

Isolation, Standard precautions, Airborne Infection Isolation Rooms (AIIR)

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Isolation

- The purpose of isolation is to prevent the transmission of microorganisms from infected or colonized patients to other patients, hospital visitors, and health care workers, who may subsequently transmit them to other patients or become infected or colonized themselves.

Pros and Cons

- Because patient isolation is expensive, time consuming, and uncomfortable for patients, impedes care, and generates large volumes of trash because of the use of disposable products, it should be **implemented only when necessary**.
- Conversely, failure to isolate a patient with a transmissible disease may lead to morbidity and mortality and may ultimately be expensive when one considers the direct costs of an investigation of an outbreak and excess length of stay and the indirect costs of lost productivity.

- In 2007, the CDC and the Healthcare Infection Control Practices Advisory Committee issued a revision of the recommended guidelines for isolation.

- These guidelines outlined a two-tiered approach:
 - **standard precautions**, which apply to all patients, and
 - **transmission-based precautions**, which apply to patients with documented or suspected infection or colonization with certain microorganisms.

Standard precautions

- Standard precautions are based on **the assumption that any patient may potentially be colonized or infected with organisms that are transmissible.**
- Therefore, standard precautions apply ***to all patients, in all settings, at all times.***
- The essential elements of standard precautions are **hand hygiene, personal protective equipment** (gowns, gloves, masks, and eye protection), and **safe needle practices.**

Hand Hygiene

- Because most HAIs are transmitted by contact, primarily via the hands of health care workers, hand hygiene remains **the single most important means** to prevent transmission of nosocomial pathogens.

- Compliance by health care workers remains **suboptimal** although improving through numerous efforts.

- The microorganisms on hands can be divided into transient flora and resident flora.
- The **resident flora** include organisms of low virulence (*e.g.*, *coagulase-negative staphylococci*, *Micrococcus*, *Corynebacterium*) that are **rarely** transmitted to patients except when introduced by invasive procedures. They are not easily removed through hand washing.
- The **transient flora**, however, are important causes of HAIs. These organisms are acquired primarily by contact, are loosely attached to the skin, and are **easily** washed off.

- In addition, HAIs have been attributed to bacterial contamination of **artificial fingernails**; therefore, health care workers **should not wear** them.

- Alcohol-based hand rubs have become the recommended agents for hand hygiene in the health care setting.
- In situations in which the hands are visibly soiled, washing with soap (antimicrobial or non-antimicrobial) and water is recommended.

- Soap and water is also preferred when caring for patients with **Clostridium difficile infection** (owing to the poor sporicidal activity of alcohols) or **norovirus infection**.

- Hand hygiene should be performed:
 - **before and after** contact with patients,
 - **before any aseptic task,**
 - **after contact with inanimate objects** in the patient's surrounding environment, and
 - immediately **after removing gloves.**

- Technologic interventions to improve hand hygiene compliance include
 - electronic dispensing counters,
 - radiofrequency identification,
 - alcohol vapor detection sensors,
 - videosurveillance

Personal Protective Equipment

Personal Protective Equipment Definition

“specialized clothing or equipment worn by an employee for protection against infectious materials”
(OSHA)

Factors Influencing PPE Selection

- Type of exposure anticipated
 - Splash/spray versus touch
 - Category of isolation precautions
- Durability and appropriateness for the task
- Fit

Types of PPE Used in Healthcare Settings

- Gloves – protect hands
- Gowns/aprons – protect skin and/or clothing
- Masks and respirators– protect mouth/nose
 - Respirators – protect respiratory tract from airborne infectious agents
- Goggles – protect eyes
- Face shields – protect face, mouth, nose, and eyes

Gloves

- Standard precautions stipulate that gloves should be worn to touch any of the following:

blood, all body fluids, secretions, and excretions, except sweat,

regardless of whether they are visibly bloody, nonintact skin, and mucous membranes.

- Gloves should be changed during the care of a patient **when moving from a contaminated body site** (e.g., wound or perineal care) **to a clean body site**.
- However, gloves **do not replace** the need for hand hygiene.

