Objectives

• Describe the chain of infection

• Explain the role of personal protective equipment (PPE) in interruption of transmission of infection

• List the proper order for donning & doffing PPE

• Describe issue of emerging antibiotic resistance
Interrupting Transmission

• Breaking any link in the chain

• Examples
  – Eliminate the pathogen
  – Eliminate portal of entry
  – Modify status of susceptible host
  – Interrupt mode of transmission
• Types of Pathogens
  – Bacteria
  – Virus
  – Fungi

• Eliminate the Pathogen or Reservoir
  – Antibiotics/antivirals/antifungals
  – Disinfection of surfaces/equipment
Minimize Portal of Entry

• Invasive devices
  – Foley
  – Central Lines
  – Vent

• Maintain skin integrity
  – Incisions
  – Decubitus
  – Skin tears
Susceptible Host

- Modifiable vs Non-modifiable
  - Age
  - Immune status
  - Comorbidities
  - Vaccinate
  - Discharge!!!
Interrupt Transmission

• Hand hygiene
  – *#1 method to prevent the spread of infection!*

• Monitoring Activities
  – What is ultimate message???
Commentary

Are we sending the wrong message when we ask health care workers to wash their hands?

Sharon L. Kurtz RN, MPH, CIC *

Walden University, Minneapolis, MN
“When asking healthcare workers to wash their hands, perhaps a better message would be to ask them not to transmit disease. This changes the emphasis from a single act of adherence to a concept of behavior change.”
How to Handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS WHEN VISIBLY SOILED

Duration of the entire procedure: 20-30 seconds

1a. Apply a palmful of the product in a cupped hand, covering all surfaces;
1b. Rub hands palm to palm;
2. Right palm over left dorsum with interlaced fingers and vice versa;
3. Palm to palm with fingers interlaced;
4. Backs of fingers to opposing palms with fingers interlocked;
5. Rotational rubbing of left thumb clasped in right palm and vice versa;
6. Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;
7. Once dry, your hands are safe.
8. 

World Health Organization | Patient Safety | SAVE LIVES
A World Alliance for Safer Health Care | Clean Your Hands

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Handwash chart from the World Health Organisation website, 2009
How to Handwash?
WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

Duration of the entire procedure: 40-60 seconds

0. Wet hands with water;

1. Apply enough soap to cover all hand surfaces;

2. Rub hands palm to palm;

3. Right palm over left dorsum with interlaced fingers and vice versa;

4. Palm to palm with fingers interlaced;

5. Backs of fingers to opposing palms with fingers interlocked;

6. Rotational rubbing of left thumb clasped in right palm and vice versa;

7. Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;

8. Rinse hands with water;

9. Dry hands thoroughly with a single use towel;

10. Use towel to turn off faucet;

11. Your hands are now safe.

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Handwash chart from the World Health Organisation website, 2009
Interrupt Transmission, cont. . .

• Personal Protective Equipment
  – Gowns
  – Gloves
  – Eye shields
  – Masks

• Universal Precautions vs. Standard Precautions
Universal Precautions

• Developed by OSHA
• Treat all blood and certain body fluids as infectious
• Target HIV, Hepatitis B, Hepatitis C
Standard Precautions

• Developed by CDC to protect care givers from spread of infectious diseases by all modes

• Expanded Universal Precautions to include
  • all blood
  • body fluids, secretions, and excretions (except sweat) bloody or not
  • non-intact skin
  • mucous membranes
Transmission Based Precautions

- Standard Precautions **plus**
  - Contact
  - Droplet
  - Airborne
- Choose PPE according to anticipated exposure
• 14th Century Plague Doctor
  – Hat
  – Mask (Beak)
  – Glasses/goggles
  – Gown
  – Pointer

https://www.cdc.gov/plague/history/index.html
PPE Now......
• Consider this….
  – Severe Acute Respiratory Syndrome (SARS)- 2003
  – Middle East Respiratory Syndrome (MERS)- 2012
  – Ebola-2013

• All implicated improper removal of PPE in transmission of infection to HCW
### Characteristics of the SARS outbreak in the greater Toronto Area and Taiwan, March-June 2003

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>GTA, no. (%)</th>
<th>Taiwan, no. (%)&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cases</td>
<td>375</td>
<td>NA</td>
</tr>
<tr>
<td>Probable</td>
<td>247 (66)</td>
<td>668</td>
</tr>
<tr>
<td>Suspected</td>
<td>128 (34)</td>
<td>NA</td>
</tr>
<tr>
<td>Deaths</td>
<td>44 (12)</td>
<td>72 (11)</td>
</tr>
<tr>
<td>Healthcare related</td>
<td>271 (72)</td>
<td>370 (55)</td>
</tr>
<tr>
<td>Healthcare workers</td>
<td>164 (44)</td>
<td>120 (18)</td>
</tr>
<tr>
<td>Patients or visitors</td>
<td>107 (28)</td>
<td>256 (38)</td>
</tr>
<tr>
<td>Hospitals with hospitalized SARS patients</td>
<td>23</td>
<td>84</td>
</tr>
<tr>
<td>Hospitals with SARS transmission</td>
<td>10 (43)</td>
<td>8 (10)</td>
</tr>
<tr>
<td>Hospitals that closed wards or an emergency room</td>
<td>10 (43)</td>
<td>NA</td>
</tr>
</tbody>
</table>

