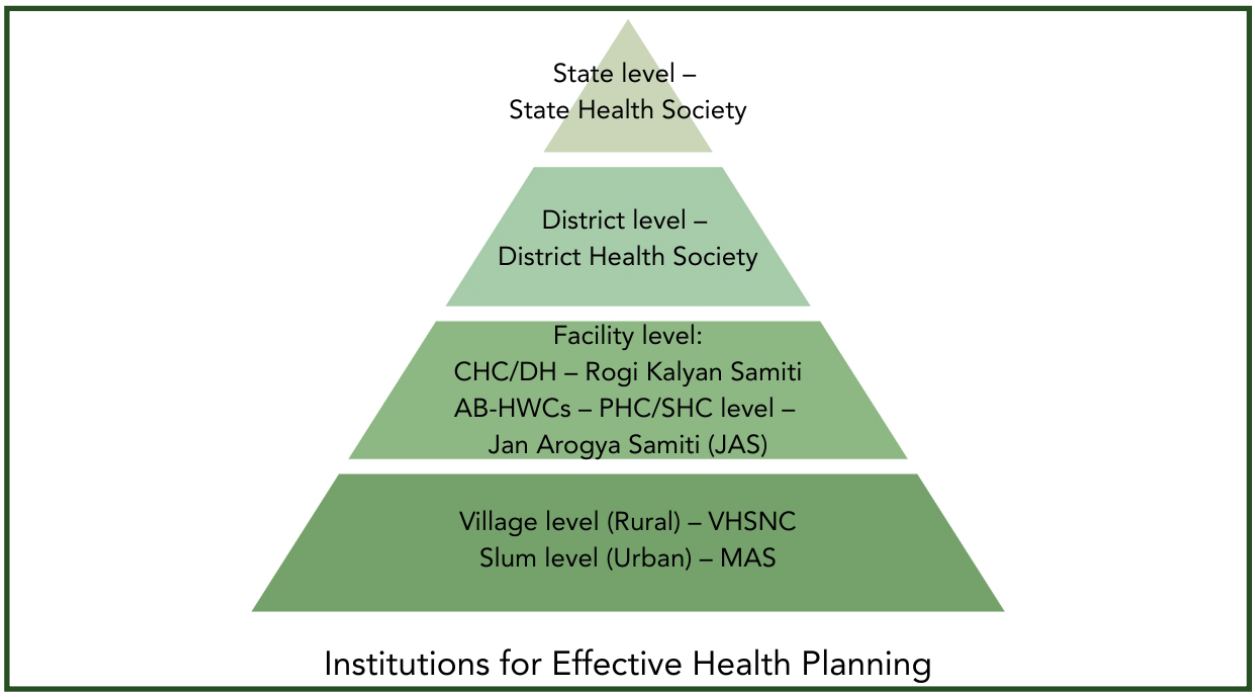
With the launch of Ayushman Bharat, Primary Health Centres (PHCs) are also being upgraded as Health and Wellness centres throughout the country. In view of this, Rogi Kalyan Samiti at PHC is being reformed as Jan Arogya Samiti- PHC (JAS-PHC), which will be responsible for monitoring the functioning of Infection control.

At Ayushman Arogya Mandir-Sub Centre (AAM-SC), the infection control, cleanliness and Kayakalp function will be undertaken, reviewed, and monitored by the JAS (Jan Arogya Samiti). The JAS committee at AAM SC is constituted of the Sarpanch, MOPHC, CHO, chairperson of VHSNC, ASHA, ANM, MPW, school health ambassador, president of self-help support group, peer educator and invitee members. (Community Ownership of Health & Wellness Centres-Guidelines for Jan Arogya Samitis-Dec 2020).

JAS will also support AB-HWC team in working with Village Health Sanitation & Nutrition Committees (VHSNCs), for Health Promotion and Action on Social and Environmental Determinants of Health, in community level activities of National Health Programmes and other community interventions.

Community Health Officer (CHO) at AB-HWC, who is responsible for prevention of infectious diseases such as TB, Leprosy, HIV/AIDS, STI/RTIs etc, and conducts monthly VHSNC meetings, will also supervise and monitor infection control activities at AB-HWC.

Figure 14.1: Institutions for Effective Health Planning



This hierarchical system can be utilized for aprropriate AIC IPC activities at all levels of public health system.

14.5 Roles and Responsibilities of different cadres with reference to TB IPC

Please refer to Annexure 11 for details on roles and responsibilities of different cadres with reference to TB IPC

14.6 Documentation requirements for HICC

- Facility infection control plans which are reviewed annually
- Records of implementation (training, surveillance, vaccination, others)
- Risk assessment records
- M & E records
- HICC Meetings documentation (meeting minutes and action taken report)
- Quarterly reports on AIC IPC

Annexures

Annexure 1: Proposed composition of national, state and district level infection control committees