Do's and Don'ts of Glove Use

- Work from “clean to dirty”
- Limit opportunities for “touch contamination” - protect yourself, others, and the environment
 - Don't touch your face or adjust PPE with contaminated gloves
 - Don't touch environmental surfaces except as necessary during patient care

Do's and Don'ts of Glove Use (cont'd)

- Change gloves
 - During use if torn and when heavily soiled (even during use on the same patient)
 - After use on each patient
- Discard in appropriate receptacle
 - Never wash or reuse disposable gloves

- Contamination of the hands can occur with organisms on the surface of the gloves **when they are removed**, and some gloves have **small perforations** that may allow organisms to contaminate the hands.

*Thus, gloves should be viewed as an **adjunctive protective barrier** **but not as a substitute for hand hygiene**, which should be performed immediately after gloves are removed.*

Mask, Gown, Face shield

- For procedures that are likely to generate **splashes or sprays of body fluid, a mask with eye protection or a face shield** to protect the mucosa of the eyes, nose, and mouth, as well as a **gown**, should be worn.

- PPE types for respiratory protection:
 - Particulate respirators
 - Half- or full-face elastomeric respirators
 - Powered air purifying respirators (PAPR)







How to Don a Gown

- Select appropriate type and size
- Opening is in the back
- Secure at neck and waist
- If gown is too small, use two gowns
 - Gown #1 ties in front
 - Gown #2 ties in back



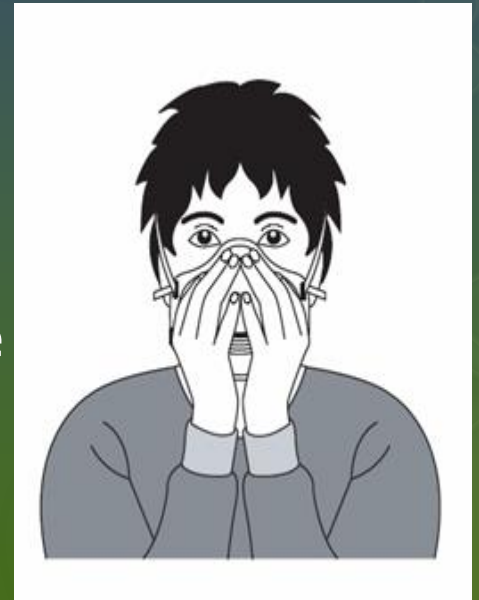
How to Don a Mask

- Place over nose, mouth and chin
- Fit flexible nose piece over nose bridge
- Secure on head with ties or elastic
- Adjust to fit



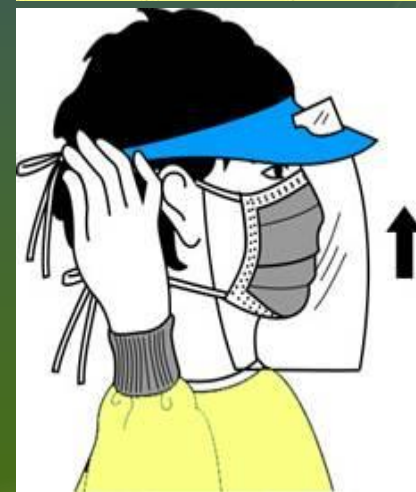
How to Don a Particulate Respirator

- Select a fit tested respirator
- Place over nose, mouth and chin
- Fit flexible nose piece over nose bridge
- Secure on head with elastic
- Adjust to fit
- Perform a fit check –
 - Inhale – respirator should collapse
 - Exhale – check for leakage around face



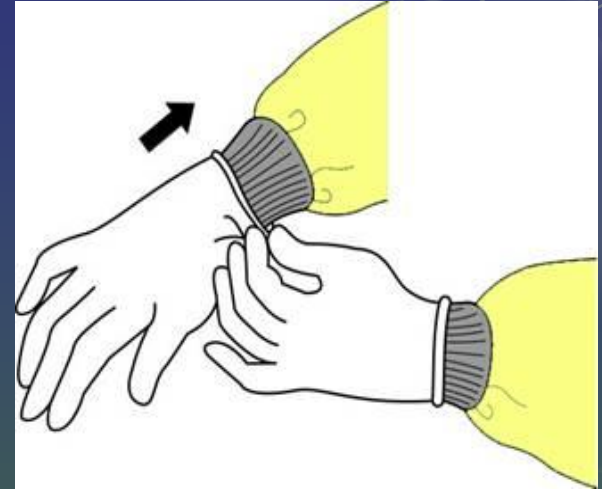
How to Don Eye and Face Protection

- Position goggles over eyes and secure to the head using the ear pieces or headband
- Position face shield over face and secure on brow with headband
- Adjust to fit comfortably



