

In the name of God

Nosocomial infection and infection control

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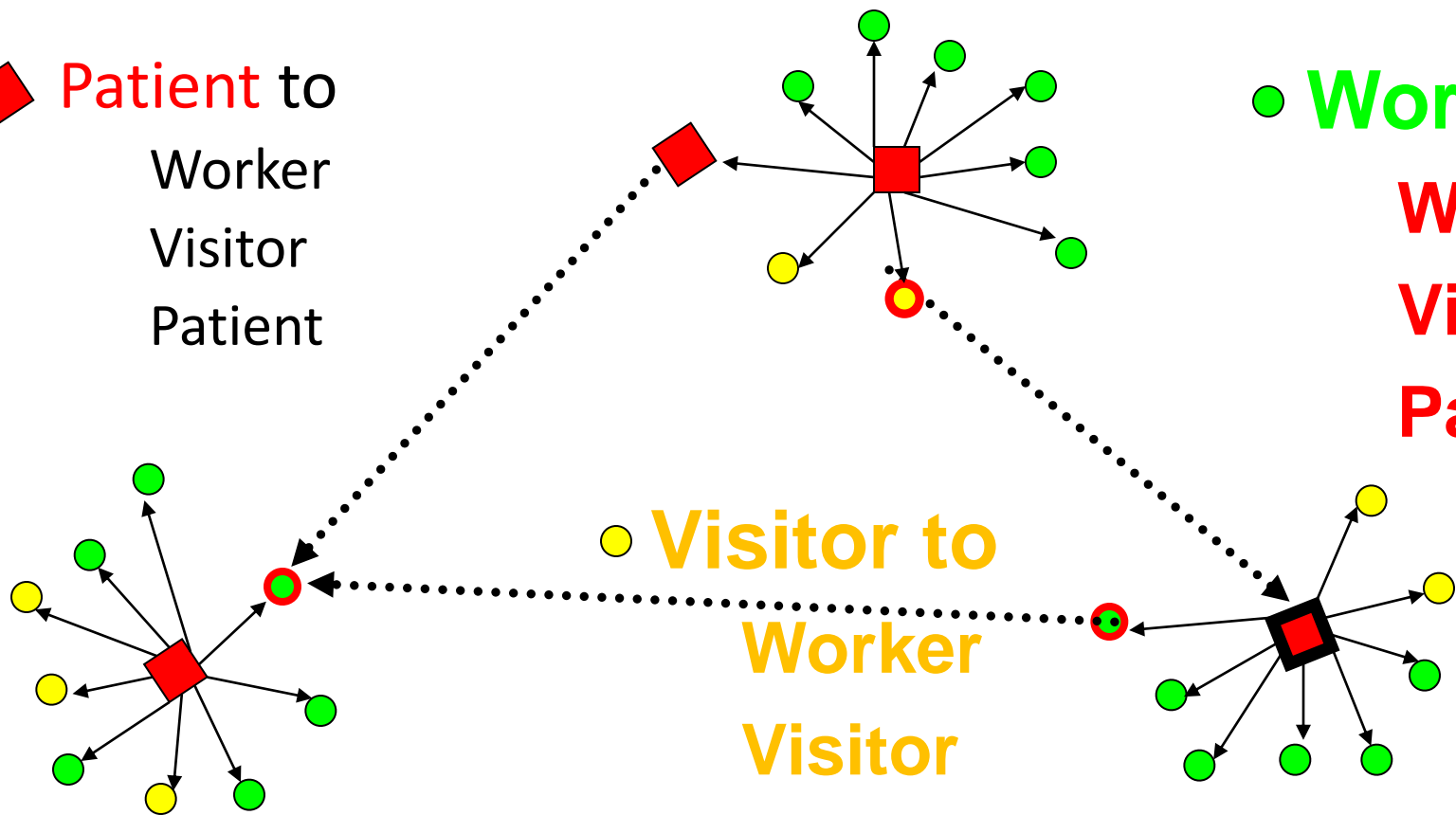
Arak university of medical science

