

# **Hospital Acquired Infections (HAI)**

*DR. FATIMAH AL SHAHRANI*

*Infectious Diseases Consultant*

*Clinical Assistant Professor of Medicine*

# Objectives

- Know different types of HAI and how to prevent them
- Highlight the crucial importance of Hand Hygiene
- Understand different types of Isolation Precautions and how to comply with them

# Hospital-acquired infection

is also called **Nosocomial infection** or

**Healthcare-associated infections.**

"nosus" = disease

"komeion" = to take care of

# Hospital Acquired Infections (HAI)

- Between 5% and 10% of patients admitted to hospitals acquire one or more HAI
- Causes more serious illness
- Prolong hospital stay
- Long-term disability
- High personal burden on patients and their families
- High additional financial burden
- Deaths

# Estimated rates of HAI worldwide

- In the developed world:
  - 5-10% of patients acquire one or more infections
- In developing countries :
  - HAI can exceed 25%
- In intensive care units:
  - HAI affects about 30% of patients and the attributable mortality may reach 44%

# Source of infection

- HAIs are caused by infectious agents from:
  - 1] **Endogenous sources** such as the skin, nose, mouth, GI tract, or vagina that are normally inhabited by microorganisms (normal flora)
  - 2] **Exogenous sources** external to the patient such as health care workers (HCW), visitors, patient care equipment, medical devices, or the health care environment

# **Types of HAI**

**Catheter-Associated Urinary Tract Infections (CAUTI)**

**Catheter-Associated Bloodstream Infections (CLABSI)**

**Ventilator-Associated Pneumonia  
(VAP)**

**Surgical site infections  
(SSI)**

# Catheter-Associated Urinary Tract Infections (CAUTI)

- Indwelling urinary catheter
- Urinary invasive procedures
- Risk Factors:
  - Advanced age
  - Severe underlying disease
  - Urolithiasis
  - Pregnancy
  - DM



# CAUTI

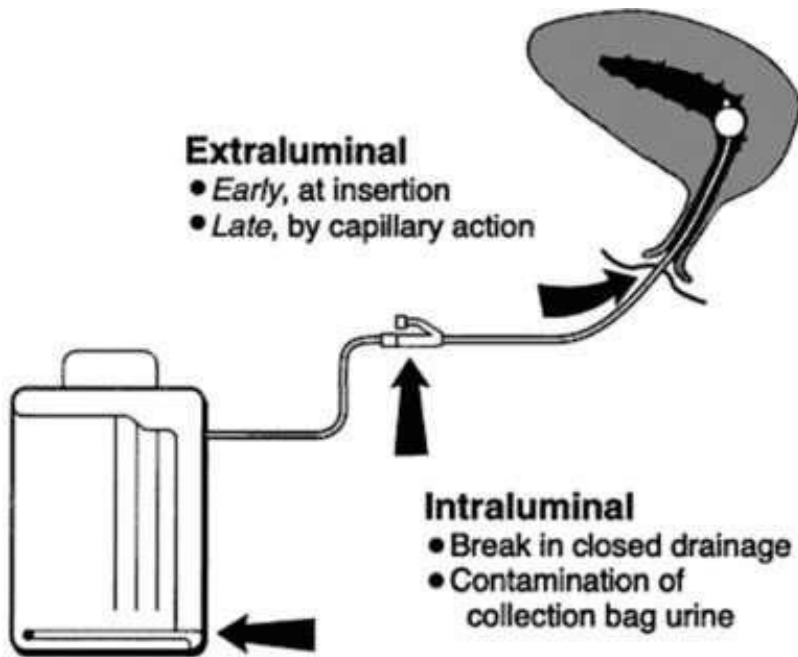
- Most common type of HAI: > 30%
  - Estimated > 500,000 of hospital UTIs annually
- Increased morbidity & mortality
  - Estimated 13,000 attributable deaths annually
  - Leading cause of secondary blood stream infection with ~10% mortality
- Excess length of stay: 2-4 days

# Indwelling Urinary Catheters

- 15-25% of hospitalized patients
- Often placed for inappropriate indications
- Physicians frequently unaware:
  - > 50% did not monitor which patients catheterized
  - 75% did not monitor duration and/or discontinuation