How to Don Gloves

- Don gloves last
- Select correct type and size
- Insert hands into gloves
- Extend gloves over isolation gown cuffs



Sequence* for Donning PPE

- Gown first
- Mask or respirator
- Goggles or face shield
- Gloves

***Combination of PPE will affect sequence – be practical**

“Contaminated” and “Clean” Areas of PPE

- **Contaminated – outside front**
 - Areas of PPE that have or are likely to have been in contact with body sites, materials, or environmental surfaces where the infectious organism may reside
- **Clean – inside, outside back, ties on head and back**
 - Areas of PPE that are not likely to have been in contact with the infectious organism

Sequence for Removing PPE

- Gloves
- Face shield or goggles
- Gown
- Mask or respirator

Where to Remove PPE

- At doorway, before leaving patient room or in anteroom*
- Remove respirator outside room, after door has been closed*

* Ensure that hand hygiene facilities are available at the point needed, e.g., sink or alcohol-based hand rub

Injection Safety

- Needles and syringes should be used **only once** and, when possible, **single-dose medication vials** should be used.
- Single-use vials of medication should not be used for more than one patient, and when possible multiuse vials should be assigned to a single patient.
- Intravenous solution bags should not be used as a common source of supply for more than one patient.
- Needles **should not be recapped, bent, or broken** but should be disposed of in puncture-resistant containers.

Bare Below the Elbows

- For the past several years, the National Health Service in the United Kingdom has mandated a “bare below the elbows” approach to patient care.
- To ensure optimal hand hygiene, this mandate requires that all health care workers wear either **short-sleeved garments or long sleeves that are rolled up**.
- In addition, **wrist watches, bracelets, and rings** with stones are **not** allowed.
- Neckties, if worn, must be kept tucked in.

What Type of PPE Would *You* Wear?

- Giving a bed bath?
 - Generally none
- Suctioning oral secretions?
 - Gloves and mask/goggles or a face shield – sometimes gown
- Transporting a patient in a wheel chair?
 - Generally none required
- Responding to an emergency where blood is spurting?
 - Gloves, fluid-resistant gown, mask/goggles or a face shield
- Drawing blood from a vein?
 - Gloves
- Cleaning an incontinent patient with diarrhea?
 - Gloves w/wo gown
- Irrigating a wound?
 - Gloves, gown, mask/goggles or a face shield
- Taking vital signs?
 - Generally none

TRANSMISSION-BASED PRECAUTIONS

- Three types of transmission-based precautions have been developed for the major modes of transmission of infectious agents in the health care setting:
airborne, droplet, and contact

Air-borne precautions

- Measles
- MERS*
- Monkeypox*
- Tuberculosis, pulmonary, laryngeal; draining lesion (e.g., from osteomyelitis)*
- SARS*
- Smallpox*
- Varicella*
- Zoster (disseminated; immunocompromised patient until dissemination ruled out)*

Thus,

- Vesicular rash*
- Maculopapular rash with cough, coryza, and fever
- Cough, fever, upper lobe pulmonary infiltrate
- Cough, fever, any pulmonary infiltrate in an HIV-infected patient (or at high risk for HIV infection)
- Cough, fever, any pulmonary infiltrate, recent travel to regions with outbreaks of SARS or avian influenza*

Under airborne precautions, patients should be placed in:

- a **private room** with monitored **negative air pressure** in relation to surrounding areas, and
- the room air must undergo **at least 6**, but preferably , exchanges per hour.
- The door to the isolation room must **remain closed**.
- Air from the isolation room should be **exhausted directly to the outside**, away from air intakes, and not recirculated.
- If outdoor exhaust is not possible, air should be exhausted through **high-efficiency particulate filters** before it is returned to the general ventilation system.

- All persons entering the room of patients with suspected or confirmed tuberculosis must wear a personal respirator that filters **1- μ m particles with an efficiency of at least 95% (N95 mask)**.

Droplet precautions

- Droplet precautions are used to prevent transmission by large-particle (droplet) aerosols. Unlike droplet nuclei, droplets are larger, **do not remain suspended in the air, and do not travel long distances.**
- They are produced when the infected patient **talks, coughs, or sneezes and during some procedures** (e.g., suctioning, bronchoscopy).
- A susceptible host may become infected if the infectious droplets land on the **mucosal surfaces** of the nose, mouth, or eye.