<sup>a</sup>SARS, severe acute respiratory syndrome; GTA, greater Toronto area; NA, data not available

<sup>b</sup>Percentage expresses proportion of all probable SARS cases

MERS In the US

• Two unrelated cases
  – Indiana & Florida
  – Both *healthcare workers* in Saudi Arabia

• Study in Thailand supported use of PPE to prevent transmission
  – Tested HCW with known exposure (avg 35 min) with PPE
  – All samples negative
• HCW Guinea
  – 162 (7.9 %) cases were HCW
  – 42.2 times higher than non HCW

• Guinea:
  – doctors > nurses

• Sierra Leone
  – nurses > doctors

Reference: Ebola Virus Disease in Health Care Workers — Guinea, 2014
MMWR October 2, 2015 / 64(38);1083-1087
EBOLA, cont.

• US Ebola Experience
  – Oct 10, 2014
    • HCW tested + Ebola after caring for an imported case
  – Oct 15, 2014
    • 2\textsuperscript{nd} HCW tested +
    • Also cared for index case
# Example of Checklist for Donning/Doffing for Ebola

## Donning - PPE Checklist

**Name:** 

**Vital Signs:** T_____ P_____ bpm R_____ /min BP_____ /_____ mm Hg

**Donning Partner:** 

---

<table>
<thead>
<tr>
<th>Step</th>
<th>Task</th>
<th>Check when Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Perform Hand Hygiene</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Change into hospital provided scrubs and footwear</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Remove all jewelry and personal items</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Secure hair</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Perform Hand Hygiene</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Apply standard nitrile gloves</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Put on boot cover</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Apply jumpsuit. (1) Keep glove cuff under sleeve (2) Secure hook over gloved thumb</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Apply N95</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>(1) Seal mask to face (2) Straps should not be crossed-placed at crown of head and base of neck (3) Perform fit check</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Apply hood</td>
<td></td>
</tr>
</tbody>
</table>
Current Compliance Studies

- ER study - 1999
  - Observed 88 videotaped cases
    - Major break (involved in invasive procedure) observed in 33.6%
    - Minor break (adjacent to patient) observed in 55.5%
    - Most common = no eye protection
2009 Canadian Study
  - More experienced HCW are more compliant

2013 Canadian PPE Study (Resp Illness)
  - 34% donned all PPE required
  - 54% doffed in correct sequence
    - (MDs worst)
  - 9% did not perform HH

2013 Canadian Mask Study
  - 11% performed 6 necessary steps for correct donning
  - ER nurses least compliant
• 2014 US PPE Study
  – Observed 30 HCW in Contact Isolation remove PPE
    – 17% correct order & correct disposal
    – 53% wore PPE in hall

• 2015 PPE Training Survey
  – 14% MDs reported no PPE training
  – 18% agreed HH not needed if gloves are used
  – 29% interested in receiving training
Influences on Compliance

- Organizational culture
- User input in selection
- Comfort
- Time
- Availability
- Belief PPE interferes w/ nurse-patient relationship
- Education
  - When and how
PPE Donning & Doffing

- Purposeful
- Careful
- Slow
- Gentle

HOW I FEEL COMING OUT OF ISOLATION ROOMS
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

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

- Keep hands away from face
- Limit surfaces touched
- Change gloves when torn 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 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

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

(CDC)
**Proper Donning**

**SEQUENCE FOR DONNING PERSONAL PROTECTIVE EQUIPMENT (PPE)**

The type of PPE used will vary based on the level of precautions required; e.g., Standard and Contact, Droplet or Airborne Infection Isolation.

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 torn or heavily contaminated
- Perform hand hygiene

---

**SECUENCIA PARA PONERSE EL EQUIPO DE PROTECCIÓN PERSONAL (PPE)**

El tipo de PPE que se debe utilizar depende del nivel de precaución que sea necesario; por ejemplo, equipo Estándar y de Contacto o de Aislamiento de infecciones transportadas por gotas o por aire.