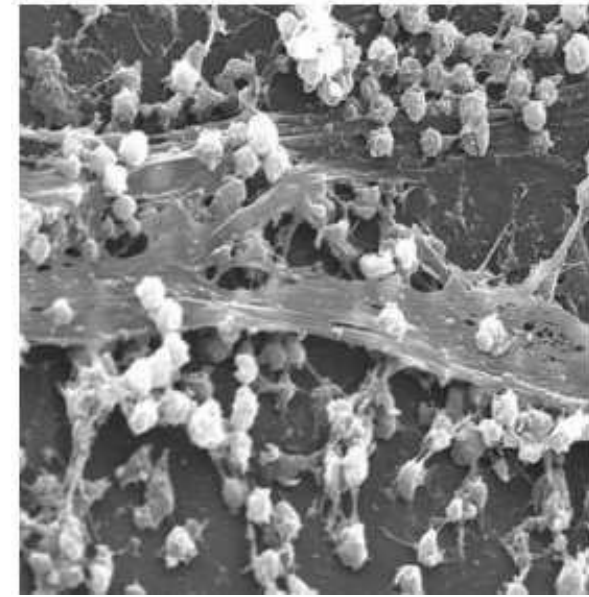
# Pathogenesis of CAUTI

- Source of microorganisms:
  - Endogenous (meatal, rectal, or vaginal )
  - Exogenous, usually via contaminated hands of HCW during catheter insertion or manipulation of the collecting system



# Pathogenesis of CAUTI

- Formation of biofilms by urinary pathogens is common on the surfaces of catheters and collecting systems
- Bacteria within biofilms are resistant to antimicrobials and host defenses
- Must remove catheter for cure



# CAUTI

- Symptomatic UTI must meet at least 1 of the following criteria
  - Fever ( $38^{\circ}$  C or above), urgency, frequency, dysuria, or suprapubic tenderness
  - Positive urine culture, that is more than  $10^5$  CFU per ml, with no more than 2 species of microorganisms
- A positive culture of a urinary catheter tip is not an acceptable laboratory test to diagnose UTI

# Prevention: CAUTI Bundle

- Insert catheters only for appropriate indications
- Leave catheters in place only as long as needed
- Ensure that only properly trained persons insert and maintain catheters
- Insert catheters using aseptic technique and sterile equipment (acute care setting)
- Following aseptic insertion, maintain a closed drainage system
- Maintain unobstructed urine flow
- Daily revision of need of catheterization
- Hand hygiene

# Prevention: CAUTI Bundle

- Minimize use in all patients, particularly those at higher risk of CAUTI and mortality :
  - Women, elderly, impaired immunity
- Avoid its use for management of incontinence
- Use catheters in operative patients only as necessary
- Remove catheters ASAP postoperatively, preferably within 24 hours, unless there are appropriate indications for continued use

# CLABSI

- Definition:
  - Laboratory-confirmed bloodstream infection by a positive blood culture
  - Not related to an infection at another site
  - Develops at least after 48 hours of a central line placement
- Most common site: femoral central lines



# CLABSI Organisms

- GPC
  - CoNS 35%
  - *enterococci spp* 15%;
  - *Staphylococcus aureus* 10%
- GNB:
  - *Klebsiella pneumoniae* 6%
  - E.coli 3%
  - *Enterobacter spp.* 3%
  - *Pseudomonas aeruginosa* 3%
  - *Acinetobacter baumannii* 2%
- Candida spp. 12%
- Other 10%

# CLABSI Treatment

- Removal of central line
- Antimicrobial therapy
  - Type and duration depends on culture results, type of organism, complicated disease
    - e.g. of antibiotics used: Vancomycin, cloxacillin, cefazolin, piperacillin/ tazobactam, cefepime, ceftazidime, carbapenems, Aminoglycosides, colistin, daptomycin, echinocandins

# CLABSI Prevention Bundle

- Prevention Guidelines During Insertion:
  - Hand hygiene before wearing gloves
  - Strict aseptic technique by maximal sterile barrier precautions including a full-body drape
  - Use of 2% chlorhexidine skin preparations for disinfecting/ cleaning skin before insertion
  - Ultrasound guidance by an experienced personnel and reduce the number of attempts.
  - Avoid the femoral vein, prefer the subclavian vein
  - Promptly remove any central line that is no longer required
  - Replace central lines placed during an emergency (asepsis not assured) as soon as possible or at least within 48 hours
  - Use a checklist