- Droplet precautions require patients to be placed in a **private room**, but no special air handling is necessary.
- Alternatively, patients with the same disease can be placed in *the same room with the privacy curtain between beds drawn if a private room is not available*.

- Because droplets do not travel long distances (**usually no more than 3 feet, although occasionally 6 to 10 feet**), the door to the room may remain open.

- Health care workers should **wear a standard surgical mask** when entering the room.
- Gowns and gloves should be worn when dictated by standard precautions.
- When transported out of the isolation room, the patient should be fitted with **a standard surgical mask**.

Adenovirus pneumonia*;
*conjunctivitis**

Diphtheria, pharyngeal
Haemophilus influenzae
meningitis, epiglottitis;
pneumonia (infants,
children)

Influenza

Meningococcal infections

Mumps

Mycoplasma pneumoniae

Pneumonia

Parvovirus B19

Pertussis

Plague, pneumonic

Rhinovirus*

Rubella

SARS*

Streptococcal (group A)
pneumonia; serious invasive
disease; major SSTI;*
pharyngitis, scarlet fever
(infants or young children)

Viral hemorrhagic fevers*

- Although influenza is generally transmitted via **droplets**, on rare occasions airborne transmission can occur.
- Patients with seasonal influenza can generally be managed **under droplet precautions**,
- except when undergoing **aerosol-generating procedures**, such as *bronchoscopy, sputum induction, elective intubation and extubation, and autopsies*, during which management requires airborne precautions.

Thus,

- Meningitis
- Petechial or ecchymotic rash with fever
- Paroxysmal or severe persistent cough during periods of pertussis activity
- Respiratory tract infection in infants and young children*

Contact precautions

- Contact precautions are implemented to prevent the transmission of epidemiologically important organisms from an infected or colonized patient through **direct contact (touching the patient) or indirect contact (touching contaminated objects or surfaces in the patient's environment)**.

- Patients with contact precautions should be placed in a private room, although patients infected with the same organism may be placed in the same room when private rooms are not available.
- Therefore, barrier precautions to prevent contamination of exposed skin and clothing should be used.

- **Gowns and gloves** should be worn when caregivers enter the patient's room and removed before leaving it.
- Gowns should be removed before leaving the isolation room, and care must be taken to prevent contamination of clothing while removing the gown.
- After removing gloves, the **hands must be decontaminated immediately** with a medicated hand-washing agent or an alcohol-based hand rub, and care should be taken to prevent recontamination of the hands before leaving the room.

- Adenovirus pneumonia*; conjunctivitis*
- Burkholderia cepacia pneumonia in cystic fibrosis
- Clostridium difficile infection
- Conjunctivitis, acute viral
- Decubitus ulcer, *infected, drainage not contained*
- Diarrhea, infectious, *in diapered or incontinent patient*
- Diphtheria, *cutaneous*
- Ectoparasites (lice, scabies)
- Enteroviral infections (infants, young children)
- Furunculosis (infants, young children)
- Hepatitis A, E (*diapered or incontinent patient*)
- HSV (*neonatal, disseminated, severe primary mucocutaneous*)
- Human metapneumovirus
- Impetigo
- **MDRO⁺ infection or colonization** : multidrug-resistant organism (e.g., carbapenem-resistant Enterobacteriaceae [CRE], extended-spectrum β -lactamase [ESBL], MDR-Acinetobacter, methicillin-resistant Staphylococcus aureus [MRSA], resistant Streptococcus pneumoniae, vancomycin-resistant enterococci [VRE], vancomycin-intermediate S. aureus [VISA], vancomycin-resistant S. aureus [VRSA]).
- MERS*†

- Monkeypox*
- Norovirus
- Parainfluenza infection (infants, children)
- Rhinovirus*
- Rotavirus
- RSV infection (infants, children, immunocompromised)
- Rubella, congenital
- SARS*
- Smallpox*
- Staphylococcus aureus major SSTI
- Streptococcal (group A) major SSTI*
- Tuberculous draining lesion
- Vaccinia: fetal, generalized, progressive, eczema vaccinatum
- Varicella*
- Viral hemorrhagic fevers*
- Zoster (disseminated; immunocompromised until dissemination ruled out)*