- **Infection Control**—The process by which health care facilities develop and implement specific policies and procedures to prevent the spread of infections among health care staff and patients
- **Nosocomial Infection**—An infection contracted by a patient or staff member while in a hospital or health care facility (and not present or incubating on admission)

◆ Patient to
Worker
Visitor
Patient

● Worker
Worker
Visitor
Patie

● Visitor to
Worker
Visitor
Patient



- Cross transmission in the hospital environment has been linked to contamination of hospital **surfaces**, contaminated **medical devices** and other fomites, and contamination of healthcare worker **hands** and **clothing**.
- Bacterial pathogens of epidemiologic significance typically inhabit specific niches on or in the human body, or in the hospital environment, that can serve as **reservoirs** for transmission. Patients' skin, intestinal, and respiratory **microbiota** are distorted within a **few** days in the hospital, and their flora in turn colonize their inanimate environment within the hospital

- Patients who are **colonized** with resistant bacteria serve as accidental **reservoirs** for spread to other patients.
- **Most** nosocomial pathogens are thought to be transmitted from person to person on the **hands** of health care personnel, from contaminated **surfaces** in the hospital environment, or from contaminated patient care **equipment**

Why Infection Control?

- Hospital acquired infections are a common problem prevalence about **9%**
- Hospital acquired infections contribute to **AMR**
 - Overuse of antimicrobials (development)
 - Poor infection control practices (spread)

Development of AMR

- **Poor or absent** IC practices, especially in **intensive care units**, results in cross-transmission of antibiotic-resistant bacteria.
- Resistant bacteria prompts even **greater antibiotic use** by physicians.
- Perception of knowledge by physicians of **poor** sterilization, disinfection, or patient care practices prompts **increased** antibiotic use (e.g., broad spectrum and prolonged surgical prophylaxis in an effort to prevent infections).

Epidemiology of Nosocomial Infections

- Most common sites for nosocomial infections
 - Surgical incisions
 - Urinary tract (i.e., catheter-related)
 - Lower respiratory tract
 - Bloodstream (i.e., catheter-related)

Common microorganisms

- Aerobic gram-**positive** cocci (*Staphylococcus aureus* [MRSA], enterococci [vancomycin-resistant]).
- Aerobic gram-**negative** bacilli (*Escherichia coli*, *P. aeruginosa*, *Enterobacter* spp., and *Klebsiella pneumoniae*).

Root Causes of Nosocomial Infections

- Lack of training in basic IC
- Lack of an IC infrastructure and poor IC practices (procedures)
- Inadequate facilities and techniques for hand hygiene
- Lack of isolation precautions and procedures

- Use of advanced and complex treatments without adequate training and supporting infrastructure, including:
 - Invasive devices and procedures
 - Complex surgical procedure
 - Intravenous catheters, fluids, and medications
 - Urinary catheters
 - Mechanical ventilators
- Inadequate sterilization and disinfection practices and inadequate cleaning of hospital

Infection Control Committee

Membership—

- Doctors
 - General physician
 - Infectious disease specialist
 - Surgeon
 - Clinical microbiologist
- Infection control nurse
- Representatives from other relevant departments
 - Laboratory
 - Pharmacy and central supply
 - Administration

Goal:

- To prevent the spread of infections within the health care facility

Functions:

- Addressing **food** handling, **laundry** handling, **cleaning** procedures, **visitation policies**, and **direct patient** care practices
- Obtaining and managing critical **bacteriological** data and information, including surveillance data

Functions

- Recognizing and investigating **outbreaks** of infections in the hospital and community
- **Intervening** directly to prevent infections
- **Educating** and training health care workers, patients, and nonmedical caregivers

Methods of Environmental Cleaning and Disinfection

- Environmental cleaning and disinfection focus on **surfaces** that are repeatedly soiled, such as bathrooms and surfaces that are “**high touch**.” Even floors should be considered as potential sources of transmission to patients. Hydrogen peroxide and bleach solutions have activity against these pathogens, in addition to standard viruses and vegetative bacteria, and may be preferable for routine environmental cleaning and disinfection.