# CLABSI Prevention Bundle

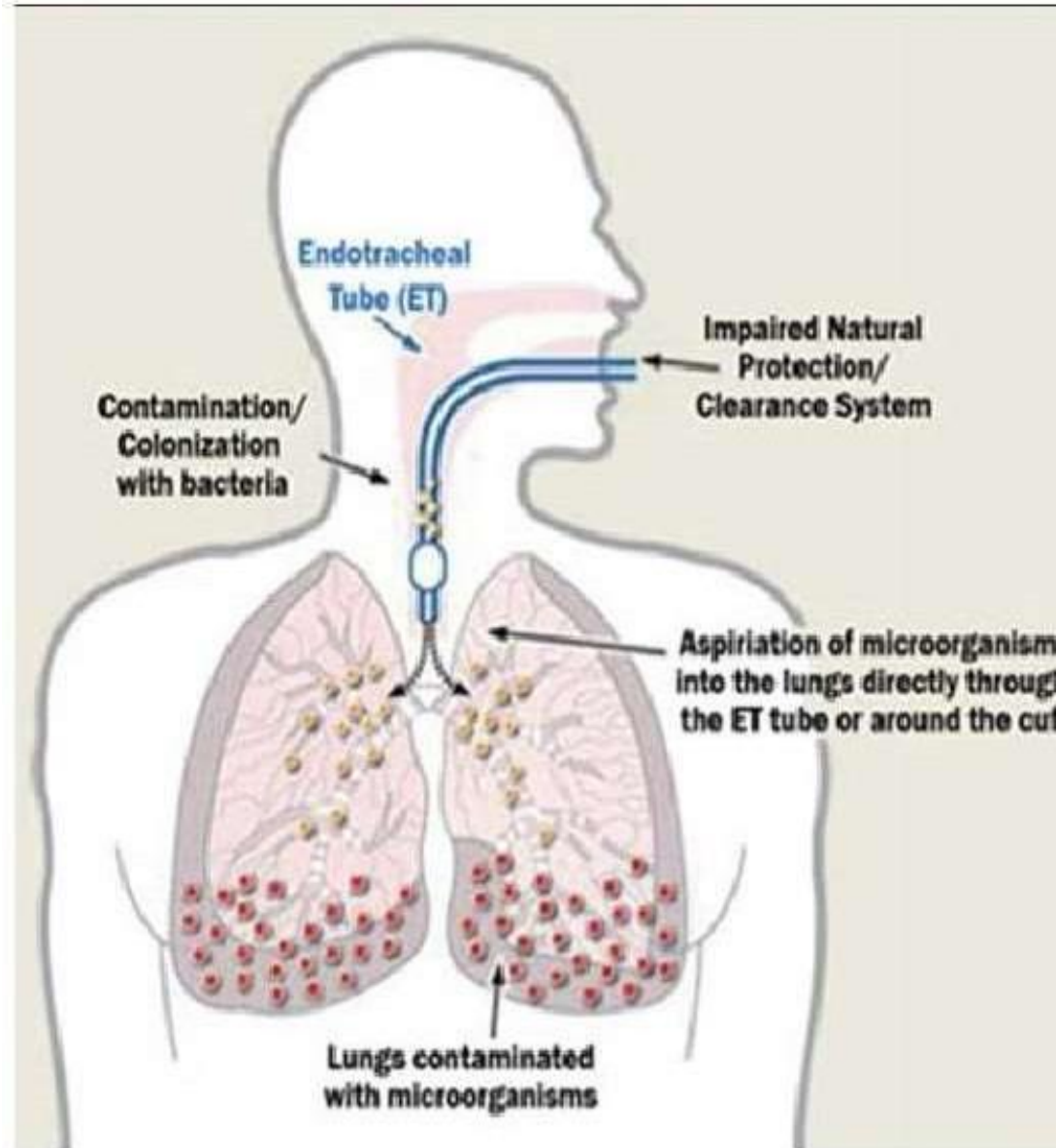
- Prevention Guidelines During Maintenance:
  - Disinfect catheter hubs, injection ports, and connections before accessing line
  - Replace administration sets other than sets used for lipids or blood products every 96 hours
  - Assess the need for the central line daily

# VAP

- VAP is one of the most common infections acquired by adults and children in intensive care units
- Affects critically ill patients
- VAP is a cause of significant morbidity and mortality, increased utilization of healthcare resources
- The mortality attributable to VAP exceed 15%

# Pathogenesis of and risk factors for

- The 3 common mechanisms:
  - Aspiration of secretions
  - Colonization of the aerodigestive tract
  - Use of contaminated equipment



# Prevention: VAP Bundle

1-Prevent aspiration of secretions

2-Reduce duration of ventilation

3-Reduce colonization of airway and digestive tract

4-Prevent exposure to contaminated equipment

# VAP Bundle

- **Prevent Aspiration of Secretions**

- Maintain elevation of head of bed (HOB) 30-45 degrees
- Avoid gastric over-distention
- Avoid unplanned extubation and re-intubation
- Use cuffed endotracheal tube with in-line or subglottic suctioning
- Encourage early mobilization of patients with physical/occupational therapy



# VAP Bundle

- **Reduce Duration of Ventilation**
  - Conduct “sedation vacations”
  - Assess readiness to wean from vent daily
  - Conduct spontaneous breathing trials