Thus,

- Acute diarrhea with likely infectious cause
- Vesicular rash*
- Respiratory tract infection in infants and young children*
- History of infection or colonization with MDRO†
- SSTI or UTI with recent stay in a facility where MDROs† are prevalent
- Abscess or draining wound that cannot be covered
- Cough, fever, any pulmonary infiltrate, and recent travel to regions with outbreaks of SARS or avian influenza*

| ELEMENTS | STANDARD PRECAUTIONS | TRANSMISSION-BASED PRECAUTIONS | | |
|-----------------------------|--|---|---|---|
| | | Contact | Droplet | Airborne |
| Room | Single-patient room preferred; door may remain open. | Single-patient room preferred; door may remain open; use disposable, noncritical, patient care equipment or dedicate to a single patient. | Single-patient room preferred; door may remain open. | Negative pressure, single-patient room required with air exhausted to outside or through HEPA filters; door must be closed. |
| Mask | | | Surgical mask for those entering room; place surgical mask on patient if transport out of room is required. | N95 or portable respirator for entering the room; place surgical mask on patient if transport out of room is required. |
| Eye, mouth, nose protection | For any activity likely to generate a splash, spray, or aerosol | | | |
| Gowns | For any activity likely to generate a splash, or spray | On room entry | | |
| Gloves | For contact with any body fluid, mucous membrane, or nonintact skin | On room entry | | |
| Hand hygiene | Before and after patient contact; before any aseptic task; after contact with any body fluid, mucous membrane, or nonintact skin; after contact with inanimate objects in the immediate vicinity of the patient; after glove removal | | | |

HEPA, high-efficiency particulate air.

Airborne Infection Isolation Rooms (AIIR)

- A properly designed and operating AIIR can be an effective infection control measure. Infectious airborne particles are contained within the room, and the concentration of these particles inside the room is reduced.
- However, a badly designed and/or incorrectly operating AIIR can place HCWs and other patients at risk for TB infection and disease. In this situation, infectious particles may not be contained in the room, and/or their concentration inside the room may not be effectively reduced. *Staff members who rely on such an AIIR may have a false sense of security.*

Architectural Considerations

- Architecturally, an AIIR should meet all the detailed requirements for a single-patient room, including a dedicated adjacent bathroom.

- To increase the effectiveness of negative pressure, the architectural elements should ensure that:
 - the AIIR suite is sealed, except for a **half-inch high air gap under the door**.
 - Towards this end, the ceiling should be **plaster/sheet rock** rather than removable ceiling tiles, and **lights should be surface-mounted**.
 - **Gasketing** should be provided at the sides and top of the door, and at ceiling and wall penetrations such as those around medical and electrical outlets.

- The location of the proposed AIIR should also be considered: areas prone to strong drafts, such as those near **elevator banks or doorways**, should be **avoided** if possible.
- AIIR doors should be equipped with **self-closing** devices.

- The ventilation rate is usually expressed in **air changes per hour (ACH)**.
- One air change occurs in a room when **a volume of air equal to the volume of the room is supplied and/or exhausted**.
- The air change rate in ACH is the volume of air circulating every hour divided by the room volume.
- It is recommended that AIIRs have an **exhaust air ventilation rate of at least 12 ACH**.
- The ACH of the dedicated **bathroom or anteroom**, when present, should be calculated **separately** from that of the AIIR itself.
- In other words, only include exhaust air that is exhausted in the AIIR.

Locating Supply and Exhaust Ductwork and Outlets

- The supply and exhaust location should be chosen to maximize air mixing and to optimize **directional airflow** from the **staff member towards the patient**.

- Exhaust should be removed near the possible contamination source. The best arrangement is to supply air at the **ceiling above the foot of the bed**, and to exhaust air **on the wall near the floor at the head of the bed** (where the patient's head is likely to be).
- The supply diffuser should be **the louvered blade type**, rather than the perforated face type.
- The diffuser neck size and blow pattern should be selected so that air is **directed to all parts** of the room.
- Locate the diffuser where the airflow **is not obstructed by items** such as surface-mounted light fixtures or a suspended television set.

- The bottom of the exhaust grille should be located approximately **6 inches above the floor**.
- Because the grille does not direct air, its face pattern is not as important as that of the diffuser.
- The vertical exhaust duct should be installed in the AIIR wall.

Maintaining Negative Pressure

- The **CDC** Guidelines recommend a negative pressure differential of at least **0.01 inches of water gauge** ("W.G.).
- **CNTC** recommends that the negative pressure differential across the AIIR door be approximately 0.03" W.G.

AIR with Anteroom