Annexure 2: Ventilation monitoring checklist

Annexure 3a: Details of ACPH calculation

Annexure 3b: ACPH worksheet

Annexure 4: GUV installation and maintenance checklist

Annexure 5: GUV need assessment checklist

Annexure 6a: HCW screening and surveillance for TB disease and TB infection

Annexure 6b: HCW vaccination format

Annexure 7: Facility risk assessment checklist

Annexure 8: Template of HICC meeting minutes

Annexure 9: Quarterly reporting format

Annexure 10: Checklist for program review

Annexure 11: Roles and responsibilities of all cadres of HCWs for AIC-IPC

Annexure 1
Proposed composition of national, state and district level infection control committees

Proposed composition for the National Infection Control Committee (NICC)

1. Chairman: Director General Health Services
2. Members
    - ◊ Executive Director, NHSRC
    - ◊ Joint Director, NCDC
    - ◊ DDG-TB
    - ◊ DDG, Care, Support and Treatment, NACO
    - ◊ Regional / Divisional Dy. Directors
    - ◊ Chairperson, National Task Force for Medical Colleges
    - ◊ Architects and Engineers from PWD and Central Design Bureau
    - ◊ Director General, Nursing Administration and Training
    - ◊ Representative of IMA (National Body)
    - ◊ National NTEP / NACP Consultants
    - ◊ NGO / CBO

Proposed composition for the State Infection Control Committee (SICC)

1. Chairman: Secretary, Health
2. Vice Chairman:
    - ◊ Mission Director, National Rural Health Mission
3. Member Secretary
    - ◊ Director Health Services
4. Members
    - ◊ Director Medical Education
    - ◊ Director, SHSRC
    - ◊ Joint Director, Hospital and administration (Nodal Officer)
    - ◊ Regional / Divisional Dy. Directors
    - ◊ Joint Director, Care, Support and Treatment, SACS
    - ◊ State TB Officer
    - ◊ Chairperson, State Task Force for Medical Colleges
    - ◊ Architects and Engineers from State PWD
    - ◊ Director, Nursing Administration and Training

- ◊ Representative of State Pollution Control Board
- ◊ Representative of IMA (State Body)
- ◊ State NTEP / NACP Consultants
- ◊ NGO / CBO

Proposed sub-Committee on Biomedical Waste Management / Infection Control (BMW / IC) under the District Health Society (DHS)

1. District Magistrate
2. Civil Surgeon / CMHO (Nodal Officer)
3. District Health Officer
4. District TB Officer

The following additional members also may be considered:

- ◊ DACS (wherever applicable) / DAPCU Nodal Officer / DNO AIDS
- ◊ Dean / MS, Medical College / District Hospital
- ◊ STF Member / IRL Microbiologist / Chairperson DP Site Committee (where applicable)
- ◊ Director, Nursing Administration and Training or equivalent
- ◊ Representative of Pollution Control Board Office at the district
- ◊ Representative of IMA (Local Body) / NGO / CBO

Annexure 2: Ventilation Monitoring Checklist

Name of facility……

Ventilation monitoring chart for the month of……..

8:00 AM

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Windows and doors Open																															
Fans turned on																															
Exhausts turned on																															
GUV turned on																															

Annexure 2: Ventilation Monitoring Checklist

2:00 PM

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Windows and doors Open																															
Fans turned on																															
Exhausts turned on																															
GUV turned on																															

Annexure 2: Ventilation Monitoring Checklist

8:00 PM

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Windows and doors Open																															
Fans turned on																															
Exhausts turned on																															
GUV turned on																															

ACPH: Date and time……

(To be done once in a quarter/ change of seasons/infrastructure modification)

Annexure 3a
Details of ACPH Calculation

Site Name: .....

Within Site, Facility name: .....

	Enter Values	supply inlet Window 1/Door1	supply inlet Window 2/Door2	supply inlet window 3/Door3	supply inlet window 4/Door 4	supply inlet window 5/Door 5	supply inlet window 6/Door 6
1	H: Height of supply window/ door (ft)						
2	W: Width of supply window/ door (ft)						
3	A: Area of supply window/ door (Sq ft) [Height*Width]						
4	V_1: Air velocity at Location 1(ft/min)						
5	V_2: Air velocity at Location 2 (ft/min)						
6	V_3: Air velocity at Location 3 (ft/min)						
7	V_4: Air velocity at Location 4 (ft/min)						
8	V_5: Air velocity at Location 5 (ft/min)						
9	Length of room (ft)						
10	Height of room (ft)						
11	Breadth of room (ft)						

Steps for calculation of ACPH:

Step 1: Identify from which Door or Window air comes in the room (Source of inlet) using a Vaneometer (instrument to check the airflow direction).

Step 2: Now calculate the area of the door or window by multiplying the length and width of the open portion of the identified (supply) door or window in feet.

$A_1 = H_1 x W_1$; $A_2 = H_2 x W_2$; $A_3 = H_3 x W_3$… and so on

H- Height of door or window, W- width of the door or window.

Step 3: Calculate the air velocity in feet per minute blowing through the door or window using an anemometer (instrument to measure velocity of air). Take 5 readings (four corners and the center of the door or window) and calculate the average of the five readings).

$V(1)_{avg.} = (V_{11}+V_{12}+V_{13}+V_{14}+V_{15})/5$ [where, Vn is the velocity observed at each point; $V(1)_{avg}$ Average air velocity in feet per minute across 1st window/door.