# VAP Bundle

- **Reduce Colonization of Airway and Digestive Tract**
  - Use cuffed Endotracheal Tube with inline or subglottic suctioning
    - Minimizes secretions above cuff; prevents contamination of lower airway
  - Avoid acid suppressive therapy for patients not at high risk for stress ulcer or stress gastritis
    - Increases colonization of the digestive tract

# Most frequent sites of infection and their risk factors

## URINARY TRACT INFECTIONS

34%

**Urinary catheter**  
**Urinary invasive procedures**

Advanced age  
Severe underlying disease  
Urolithiasis  
Pregnancy  
Diabetes

13%

## LOWER RESPIRATORY TRACT INFECTIONS

**Mechanical ventilation**

**Aspiration**

**Nasogastric tube**

Central nervous system depressants  
Antibiotics and anti-acids  
Prolonged health-care facilities stay  
Malnutrition  
Advanced age  
Surgery  
Immunodeficiency

Most common sites of health care-associated infection and the risk factors underlying the occurrence of infections

17%

## SURGICAL SITE INFECTIONS

**Inadequate antibiotic prophylaxis**  
**Incorrect surgical skin preparation**  
**Inappropriate wound care**

Surgical intervention duration  
Type of wound  
Poor surgical asepsis  
Diabetes  
Nutritional state  
Immunodeficiency  
Lack of training and supervision

14%

## BLOOD INFECTIONS

**Vascular catheter**

**Neonatal age**

**Critical care**

Severe underlying disease  
Neutropenia  
Immunodeficiency  
New invasive technologies  
Lack of training and supervision

# Surgical Site Infection (SSI)

- Inadequate antibiotic prophylaxis
- Incorrect surgical skin preparation
- Inappropriate wound care
- Risk Factors:
  - Surgery duration
  - Type of surgery: clean, clean-contaminated, contaminated, dirty
  - Type of wound
  - Improper surgical aseptic preparation
  - Poor glucose control
  - malnutrition
  - Immunodeficiency
  - hypothermia
  - Lack of training and supervision

# SURGICAL WOUND CLASSIFICATIONS

- **I. Clean:**

- Uninfected, no inflammation
- Resp, GI, GU tracts not entered
- Closed primarily

Examples: Ex lap, mastectomy, neck dissection, thyroid, vascular, hernia, splenectomy

- **II. Clean-contaminated:**

- Resp, GI, GU tracts entered, controlled
- No unusual contamination

Examples: Chole, SBR, Whipple, liver txp, gastric surgery, bronch, colon surgery

# SURGICAL WOUND CLASSIFICATIONS

- **III: Contaminated:**
- Open, fresh, accidental wounds
- Major break in sterile technique
- Gross Spillage from GI tract
- Acute nonpurulent inflammation
  - Examples: Inflamed appendix, bile spillage in chole, diverticulitis, Rectal surgery, penetrating wounds
- **IV: Dirty:**
- Old traumatic wounds, devitalized tissue
- Existing infection or perforation
- Organisms present BEFORE procedure
  - Examples: Abscess I&D, perforated bowel, peritonitis, wound debridement, positive cultures pre-op

# SSI

## **Burden**

- **17% of all HAI; second to UTI**
- 2%-5% of patients undergoing inpatient surgery

## **Mortality**

- 3 % mortality
- 2-11 times higher risk of death
- 75% of deaths among patients with SSI are directly attributable to SSI

## **Morbidity**

- long-term disabilities

# Superficial SSI

- Infection occurs within 30 days after the operative procedure and involves only skin and subcutaneous tissue of the incision
- Purulent drainage from the superficial incision
- Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision
- Often Clinical diagnosis: pain or tenderness, localized swelling, redness, or heat, lack of systemic symptoms (e.g. fever)
- A negative culture does not rule it out



# Deep SSI

- Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure
- involves deep soft tissues (eg, fascial and muscle layers) of the incision
- Clinically may have abscess, fever

# SSI Pathogenesis

## **Pathogen Sources:**

### **Endogenous**

- Patient flora
  - skin
  - mucous membranes
  - GI tract
- Seeding from a distant focus of infection

# SSI Pathogenesis

## Pathogen Sources:

### Exogenous

- Surgical Personnel (surgeon and team)
  - Soiled attire
  - Breaks in aseptic technique
  - **Inadequate hand hygiene**
- O.R. physical environment and ventilation
- Tools, equipment, materials brought to the operative field