- **Water Management** As with other health care–associated infections, waterborne infections can cause significant morbidity and mortality, and some are preventable. Pathogens such as ***Legionella*** and **nontuberculous mycobacteria** can **colonize** the central pipes or outlets of potable water distribution systems in hospitals, and other gram-negative bacteria reside in **biofilms** near the points of use

- Although most municipal water may be adequately **chlorinated**, free chlorine, the component of total chlorine that has **antimicrobial** activity
- Supplemental disinfection systems add chlorine (in the form of sodium hypochlorite, or bleach), monochloramine, chlorine dioxide, ozone, or copper-silver ions to the water supply.

- **Air Handling** Hospital ventilation is a critical feature of the building infrastructure that must be engineered to meet a range of infection-control requirements in different areas of the hospital
- Notable issues include **negative** pressure isolation rooms for patients who have suspected or confirmed **airborne** infections; **positive** pressure protective environment rooms for patients who are undergoing treatment for **leukemia** or **stem cell** transplantation; and laminar flow in operating rooms.

- Therefore, hospitalized patients who have suspected or known **airborne infection** should be housed in airborne isolation rooms—**private** rooms that have monitored negative airflow with respect to the anteroom or hallway, and **6 to 12 air changes per hour**, with the exhausted air filtered through a **high-efficiency particulate air (HEPA)** filter or released to the outside

TRANSMISSION-BASED INFECTION-CONTROL PRECAUTIONS

- **Colonization** Colonization refers to the peaceable presence of bacteria or fungi on or in a person, including organisms that are part of the normal human microbiota. Colonized patients can serve as silent reservoirs for transmission.
- **Organisms Transmitted by Contact** Most epidemiologically important bacteria, including MDROs and many viruses, are spread **directly** by means of person-to-person contact, or **indirectly** via contact with contaminated patient care equipment or surfaces.

TABLE 298.2 Sites for Microbial Surveillance to Detect Colonization With Select Multidrug-Resistant Organisms

RESISTANT ORGANISM	HIGHEST-YIELD SITES
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Methicillin-resistant <i>Staphylococcus aureus</i>	Anterior nares ¹⁸⁷
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Vancomycin-resistant <i>Enterococcus faecium/faecalis</i>	Rectal/perirectal ¹⁸⁸
-----------------------------------------------------------	----------------------------------

Multidrug-resistant <i>Acinetobacter baumannii</i>	Groin and throat ^{189,190}
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Multidrug-resistant Enterobacteriaceae	Rectal/perirectal ¹⁸⁹
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<i>Candida auris</i>	Groin and axillae ²⁸
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- **Contact** precautions with use of barriers such as **gowns** and **gloves** are intended to interrupt transmission of **MDROs** and other pathogens, although their effectiveness can be undermined by contaminated equipment such as stethoscopes or portable radiography film cartridges that are not properly disinfected.
- **Organisms Transmitted by Droplet** Pathogens that infect or colonize the upper respiratory tract, such as respiratory viruses, staphylococci, *Bordetella pertussis*, and group A streptococci, can spread via droplet routes.

- These pathogens are shed from the upper respiratory tract in droplets that are typically **greater than 5 μM** in size and fall within **1 to 2** meters of the patient
- Pathogens within those droplets can spread to health care personnel when they land on **mucous** membranes or may be transmitted indirectly via hands or fomites. Thus a **face mask** and **gloves** are components of droplet isolation.

- **Organisms Transmitted by the Airborne Route** Infections known to spread via the airborne route include **tuberculosis, varicella, and measles**. Pathogens that are shed in droplet nuclei, which are viable particles **2 to 5 μM** in size, can remain airborne for prolonged periods, traveling in air currents.
- Health care personnel wear fitted particulate respirators, referred to as **N95** respirators because they filter 95% of airborne particles, or powered air-purifying respirators that draw air into a hood through a **HEPA filter** and provide better protection

- **Aerosol-producing procedures**, such as **endotracheal intubation**, **bronchoscopy**, **sputum induction** merit use of respirators to protect health care personnel from the temporarily airborne particles.