Similarly repeat the step 2 to take readings of average velocity across each supply door or window (for example :$V(2)_{avg.} = (V_{21}+V_{22}+V_{23}+V_{24}+V_{25})/5$; and so on…..

(where, $V(n)_{avg}$ Average air velocity in feet per minute across each window/door).

Steps 4: Calculate the volumetric airflow [$Q_{(n)}$] from each window/ door by the following formula: $Q_1 = A_1 \times V(1)_{avg}$; $Q_2 = A_2 \times V(2)_{avg}$; $Q_3 = A_3 \times V(3)_{avg}$….and so on

where, $A_{(n)}$= Area of door/ window in square feet, V(n)avg= Average air velocity in feet per minute across each door/ window.

Step 5: Calculate the total Volumetric airflow coming into the room by the following formula: Q= Q1 + Q2 + Q3 + Q4… and so on

Steps 6: Calculate the total room volume by multiplying the length, width, and height of the room in feet.

Volume of room- LxWxH

Steps 7: Calculate the air change per hour using the following formula:

Air change per hour (ACPH) = Q x 60/volume of room

Where, 60 is multiplying factor to convert minutes to hour.

Note: If length is measured in meters and velocity is measured in meter/ sec then formula for ACPH

ACPH= Q x 3600/ Volume. (3600 is multiplying factor to convert sec to hour)

Annexure 3b
ACPH worksheet

Site Name: .....

Within Site, Facility name: .....

	ACPH calculator	Natural Ventilation			
	Enter Values	**supply inlet Window 1/ Door1**	**supply inlet Window 2/ Door2**	**supply inlet window 3/ Door3**	**supply inlet window 4/ Door 4**
1	H: Height of supply window/ door (ft)				
2	W: Width of supply window/ door (ft)				
3	A: Area of supply window/ door (Sq ft)				
4	V_1: Air velocity at Location 1 (ft/min)				
5	V_2: Air velocity at Location 2 (ft/min)				
6	V_3: Air velocity at Location 3 (ft/min)				
7	V_4: Air velocity at Location 4 (ft/min)				
8	V_5: Air velocity at Location 5 (ft/min)				
9	Average air velocity (ft/min) for supply window/ door				
10	Average air velocity (ft/hr) for supply window/ door				
11	Air flow rate= Area of window × Average air velocity				
12	Total Air flow rate (all inflow)				
13	Length of room (ft)				
14	Height of room (ft)				
15	Breadth of room (ft)				

16	Room Volume (cubic feet)				
17	ACPH = Air flow rate/ Room voulme				

ACPH calculation step in General (Natural):

Step 1: V(Average) = (V1 + V2 + V3 + V4 + V5) / 5

V is the velocity observed at each point. (Door or window) from Air is coming in.

Step 2: Now calculate the area of Door or window by multiplying the length and width of the Door or window in the feet.

A = L x W
L - Length of Door or window, W - width of the Door or window

Step 3: Calculate the total air volume per minute supplied in the cleanroom by the following formula:
Q = A x V

whereas A = Area of Door or window in square feet,
V = Average air velocity in feet per minute

Step 4: Calculate the total room volume by multiplying the length, width, and height of the room in feet.

Volume = L x W x H

Step 5: Calculate the air change per hour using the following formula:

Air change per hour (ACPH) = Q x 60 / Volume

Annexure 4
GUV installation and maintenance checklist

Upper room GUV Installation report and checklist			
Name of Site:		Supplier details:	
Address:			
Contact Person:			
Contact Number:			
Equipment Details			
Make		Date of installation:	
Model			
Sr. No.		Name of Engineer:	
Installation Location			
Fixture Type		Contact No:	
Wattage of UV Lamp			
UVC output of GUV Fixture			

Master Instruments used for Installation			
Multimeter Make:		Radiometer Make:	
Model:		Model:	
Sr. No:		Sr. No:	
Voltage readings	P-N: _____ N-E: _____ P-E: _____	Calibration certificate no:	
Installation Height			
Room Height			

Checkpoint	Yes	No	Checkpoint	Yes	No
Physical damage to UV lamp			Whether Safety and operational training to user conducted		
Physical Damage to Fixture			Submission of Manufacturer catalogues, Test certificates etc.		

Provision of dedicated on/ off switch (the same area below the Upper room GUV fixtures)			Any obstructions in the kill zone		

Test performed (Checkpoint)	Yes	No	Observed parameters/ Values	Pass / Fail	Acceptable Tolerance Range
Upper room UVC^{254} fixture efficacy assessment					Irradiance will be measured in the upper killing zone at 1meter distance from the fixture along the center line and must meet the manufacturer's claims of minimum irradiance at this location (µW/cm2). Slowly moving detector up and down, side to side, monitor UVC irradiance shown on a meter display, and find the highest (peak) irradiance value in µW/ cm2 received and record it. - Variation acceptable is ± 20% with the manufacturer claim test report submitted in the technical proposal
Upper room UVC^{254} safety assessment (Safety Test)					The maximum effective irradiance at eye level {~ 6ft (183 cm) height, ~ 4ft (122 cm) height and ~ 3ft (92 cm) height to correspond to the eye levels at standing, sitting and pillow levels respectively} measured by a calibrated radiometer from ground level. - Eye safety measurement with FOV cone should not exceed 0.2 µW/cm2. - Skin safety measurement without FOV cone should not exceed 0.35 µW/cm2. Note: In any case, it should not exceed the threshold limit value (TLV) for UVC254 exposure.
Observation/ Recommendation by Engineer Sign & stamp of Agency					