# Organisms Causing SSI

<b><i>Staphylococcus aureus</i></b>	<b>30.0%</b>
Coagulase-negative staphylococci	13.7%
Enterococcus spp.	11.2%
<i>Escherichia coli</i>	9.6%
<i>Pseudomonas aeruginosa</i>	5.6%
Enterobacter spp	4.2%
<i>Klebsiella pneumoniae</i>	3.0%
Candida spp.	2.0%
<i>Klebsiella oxytoca</i>	0.7%
<i>Acinetobacter baumannii</i>	0.6%

# SSI Epidemiology

- Important Modifiable Risk Factors:
  - Antimicrobial prophylaxis
    - Inappropriate choice (procedure specific)
    - Improper timing (pre-incision dose)
    - Inadequate dose based on body mass index, procedures >3h
- Skin or site preparation ineffective
- Colorectal procedures
  - Inadequate bowel prep/antibiotics
- Inadequate wound dressing protocol
- Improper glucose control
- Colonization with preexisting microorganisms

# SSI Prevention Strategies

- **Preoperative Measures:**

**Administer antimicrobial prophylaxis in accordance with evidence based standards and guidelines**

- Administer within 30-45 minutes to incision
  - 1-2hr for vancomycin and fluoroquinolones
- Select appropriate agents on basis of
  - Surgical procedure
  - Most common SSI pathogens for the procedure
  - Published recommendations

# SSI Prevention Strategies

- Nasal screen and decolonize only

***Staphylococcus aureus*** carriers undergoing

- 1) Elective cardiac surgery
- 2) Orthopaedic surgery
- 3) Neurosurgery procedures with implants

USING

**Pre-operative mupirocin ointment therapy**

# Prevention: SSI Bundle

- Shower night before surgery
- Antimicrobial prophylaxis should be administered only when indicated
  - Certain surgeries only
  - Single pre-operative dose 30-45 min before incision
  - Topical antibiotics should not be applied to the surgical site
  - In clean and clean-contaminated surgery: No additional prophylactic antimicrobial doses should be given even in the presence of a drain
- Skin preparation in the O.R. by alcohol-based agent
- Good glycemic control during surgery
- Normothermia should be maintained throughout surgery
- Administration of FIO<sub>2</sub> during surgery and after extubation



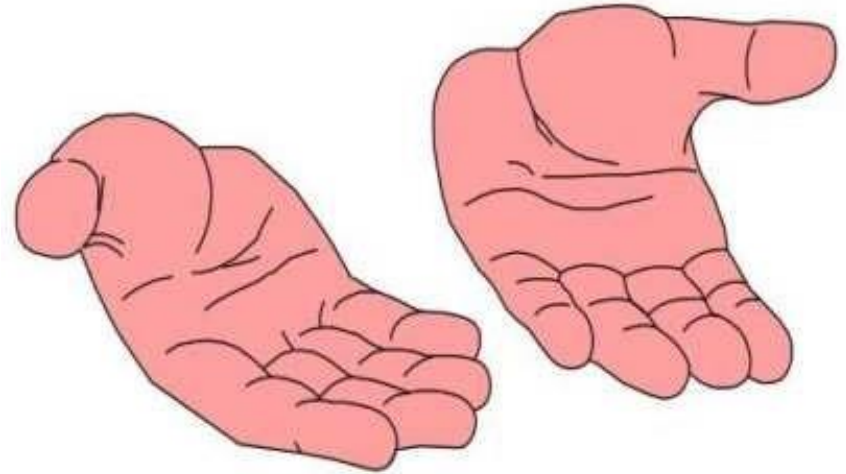
# Prevention of HAI

- Validated and standardized prevention strategies have been shown to reduce HAI
- At least 50% HAI could be prevented
- Most solutions are simple and not resource-demanding and can be implemented with ease by all HCW
  - Hand hygiene
  - Bundles
  - Compliance with isolation precautions
  - Annual influenza vaccination
  - Annual TB screening: TST, IGRA
  - UpToDate with vaccinations: HBV Ab titre above 10, MMRV, Td

# Hand transmission

- Hands are the most common vehicle to transmit healthcare associated pathogens
- Transmission of microbiological organisms from one patient to another via HCW hands

## The Carriers of Top Ten Infectious Diseases Germs



In US 20,000 cases of HAIs are directly related to poor hand hygiene annually.