DEVICE-RELATED INFECTIONS

- **Ventilator-associated pneumonia (VAP)** is a largely preventable complication of mechanical ventilation in the ICU.
- In patients who are already intubated, national consensus guidelines recommend **minimizing sedation**, conducting **spontaneous awakening** trials, and assessing patients' readiness for **extubation daily** in an effort to reduce the duration of mechanical ventilation. In addition, patients should have the head of the bed elevated to **30 to 45** degrees to reduce reflux of gastric contents and should undergo regular subglottic secretion suctioning to avoid pooling of secretions above the **endotracheal tube cuff**

- **Central Venous Catheter–Associated Infections** Their use is associated with complications, including bloodstream infections introduced by contamination of the foreign material that is penetrating the skin and residing in a large vein. Patients who develop catheter-associated bloodstream infections have increased length of stay and approximately triple the risk of in-hospital death.

- Prevention of catheter-associated bloodstream infections:
- nursing observation of insertion procedures
- hand hygiene
- maximum sterile barrier precautions for the operator and for the patient
- chlorhexidine-alcohol antiseptic skin preparation.

- Infections related to infection-prevention breaches during catheter insertion typically manifest within **5 days** of insertion.
- **Catheter-Associated Urinary Tract Infections** Catheter-associated urinary tract infections are among the most common health care–associated infections
- Risk factors for catheter-associated urinary tract infections were established long ago and include **duration of catheterization, female sex, critical illness, and older age**

- **Daily reevaluation** of indications for urinary catheters identifies **unnecessary** catheter use and significantly reduces catheter use, duration of catheter use, and the rate of catheter-associated urinary tract infections. Use of alternatives to indwelling catheters, such as **condom catheters** and intermittent straight catheterization, also reduces risk of urinary tract infection. Other strategies that prevent catheter-associated urinary tract infections include education, sterile and atraumatic insertion, and maintenance of a sterile, closed drainage system.

DEFINITION OF TERMS

- ***Sterilization*** is defined as the complete elimination or destruction of all forms of microbial life and is accomplished in health care facilities through either physical or chemical processes.
- ***Disinfection*** describes a process that eliminates many or all pathogenic microorganisms on inanimate objects, with the exception of *bacterial spores*.
- ***Cleaning***, on the other hand, is the removal of visible soil and microbial contaminants from objects and surfaces, and it normally is accomplished by manual or mechanical means using water with detergents or enzymatic products.

- **Critical Items**

- high risk of infection if such an item is contaminated with any microorganism
- It is critical that objects that enter sterile tissue or the vascular system be sterile because any microbial contamination could result in disease transmission.
- This category includes **surgical instruments, cardiac and urinary catheters, implants, arthroscopes, laparoscopes, and ultrasound probes** used in sterile body cavities.

- Most of the items in this category should be purchased as sterile or be sterilized with steam sterilization if possible. If heat sensitive, the object may be treated with ETO, hydrogen peroxide gas plasma, vaporized hydrogen peroxide vapor, hydrogen peroxide vapor plus ozone, or liquid chemical sterilants if other methods are unsuitable.
- **Semicritical Items** Semicritical items are those that come in contact with intact mucous membranes or nonintact skin.

- Respiratory therapy and **anesthesia equipment**, some **endoscopes**, **laryngoscope** blades and handles, **esophageal manometry probes**, **endocavitary probes**, **nasopharyngoscopes**, **prostate biopsy probes**, **infrared coagulation devices**, **anorectal manometry catheters**, **cystoscopes** are included in this category.
- These medical devices should be free of all microorganisms, although small numbers of bacterial spores may be present.