Observation/ Recommendation by Authorized signatory Sign & stamp of Institute

GUV Device Quarterly Maintenance Report /Checklist			
Name of Site:		Supplier details:	
Address:			
Contact Person:			
Contact Number:			
Equipment Details			
Make		Date of installation:	
Model			
Sr. No.		Name of Engineer:	
Installation Location			
Fixture Type		Contact No:	
Wattage of UV Lamp			
UVC output of GUV Fixture			

Checkpoint	Yes	No	Checkpoint	Yes	No
Physical damage to UV lamp			Whether Safety and operational training to user		
Physical Damage to Fixture			Submission of Manufacturer catalogues, Test certificates etc.		
Provision of dedicated on/Off switch (the same area below the Upper room GUV fixtures)			Any obstructions in the Kill zone		
Observation/ Recommendation by Engineer Sign & stamp of Agency					
Observation/ Recommendation by Authorized signatory Sign & stamp of Institute					

GUV Device Half Yearly PM Report /Checklist

Name of Site:		Supplier details:	
Address:			
Contact Person:			
Contact Number:			
Equipment Details			
Make		Date of installation:	
Model			
Sr. No.		Name of Engineer:	
Installation Location			
Fixture Type		Contact No:	
Wattage of UV Lamp			
UVC output of GUV Fixture			

Master Instruments used for Installation			
Multimeter Make:		Radiometer Make:	
Model:		Model:	
Sr. No:		Sr. No:	
Voltage readings	P-N: _____ N-E: _____ P-E: _____	Calibration certificate no:	

Checkpoint	Yes	No	Checkpoint	Yes	No
Physical damage to UV lamp			Whether Safety and operational training to user		
Physical Damage to Fixture			Submission of Manufacturer catalogues, Test certificates etc.		
Provision of dedicated on/Off switch (the same area below the Upper room GUV fixtures)			Any obstructions in the Kill zone		

Test performed (Checkpoint)	Yes	No	Observed parameters/ Values	Pass / Fail	Acceptable Tolerance Range
Upper room UVC fixture efficacy assessment					Irradiance will be measured in the upper killing zone at 1meter distance from the fixture along the center line and must meet the manufacturer's claims of minimum irradiance at this location (µW/cm2). Slowly moving detector up and down, side to side, monitor UVC irradiance shown on a meter display, and find the highest (peak) irradiance value in µW/cm2 received and record it into the attached log table. If recorded irradiance value is substantially lower than previously recorded one (or than manufacturers reference value for the model), repeat measurement after thorough cleaning of the fixture lamp and reflector. If even after cleaning irradiance remains below 70% of the reference value for the model, the fixture should be re-lamped.
Upper room UVC safety assessment (Safety Test)					The maximum effective irradiance at eye level {~ 6ft (183 cm) height, ~ 4ft (122 cm) height and ~ 3ft (92 cm) height to correspond to the eye levels at standing, sitting and pillow levels respectively} measured by a calibrated radiometer from ground level.
					- Eye safety measurement with FOV cone should not exceed 0.2 µW/cm2. - Skin safety measurement without FOV cone should not exceed 0.35 µW/cm2. Note: In any case, it should not exceed the threshold limit value (TLV) for UVC254 exposure.

Observation/ Recommendation by Engineer Sign & stamp of Agency
Observation/ Recommendation by Authorized signatory Sign & stamp of Institute

GUV Device Half Yearly PM Report /Checklist			
Name of Site:		Supplier details:	
Address:			
Contact Person:			
Contact Number:			
Equipment Details			
Make		Date of installation:	
Model			
Sr. No.		Name of Engineer:	
Installation Location			
Fixture Type		Contact No:	
Wattage of UV Lamp			
UVC output of GUV Fixture			

Master Instruments used for Installation			
Multimeter Make:		Radiometer Make:	
Model:		Model:	
Sr. No:		Sr. No:	
Calibration certificate no:			

Voltage readings	P-N: _____ N-E: _____ P-E: _____	Calibration certificate no:	

Checkpoint	Yes	No	Checkpoint	Yes	No
Physical damage to UV lamp			Whether Safety and operational training to user		
Physical Damage to Fixture			Submission of Manufacturer catalogues, Test certificates etc.		
Provision of dedicated on/Off switch (the same area below the Upper room GUV fixtures)			Any obstructions in the Kill zone		

Test performed (Checkpoint)	Yes	No	Observed parameters/ Values	Pass / Fail	Acceptable Tolerance Range
Upper room UVC fixture efficacy assessment					Irradiance will be measured in the upper killing zone at 1meter distance from the fixture along the center line and must meet the manufacturer's claims of minimum irradiance at this location (μW/cm2). Slowly moving detector up and down, side to side, monitor UVC irradiance shown on a meter display, and find the highest (peak) irradiance value in μW/cm2 received and record it into the attached log table. If recorded irradiance value
					is substantially lower than previously recorded one (or than manufacturers reference value for the model), repeat measurement after thorough cleaning of the fixture lamp and reflector. If even after cleaning irradiance remains below 70% of the reference value for the model, the fixture should be re-lamped.