# Why should you clean your hands

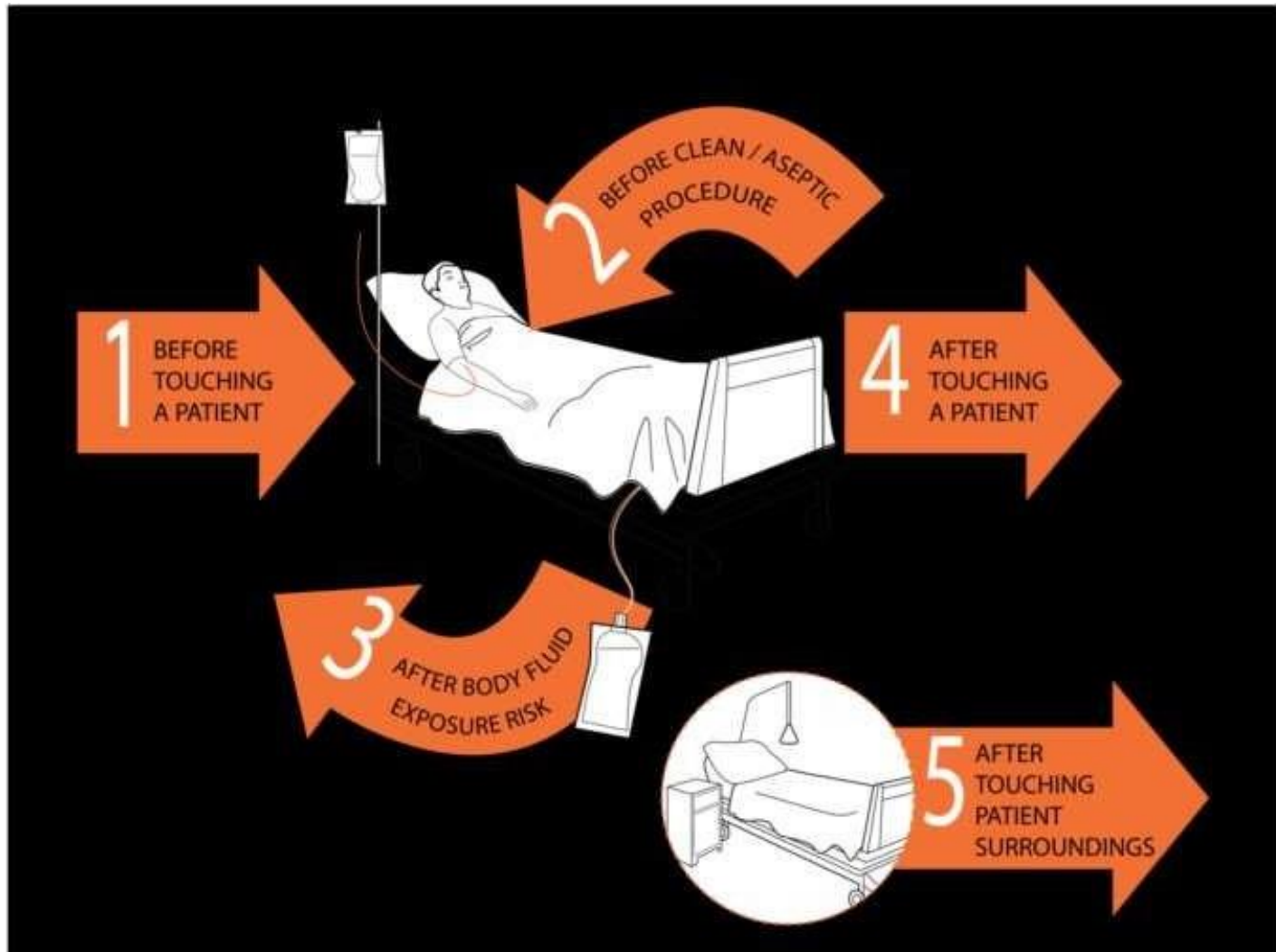
- Any HCW involved in health care needs to be concerned about hand hygiene
- Other HC workers (e.g. your colleagues and seniors) hand hygiene concerns you as well
- You must perform hand hygiene to :
  - protect the patient against harmful microbes in your hands or present on your skin
  - protect yourself and the healthcare environment from harmful microbes

# Bacteria isolated everywhere (e.g. VRE)



# **FIVE MOMENTS OF HAND HYGIENE**

# 5 Moments of Hand hygiene



# How to clean your hands

- Handrubbing with alcohol-based handrub is the preferred routine method of hand hygiene if hands are not visibly soiled
- Handwashing with soap and water - essential when hands are visibly dirty or visibly soiled (following exposure to body fluids)

# How to handrub?

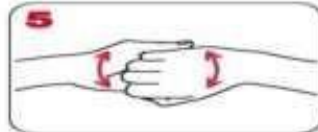
WITH ALCOHOL-BASED FORMULATION



Apply a palmful of the product in a cupped hand and cover all surfaces.