- Semicritical items minimally require high-level disinfection with chemical disinfectants.
- Glutaraldehyde, hydrogen peroxide, OPA, peracetic acid, hypochlorite (via superoxidized water) and peracetic acid with hydrogen peroxide are cleared by the Food and Drug Administration (FDA) and are dependable **high-level** disinfectants, provided that the factors influencing germicidal procedures are met

- **Noncritical Items** Noncritical items are those that come in contact with intact skin but not mucous membranes.
- Examples of noncritical items are bedpans, blood pressure cuffs, bed rails, bedside tables, patient furniture, toys, portable equipment (e.g., wheelchairs, infusion pumps, pulse oximeters, medication carts), and floors. However, these items (e.g., bedside tables, bed rails) could potentially contribute to secondary transmission by contaminating hands of health care providers or by contact with medical equipment that will subsequently come in contact with patients.

Personal Protective Equipment (PPE)

- **Hand Hygiene**

Hand hygiene has been cited frequently as the single most important practice to reduce the transmission of infectious agents in healthcare settings and is an essential element of **Standard** Precautions. The term “hand hygiene” includes both handwashing with either plain or antiseptic-containing soap and water, and use of alcohol-based products (gels, rinses, foams) that do not require the use of water.

Hand washing technique with soap and water



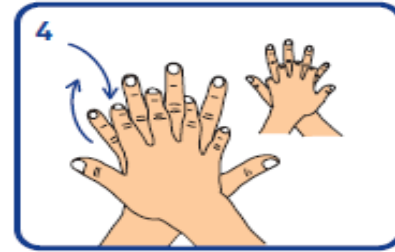
Wet hands
with water



Apply enough soap
to cover all hand
surfaces



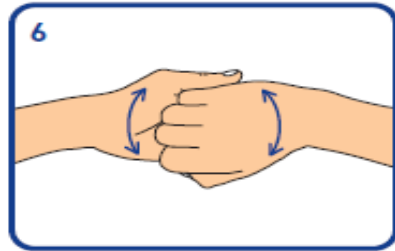
Rub hands palm
to palm



Rub back of each hand
with palm of other hand
with fingers interlaced



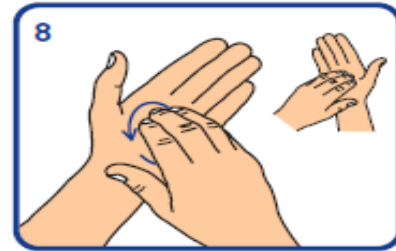
Rub palm to palm with
fingers interlaced



Rub with back of fingers
to opposing palms with
fingers interlocked



Rub each thumb clasped
in opposite hand using a
rotational movement



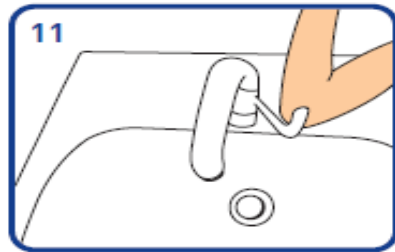
Rub tips of fingers in
opposite palm in a
circular motion



Rub each wrist with
opposite hand



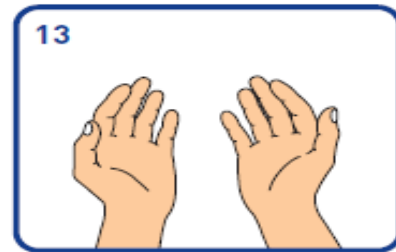
Rinse hands
with water



Use elbow to turn off tap
(if no elbow tap available
use paper towel to turn off tap)



Dry thoroughly with
a single-use towel



Hand washing should
take 40-60 seconds

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World Health
Organization

Adapted from World Health Organization Guidelines
on Hand Hygiene in Health Care 2009

- **Personal Protective Equipment (PPE) for Healthcare Personnel**

PPE refers to a variety of barriers and respirators used alone or in combination to protect mucous membranes, airways, skin, and clothing from contact with infectious agents. The selection of PPE is based on the nature of the patient interaction and/or the likely mode(s) of transmission