Upper room UVC safety assessment (Safety Test)					The maximum effective irradiance at eye level {~ 6ft (183 cm) height, ~ 4ft (122 cm) height and ~ 3ft (92 cm) height to correspond to the eye levels at standing, sitting and pillow levels respectively} measured by a calibrated radiometer from ground level. - Eye safety measurement with FOV cone should not exceed 0.2 µW/cm2. - Skin safety measurement without FOV cone should not exceed 0.35 µW/cm2. Note: In any case, it should not exceed the threshold limit value (TLV) for UVC254 exposure.
Observation/ Recommendation by Engineer Sign & stamp of Agency					
Observation/ Recommendation by Authorized signatory Sign & stamp of Institute					

Annexure 5
GUV need assessment checklist

Parameter	Value
ACPH (in different seasons, different times of the day	<12 (or <6) (any season/ any given time) * Refer to guidelines for ACPH requirements for different areas
Can minor civil work increase ACPH	No
Height of the room	>9 ft (>2.4 m) If the room height is > 3m, consider alternate types of GUV fixtures
Options for air mixing (fans, exhausts) available	Yes
Reflective surfaces/ pillars	No
Footfall/bed occupancy	Subjective, should be sufficient to justify installation
HR availability for training and maintenance	Yes
Management commitment for initial expenses (purchase, shipping, acceptance testing) and recurring costs (lamp changes, scheduled maintenance, electricity and radiometer calibrations)	Yes

Annexure 6a
HCW screening and surveillance for TB disease and TB infection

Name of hospital	
Name of HCW	
Age	
Date of entry into service	
Designation	

Date	
NIKSHAY ID	
Type of screening (entry/biannual/ annual)	
Symptom screening result	
CXR result	
Previous history of TB treatment	
EPTB (Site)	
Sputum/ sample NAAT result	
C & DST result	
Treatment initiation date	
Details of treatment	
Treatment completed date	
Sputum result at the end of treatment	
Outcome of treatment with date	
IGRA/CyTB	
TPT start	
TPT completed	
Any remarks	

Annexure 6b
HCW vaccination format

Name of staff	
Date of joining	
Designation	

	Date
Hep B 1st dose	
Hep B 2nd dose	
Hep B 3rd dose	
Anti HBs Ab titer(mIU/mL)	
Influenza	
Varicella	
Tetanus	
COVID-1	
COVID-2	
COVID-3	
Others	
1.	
2.	

Annexure 7
Facility risk assessment checklist

(A) Institute level Information:	
Name of the Institution:	
Name of the Assessor:	
Designation of the Assessor:	
Type of the Section (Registration area/OPD/Ward/DSTB Ward/ DRTB Ward/Radiology/Central Lab/TB Lab/Bronchoscopy/ICU/ ART centre/ Others, specify):	
Name of the Section:	
Date of the Assessment:	
Time of the Assessment:	
Quarter & Year of the Assessment:	
Workload of respective section assessed (OPD, Registration, Bed Occupancy, # Lab Investigations, # Procedures, # X-ray/ USG)	

(B) Measures for crowd management:	Response	Remarks
Is segregation of cough symptomatics done?		
Is fast tracking mechanism for cough symptomatics implemented?		
Is there a Public Announcement System?		
Is there a Token System available?		
Is there adequate waiting area space to manage peak hours?		
Is entry of relatives restricted to visiting hours?		

(C) Respiratory Protection	Response	Remarks
Are FFP2/N95/medical masks available for staff?		
Are Health care workers (HCWs) appropriately using respiratory protection?		
Are medical masks provided to patients?		
Are patients being educated by HCW in proper usage of respiratory protection?		
Are the patients using the respiratory protection appropriately?		

(D) Sanitation & General Cleanliness	Response	Remarks
Is use of brooms avoided?		
Is the floor cleaned using correct dilution of phenol/ hypochlorite/quaternary ammonium compounds?		
Is "triple bucket system" used for cleaning the floor?		
Do window grills, bedside racks, IV stands, tables, chairs, equipment, and workstations undergo surface cleaning with appropriate disinfectant as per guidelines?		

(E) Bio-Medical Waste Management	Response	Remarks
Are there colour coded bins and bags available?		
Is there buffer stock of colour coded bags?		
Is biomedical waste segregated appropriately at the source of generation?		
Is bar-coding being done?		
Are waste handlers using PPE (boots, heavy duty gloves, aprons, masks)?		

(F) IPC/ WASH Measures:	Response	Remarks
Is provision for hand washing with running water & soap available?		
Is alcohol-based handrub (sanitizer) available?		
Are patients in the wards using spittoons with lid and 5% phenol?		
Is 6 feet distance maintained between two adjacent beds in wards?		
Is the bed linen (pillow cover & bed sheet) in wards changed on daily basis?		
Is spill kit available?		
Are the bronchoscopes disinfected appropriately?		