Rub hands palm to palm



backs of fingers to opposing palms with fingers interlocked



right palm over left dorsum with interlaced fingers and vice versa



rotational rubbing of left thumb clasped in right palm and vice versa



palm to palm with fingers interlaced



rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa



20-30 sec



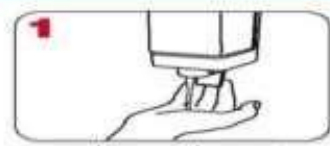
...once dry, your hands are safe.

# How to handwash?

WITH SOAP AND WATER



Wet hands with water



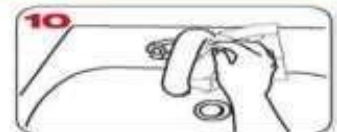
apply enough soap to cover all hand surfaces.



rinse hands with water.



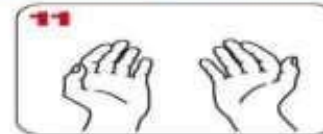
dry thoroughly with a single use towel



use towel to turn off faucet



40-60 sec



...and your hands are safe.



# Hand hygiene and glove use

- The use of gloves does not replace the need to clean the hands
- Remove gloves to perform Hand hygiene, when an indication occurs while wearing gloves
- Wear gloves only when indicated, otherwise they become a major risk for germ transmission

## SEQUENCE FOR PUTTING ON PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE used will vary based on the level of protection required, such as standard and contact, droplet or aerosol infection control precautions. The procedure for putting on and removing PPE should be tailored to the specific type of PPE.

### 1. GOWN

- Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
- Fasten in back of neck and waist



### 2. MASK OR RESPIRATOR

- Secure ties or elastic bands at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator



### 3. GOGGLES OR FACE SHIELD

- Place over face and eyes and adjust to fit



### 4. GLOVES

- Extend to cover wrist of isolation gown



## USE SAFE WORK PRACTICES TO PROTECT YOURSELF AND LIMIT THE SPREAD OF CONTAMINATION

- Keep hands away from face
- Limit surfaces touched
- Change gloves when soiled or heavily contaminated
- Perform hand hygiene

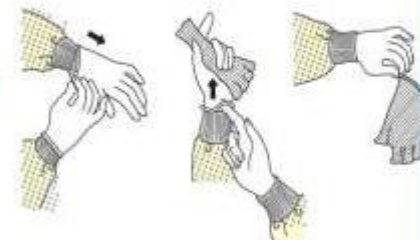


## SEQUENCE FOR REMOVING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Except for respirator, remove PPE at doorway or in anteroom. Remove respirator after leaving patient room and closing door.

### 1. GLOVES

- Outside of gloves is contaminated!
- Grasp outside of glove with opposite gloved hand; peel off
- Hold removed glove in gloved hand
- Slide fingers of ungloved hand under remaining glove at wrist
- Peel glove off over first glove
- Discard gloves in waste container



### 2. GOGGLES OR FACE SHIELD

- Outside of goggles or face shield is contaminated!
- To remove, handle by head band or ear pieces
- Place in designated receptacle for reprocessing or in waste container



### 3. GOWN

- Gown front and sleeves are contaminated!
- Unfasten ties
- Pull away from neck and shoulders, touching inside of gown only
- Turn gown inside out
- Fold or roll into a bundle and discard



### 4. MASK OR RESPIRATOR

- Front of mask/respirator is contaminated — DO NOT TOUCH!
- Grasp bottom, then top ties or elastics and remove
- Discard in waste container



PERFORM HAND HYGIENE BETWEEN STEPS IF HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE



# Types of Isolation Precautions

- Standard precautions
- Transmission-based precautions
  - Contact precautions
  - Airborne precautions
  - Droplet precautions

# TRANSMISSION-BASED PRECAUTIONS - Contact Precautions

- Infections spread by direct or indirect contact with patients or patient-care environment -C. difficile, MRSA, VRE, ESBL, CRE and MDR GNR
- Limit patient movement
- Private/SINGLE room or cohort with patients with same infection
- Wear disposable gown and gloves when entering the patient room
- Remove and discard used gown and gloves inside the patient room
- Wash hands immediately after leaving the patient room
- Use dedicated equipment if possible (e.g., stethoscope)

# Contact precautions signs



## CONTACT PRECAUTIONS



*Visitors must report to Nursing Station before entering.*

-   Perform hand hygiene before entering and before leaving room.
-   Wear gloves when entering room or cubicle, and when touching patient's intact skin, surfaces, or articles in close proximity
-   Wear gown when entering room or cubicle and whenever anticipating that clothing will touch patient items or potentially contaminated environmental surfaces.
-   Use patient-dedicated or single-use disposable shared equipment or clean and disinfect shared equipment (BP cuff, thermometers) between patients.