- ***Gloves.*** Gloves are used to prevent contamination of healthcare personnel hands when
 1. anticipating direct contact with blood or body fluids, mucous **membranes, nonintact skin** and other potentially infectious material;
 2. having direct contact with patients who are **colonized or infected** with pathogens transmitted by the contact route e.g., VRE, MRSA, RSV
 3. handling or touching visibly or potentially contaminated patient care **equipment and environmental surfaces.**

- The extent to which gloves will protect healthcare personnel from transmission of **bloodborne** pathogens (e.g., HIV, HBV, HCV) following a needlestick or other puncture that penetrates the glove barrier has not been determined.
- While there is little difference in the barrier properties of unused intact gloves, studies have shown repeatedly that **vinyl gloves** have **higher failure rates than latex or nitrile** gloves when tested under simulated and actual clinical conditions. For this reason either latex or nitrile gloves are preferable for clinical procedures that require manual dexterity and/or will involve more than brief patient contact.

- ***Isolation gowns.*** Isolation gowns are used as specified by Standard and Transmission-Based Precautions, to protect the HCW's arms and exposed body areas and prevent contamination of clothing with blood, body fluids, and other potentially infectious material
- When applying Standard Precautions, an isolation gown is worn only if contact with blood or body fluid is anticipated.

- ***Face protection: masks, goggles, face shields.***
- ***Masks.*** Masks are used for three primary purposes in healthcare settings:
 1. placed on healthcare personnel to protect them from contact with infectious material from patients e.g., respiratory secretions and sprays of blood or body fluids, consistent with Standard Precautions and Droplet Precautions.

- 2. placed on healthcare personnel when engaged in procedures requiring **sterile technique** to protect patients from exposure to infectious agents carried in a healthcare worker's mouth or nose, and
- 3. placed on **coughing** patients to limit potential dissemination of infectious respiratory secretions from the patient to others.

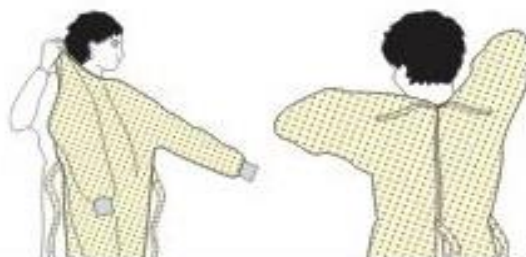
- ***Goggles, face shields*** The eye protection chosen for specific work situations (e.g., goggles or face shield) depends upon the circumstances of exposure, other PPE used, and personal vision needs.
- The role of goggles, in addition to a mask, in preventing exposure to infectious agents transmitted via respiratory droplets
- As compared with goggles, a face shield can provide protection to other facial areas in addition to the eyes. Face shields extending from chin to crown provide better face and eye protection from splashes and sprays

SEQUENCE FOR PUTTING ON PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE used will vary based on the level of precautions required, such as standard and contact, droplet or airborne infection isolation 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



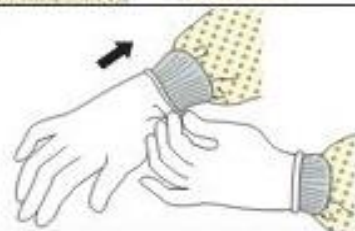
3. GOGGLES OR FACE SHIELD

- Place over face and eyes and adjust to fit



4. GLOVES

- Extend to cover wrist of isolation gown

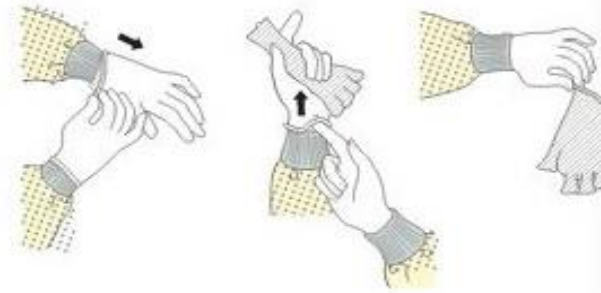


SEQUENCE FOR REMOVING PERSONAL PROTECTIVE EQUIPMENT (PPE)

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 glovet
- 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



Thanks for your attention