(G) Measures for maintaining Adequate Ventilation:	Response	Remarks
Is the window + door area >/= to 20% of the floor area?		
What is the calculated ACPH for the assessed setting? (N)		
Is the air flow unobstructed with any furniture or closed windows/ doors?		

Is the direction of airflow in the high-risk setting flowing from clean to unclean area and to open space (check using vaneometer/incense stick)?		
Does the section assessed require any mechanical ventilation to enhance air changes per hours (ACPH)?		
If the upper room germicidal ultraviolet (GUV) fixtures are present, are they maintained appropriately as per the guidelines?		
Is there a designated sputum collection area (open space or ACPH>20) for patients to collect sample?		

(H) Information, Education, Communication (IEC) Material/ Signages:	Response	Remarks
Is IEC material/ signage available on:		
o Biomedical Waste Management		
o Cough etiquette		
o Hand hygiene		
Is audio/visual available for patient education?		

(I) Healthcare Worker Safety and Surveillence	Response	Remarks
Have all the new staff been screened at entry level?		
Have the old staff been screened in the past 6 months?		
Have adequate follow up actions been taken? Treatment, IGRA, TPT?		

(J) Training	Response	Remarks
Have all the staff been trained in aspects of AIC-IPC in the quarter?		
Are records available for review?		

Summary of Observations:

Measures to be undertaken:

Signature of the Assessor

Annexure 8
Template for HICC minutes of meeting

Letter Head of the Institute

Minutes of Meeting (MoM) of HICC

Date: **Reporting Quarter & Year:**

Name of Attendees:

Sr No	Name	Designation	Designation in committee	Signature

Compliance of previous action points:

Date of last meeting:

Sr No	Action points from previous meetings	Compliance details

Discussion and action points

Sr No	Thematic area	Observations	Action points	Responsibility and timeline
1	Periodic risk assessment done or not			
2	Documented infection control Plan			
3	HAI surveillance			
4	AMR and Antibiotic policy			

5	Microbiological surveillance			
6	Measures of crowd management			
7	Respiratory Protection			
8	Sanitation and General Cleanliness			
9	BMWM			
10	WASH measures			
11	Measures for maintaining adequate ventilation			
12	GUV installation and maintenance			
13	IEC material / Signages			
14	HCW safety and surveillance (including vaccination)			
15	HCW training			
16	Budget availability for AIC-IPC			

Any other points:

Annexure 9
Quarterly reporting format

Facility AIC-IPC Quarterly Report

State :

District :

Name of the Institution :

Reporting quarter :

Date of report :

S.No	Indicators	Response
1a	Number of the sections* to be assessed for AIC & IPC (N)	
1b	Number of the sections assessed for AIC & IPC in the quarter (N)	
1c	Number of the sections assessed complying with adequate ventilation (N)	
2a	Number of respiratory symptomatic registered in the quarter (N)	
2b	Average daily bed occupancy of the DRTB wards in the quarter (%)	
3a	Is the Hospital infection control committee (HICC) constituted? (Yes / No)	
3b	Date of HICC meeting conducted in the quarter (with minutes available) (DD/MM/YYYY)	
3c	Is adequate budget available with HICC to conduct AIC activities? (Yes / No)	
3d	Is there documented facility infection control plan? (Yes / No)	
4a	Total number of beds available in the institute (N)	
4b	Total number of Infection Control Nurses (ICNs) available in the institute (N)	
5a	Total number of HCWs in the Institute (including Regular, Contractual & Outsourced) (N)	
5b	Number of HCWs trained in AIC-IPC in the quarter (N)	
5c	Number of HCWs screened for TB disease in the quarter (N)	
5d	Number of HCWs diagnosed with TB in the quarter (N)	
5e	Number of HCWs Vaccinated in last quarter	
5f	Number of HCWs tested for TB infection: (2)	
5g	Positive TB infection amongst HCW in last quarter	

5h	Number of HCWs put on TPT after ruling out active TB	
6a	Is there a valid MoU with agency for Bio-Medical waste management (BMWM) (Yes / No)	
6b	Is there a barcode system used for BMW (Yes / No)	
7a	Is segregation and fast-tracking for cough symptomatics implemented? (Yes / No)	
7b	Write if any, innovative ideas implemented for crowd management (Describe)	
8	Are respirators and medical masks available for staff and patients? (Yes / No)	
9	Is "triple bucket system" for floor cleaning implemented by institute? (Yes / No)	
10	Is patient education material on cough etiquette displayed in all relevant sections of the institute? (Yes / No)	
11	If upper room Germicidal ulraviolet (GUV) is installed in any section are all units functional with AMC /CMC in place? (Yes / No / NA)	

* Minimum sections to be assessed – Registration; Pulmonary Medicine OPD; TB OPD; All DRTB wards; All DSTB wards; TB Laboratory; Bronchoscopy; Radiology waiting area

Submitted by: Member Secretary, HICC

Annexure 10

Checklist for periodic program review

During routine visits of state/ district officials for program review, AIC-IPC activities may also be checked.