### PRECAUCIONES DE CONTACTO

*Los visitantes deben presentarse primero al puesto de enfermería antes de entrar. Lávese las manos. Póngase guantes al entrar al cuarto.*

## CONTACT PRECAUTIONS

*To prevent the spread of infection,*

### ANYONE\* ENTERING THIS ROOM MUST WEAR:



### Gloves ✓



### Gown ✓

Applies whether or not contact with the patient or the patient's environment is anticipated.

\*Patient visitors do not need to wear gloves and a gown, but must wash hands upon entering and leaving this room.

Questions? Please call the Department of Infection Control & Prevention at 936-0725



# Droplet Precautions

- Reduce the risk of transmission by large particle droplets (larger than 5  $\mu$ m in size).
- Requires close contact between the source person and the recipient
- Droplets usually travel 3 feet or less
- E.g., influenza, MERS-CoV, other respiratory viruses, rubella, parvovirus B19, mumps, *H. influenzae*, and *N. meningitidis*

# Droplet Precautions cont.

- A private/single room or
- Cohort with patient with active infection with same microorganism
- Use a mask when entering the room especially within 3 feet of patient
- Limit movement and transport of the patient. Use a mask on the patient if they need to be moved and follow respiratory hygiene/cough etiquette

# Droplet precautions signs



A green sign with red octagonal stop signs at the top corners. The left one says 'STOP' and the right one says 'ALTO'. The text 'DROPLET PRECAUTIONS' is centered. Below it, a red line of text says 'Visitors must report to Nursing Station before entering'. Three items are listed with checkmarks and icons: hand hygiene, wearing a mask, and dietary staff not entering. At the bottom, there is Spanish text and a reference code.

**STOP** **DROPLET PRECAUTIONS** **ALTO**

*Visitors must report to Nursing Station before entering.*

-   Perform hand hygiene before entering and before leaving room
-   Wear mask when entering room  
Visitors and health care workers
-   Dietary may not enter  
No debe entrar el dietista

**PRECAUCIONES DE GOTAS DIMINUTAS**

*Los visitantes deben presentarse primero al puesto de enfermería antes de entrar. Lávese las manos. Póngase máscara al entrar al cuarto. No debe entrar el dietista.*

HO 5221 Rev. 12/08



A green sign with a yellow vertical bar on the left. The text 'DROPLET PRECAUTIONS' is at the top. Below it, a line of text says 'To prevent the spread of infection, ANYONE ENTERING THIS ROOM MUST WEAR:'. A surgical mask icon is shown next to the text 'Surgical Mask' with a green checkmark. At the bottom, it says 'N-95 Respirators should not be used for personal protection of patients in droplet precautions.' and provides contact information for the Department of Infection Control & Prevention.

**DROPLET PRECAUTIONS**

*To prevent the spread of infection,*  
**ANYONE ENTERING THIS ROOM MUST WEAR:**

 **Surgical Mask** ✓

N-95 Respirators should not be used for personal protection of patients in droplet precautions.

Questions? Please call the Department of Infection Control & Prevention at 936-0725  **Vanderbilt** Infection Control & Prevention



# Airborne Precautions




- Tuberculosis, measles, varicella, MERS-CoV (severe)
- Place the patient in an airborne infection isolation room (AIIR)
- Negative Pressure should be monitored with visible indicator
- Use of respiratory protection (e.g., fit tested N95 respirator) or powered air-purifying respirator (PAPR) when entering the room
- Limit movement and transport of the patient. Use a mask on the patient if they need to be moved
- Keep patient room door closed, do not open anteroom door till other door closed

# Airborne precautions signs



**STOP** **AIRBORNE INFECTION ISOLATION PRECAUTIONS** **ALTO**

*Visitors must report to Nursing Station before entering.*

-   Perform hand hygiene before entering and before leaving room
-   Wear N95 respirator when entering room  
*Visitors see nurse for instruction on proper use.*
-   Keep door closed
-   Dietary may not enter  
*No debe entrar el dietista*

**PRECAUCIONES AMBIENTALES**  
*Los visitantes deben presentarse primero al puesto de enfermería antes de entrar. Lávese las manos. Póngase máscara N95 con filtro al entrar al cuarto. Mantenga la puerta cerrada. No debe entrar el dietista.*



**AIRBORNE PRECAUTIONS**

*To prevent the spread of infection,*  
**ANYONE\* ENTERING THIS ROOM MUST WEAR:**

 **N-95 Respirator** ✓

Also ensure that the **door** to the patient's room **remains closed at all times.**

\*Patient visitors should wear a blue surgical mask while in the patient's room.

Questions? Please call the Department of Infection Control & Prevention at 936-0225 