Check points	Compliant- Yes/ No
Is HICC functional and meeting regularly with participation of TB focal person?	
Are AIC related topics being discussed in HICC meetings?	
Are corrective actions of gaps of risk assessments being carried out adequately and in timely manner?	
Are there any requirements for civil work to enhance ventilation?	
Is sufficient budget allocated for AIC-IPC activities?	
Cross validates the quarterly report submitted by the institute	

Annexure 11
Roles and responsibilities of different cadres of healthcare workers for implementing AIC-IPC in TB settings

Both institutional staff under the respective state/municipal health departments as well as staff from the National Tuberculosis Elimination Program (NTEP) are to be equally invested in the prevention and transmission of TB infection. To this end, this document defines the roles and responsibilities of different cadres towards this end.

Institution Level staff

1. Dean/ Medical Superintendent/ Head of Institution

- Overall, in-charge of AIC and IPC activities of the institute
- Ensure HICC is in place, functional and meets regularly.
- Ensure the member secretary of DR TB committee is a member of HICC
- Enable administrative, environmental controls and respiratory protection
- Enable a budget head for AIC and IPC activities including adequate supplies and GUV maintenance
- Approve and review policies and guidelines for IPC.
- Coordinating with other government agencies to enabling optimum environmental controls
- Ensure periodic AIC and IPC risk assessments within the institute.
- Share minutes of HICC meetings and Quarterly Report on AIC-IPC with the health system (as explained in the Monitoring and Evaluation Chapter)

2. Member secretary of HICC (Infection Control Officer)

- Monitoring day-to-day AIC and IPC activities.
- Develop policies, guidelines and standard operating procedures (SOPs) on AIC-IPC (Facility Infection Control Plan) in collaboration with other members of the HICC and the IPC team. Administrative, Environmental and Respiratory protection plans should be detailed out with policy and procedures.
- Initiate and maintain activities for TB surveillance (Disease and infection) and upload in Ni-Kshay portal
- Advise staff on all aspects of IPC and AIC and maintain a safe environment for patients and staff.
- Oversee sterilization and disinfection particularly with reference to AIC.

- Oversee monitoring of ventilation
- Conduct regular airflow audits, particularly in areas of mechanized ventilation
- Investigate outbreaks and advise on control measures and isolation procedures.
- Organize and conduct regular IPC educational and training activities for HCWs.
- Audit infection control procedures, worker safety and antimicrobial usage: Risk Assessments
- Organize regular HICC meetings and implement the suggested action points from risk assessment and HICC meeting
- Prepare minutes of the meeting and the quarterly reports for sharing with the program

3. DR TB Nodal Officer

- Implement the AIC and IPC activities in the TB wards and OPDs
- Ensure the periodic risk assessment in TB wards and OPDs
- Implement the suggested action points from risk assessment and HICC meeting
- Maintain adequate supplies for AIC and IPC.
- Ensure quarterly reporting to district and state, in consensus with the HICC
- Ensure adequate ventilation in TB wards & OPDs.

4. Engineers and Facility or building maintenance committee or agency

- Ensure regular building maintenance including plumbing, heating, refrigeration equipment, electrical fittings, heating ventilation and air-conditioning systems (HVAC) and high-efficiency particulate air (HEPA) filters, and record-keeping of the same.
- Collaborate with the HICC, housekeeping, nursing staff or other appropriate groups in selecting equipment and ensuring their uninterrupted operation. E.g., GUV, HVAC
- Ensure environmental safety of the community from hospital activities such as waste disposal and protection of water sources.
- Participate in the choice of equipment, if maintenance of the equipment requires technical assistance.
- Inspect, clean and regularly replace filters of all appliances for ventilation and humidifiers; records to be shared with the HICC.
- Regularly inspect all surfaces of walls, floors, ceilings to ensure they are kept smooth and washable and monitor repairs of any opening or crack in partition walls or window frames.
- Measure ACPH in high risk areas, periodically using the equipment provided. Ensure proper calibration and use of these.

5. Hospital Manager/Quality Manager

- The Hospital Manager/Quality Manager is responsible for assisting the ICO in all his/her functions

6. Infection Control Nurses

- Implement infection control with special reference to AIC-IPC activities as directed by the facility infection control plan.
- Document all activities in formats approved by the HICC.
- Ensure adequate ventilation for satisfactory ACPH (day, night, cold climates, warm climates, monsoons)
- Monitor GUVs
- Ensure adequate sanitation and BMW Management
- Daily checklist for AIC along with BMWM checklist
- Conduct/assist in the periodic risk assessment.
- Assist in monitoring the activities assigned to the outsourced agencies.
- Conduct training of all cadres of nurses, class 3 and class 4 staff
- Facilitate HCW surveillance and vaccination program
- Implement the suggested action points from risk assessment and HICC meeting
- Ensure all staff are wearing particulate respirators.
- Ensure seal check of the respirators
- Ensure that all patients are wearing medical masks

7. Doctors, PGs, Residents:

- Facilitate and implement infection control with special reference to AIC-IPC activities as directed by the facility infection control plan.
- Implement fast tracking of cough symptomatic patients.
- Early diagnosis and initiation of treatment.
- Implement hand hygiene, respiratory hygiene, promote ventilation and patient education.

8. Staff Nurse (Nursing Officer)

- Implement facility infection control plan including AIC- IPC activities.
- Provide education/counseling to the patient and family on cough hygiene and sputum disposal.
- Distribution of masks.
- Segregation and fast tracking of cough symptomatic patients in the OPDs.
- Supervise and monitor
    - ◊ Ventilation
    - ◊ Floor and surface disinfection
    - ◊ Bio-medical waste management

9. Paramedics Class 3 (Lab technicians, radiographers, pharmacists, counselors)

- Participate in the AIC- IPC activities through ensuring sanitation, hand hygiene, ventilation, BMWM in their assigned areas of work.
- Participating in patient education activities
- Additionally, lab technicians to comply with national guidelines in activities like handling and disposal of sputum and body fluids, and disinfection of workstations

10. Paramedics class 4 (Sweepers, dressers, janitors and security guards)

- Carry out crowd management, visitor entry restriction
- Carry out housekeeping activities of sanitation and disinfection (environment, wards, windows, floors, surfaces, fans and fixtures, spittoons)
- Do collection, internal transportation and storage of Biomedical waste, as per guidelines
- Preparation of appropriate dilution of disinfectants
- Handling of linen as per the guidelines
- Assist in AIC- IPC activities including maintenance of ventilation in wards and OPDs

NTEP Staff

1. State TB Officer (STO)

- Disseminate guidelines regarding AIC-IPC.
- Coordinate at state level for conduct trainings for creating pool of Master trainers on AIC-IPC
- Monitor districts for HCW surveillance and vaccination of NTEP staff.
- Ensure that NTEP staff attend all relevant training organized by HICC/hospital
- Ensure that the reporting mechanism as defined in the M&E structure is effectively implemented.
- Coordinate through the State Quality Assurance committee for review of minutes of HICC meetings and Quarterly reports on AIC-IPC

2. District TB Officer (DTO)

- Coordination with District quality assurance committee for overseeing AIC-IPC activities
- Disseminate guidelines regarding AIC-IPC.
- Ensure HCW surveillance and vaccination of NTEP staff.
- Ensure that NTEP staff attend all relevant training organized by HICC/hospital
- Facilitate quarterly reporting of AIC-IPC and ensure that the reporting mechanism as defined in the M&E structure is effectively implemented
- DTO can be an invitee to the HICC of the institutions where NTEP facilities are collocated under his/her purview.

3. Senior Medical Officer (DR TB Centre)

- Early diagnosis and treatment
- Implement hand hygiene, respiratory hygiene, promote ventilation and patient education
- Assist Nodal DR TB officer in the following:
    - ◊ Implementing the AIC and IPC activities in the TB wards and OPDs
    - ◊ Ensuring the periodic risk assessment in TB wards and OPDs
    - ◊ Implementing the suggested action points from risk assessment and HICC meeting
    - ◊ Maintaining adequate supplies for AIC and IPC.
    - ◊ Ensuring adequate ventilation in TB wards & OPDs.

4. Medical Officer (Treatment Centre)

- Early diagnosis and initiation of treatment
- Implement hand hygiene, respiratory hygiene, promote ventilation
- Support in implementing the AIC and IPC activities in the TB wards and OPDs
- Provide education/counseling to the patient and family on cough hygiene and sputum disposal.

5. DR TB Counsellor

- Ensure education and counseling of DR TB patient and family
- Supervise the compliance of AIC-IPC related activities at Nodal DR TB center.
- Counsels the patient on,
    - ◊ Sputum disposal
    - ◊ Precautions to control transmission (Cough etiquette, masks, use of spittoons, etc.)
- Monitor nutrition in DR TB patients

6. PMDT DRTB HIV Coordinator

- Ensure patient education
- Support TB IPC implementation in the pharmacy, wards and OPDs
- Supervise the follow up of TB IPC related activities at home
    - ◊ Ventilation
    - ◊ Sputum disposal
    - ◊ Precautions to control transmission (Cough etiquette, masks, use of spittoons, etc.)

7. Senior Treatment Supervisor

- Ensure early initiation and compliance for regular treatment
- Patient education
- Guide AIC-IPC implementation in the pharmacy

- Supervise the follow up of TB IPC related activities at home
    - ◊ Ventilation
    - ◊ Sputum disposal
    - ◊ Precautions to control transmission (Cough etiquette, masks, use of spittoons, etc.)

8. Senior TB Lab Supervisor: STLS

- Monitor the lab technicians of all labs under their purview for compliance with the TB IPC program including sample collection, processing and transport.
- Participate in training, HCW surveillance and vaccination programs
- Implement hand hygiene, respiratory hygiene, promote ventilation
- Support in BMWM in lab

9. TB Health Visitor (TBHV)

- Ensure education for TB patient and family
- Implement hand hygiene, respiratory hygiene, promote ventilation
- Supervise the follow up of AIC related activities at home
    - ◊ Ventilation
    - ◊ Sputum disposal
    - ◊ Precautions to control transmission (Cough etiquette, masks, use of spittoons, etc.)
- Monitor nutrition in TB patients

Central TB Division
Ministry of Health and Family Welfare
New Delhi - 110001
https://tbcindia.mohfw.gov.in/