1. **BATA**
   - Cubra con la bata todo el torso desde el cuello hasta las rodillas, los brazos hasta la muñeca y dóblela alrededor de la espalda
   - Átesela por detrás a la altura del cuello y la cintura

2. **MÁSCARA O RESPIRADOR**
   - Asegúrese los cordones o la banda elástica en la mitad de la cabeza y en el cuello
   - Ajuste la banda flexible en el puente de la nariz
   - Acomódelo en la cara y por debajo del mentón
   - Verifique el ajuste del respirador

3. **GAFAS PROTECTRAS O CARETAS**
   - Colóquelas sobre la cara y los ojos y ajustela

4. **GUANTES**
   - Extienda los guantes para que cubran la parte del puño en la bata de aislamiento

---

**UTILICE PRÁCTICAS DE TRABAJO SEGURAS PARA PROTEGERSE USTED MISMO Y LIMITAR LA PROPAGACIÓN DE LA CONTAMINACIÓN**

- Mantenga las manos alejadas de la cara
- Limite el contacto con superficies
- Cambie los guantes si se rompen o están demasiado contaminados
- Realice la higiene de las manos
Proper Doffing

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 IMMEDIATELY AFTER REMOVING ALL PPE

SECUENCIA PARA QUITARSE EL EQUIPO DE PROTECCIÓN PERSONAL (PPE)

Con la excepción del respirador, quítese el PPE en la entrada de la puerta o en la antecámara. Quitese el respirador después de salir de la habitación del paciente y de cerrar la puerta.

1. GUANTES
   - ¡El exterior de los guantes está contaminado!
   - Agarre la parte exterior del guante con la mano opuesta en la que todavía tiene puesto el guante y quitélo.
   - Sostenga el guante que se quitó con la mano guantada.
   - Deslice los dedos de la mano sin guante por debajo del otro guante que no se ha quitado todavía a la altura de la muñeca.
   - Quitese el guante de manera que acabe cubriendo el primer guante.
   - Arroje los guantes en el recipiente de desechos.

2. GAFAS PROTECTORAS O CARETA
   - ¡El exterior de las gafas protectoras o de la careta está contaminado!
   - Para quitárselas, tómelas por la parte de la banda de la cabeza o de las piezas de las orejas.
   - Colóquelas en el recipiente designado para reprocessar materiales o de materiales de desecho.

3. BATA
   - ¡La parte delantera de la bata y las mangas están contaminadas!
   - Desate los cordones.
   - Tocando solamente el interior de la bata, pásela por encima del cuello y de los hombros.
   - Voltee la bata al revés.
   - Dóblela o enróllelo y deséchela.

4. MÁSCARA O RESPIRADOR
   - La parte delantera de la máscara o respirador está contaminada — ¡NO LA TOQUE!
   - Primero agarre la parte de abajo, luego los cordones o banda elástica de arriba y por último quitese la máscara o respirador.
   - Arrojela en el recipiente de desechos.

EFFECTÚE LA HIGIENE DE LAS MANOS INMEDIATAMENTE DESPUÉS DE QUITARSE CUALQUIER EQUIPO DE PROTECCIÓN PERSONAL.
Live Demo

• Donning
  – Gown
  – Mask
  – Goggle/Face shield
  – Gloves

• Doffing
  – Gloves
  – Goggles/face shield
  – Gown
  – Mask
The more we look at drug resistance, the more concerned we are. It basically shows us that the end of the road isn't very far away for antibiotics.

Tom Frieden, Director, Centers for Disease Control & Prevention

https://www.brainyquote.com/quotes/quotes/t/tomfrieden763145.html?src=t_antibiotic
Definition:

MDROs are defined as microorganisms, predominantly bacteria, that are resistant to one or more classes of antimicrobial agents. Although the names of certain MDROs describe resistance to only one agent (e.g., MRSA, VRE), these pathogens are frequently resistant to most available antimicrobial agents.

CDC, Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006
How Antibiotic Resistance Happens

1. Lots of germs. A few are drug resistant.
2. Antibiotics kill bacteria causing the illness, as well as good bacteria protecting the body from infection.
3. The drug-resistant bacteria are now allowed to grow and take over.
4. Some bacteria give their drug-resistance to other bacteria, causing more problems.

**Examples of How Antibiotic Resistance Spreads**

1. Animals get antibiotics and develop resistant bacteria in their guts.
2. Drug-resistant bacteria can remain on meat from animals. When not handled or cooked properly, the bacteria can spread to humans.
3. Fertilizer or water containing animal feces and drug-resistant bacteria is used on food crops. Drug-resistant bacteria in the animal feces can remain on crops and be eaten. These bacteria can remain in the human gut.
4. George gets antibiotics and develops resistant bacteria in his gut.
5. George stays at home and in the general community. Spreads resistant bacteria.
6. George gets care at a hospital, nursing home or other inpatient care facility.
7. Resistant germs spread directly to other patients or indirectly on unclean hands of healthcare providers.
8. Resistant bacteria spread to other patients from surfaces within the healthcare facility. Patients go home.

**Simply using antibiotics creates resistance. These drugs should only be used to treat infections.**
Evolution of Antibiotic Resistance

- 1940’s Penicillin available for medical use
  - 1967- 1st penicillin resistant strep
  - 1980- 3-5% resistant
  - 1998- 34% resistant

- MRSA (Methicillin-resistant *Staph Aureus*)
  - 1961-MRSA identified in England
  - 1968-MRSA identified in United States (Boston)
• VRE (Vancomycin Resistant Enterococci)
  • 1988-1st report of VRE
  • 20 fold increase from 1989 (0.3%) to 1993 (7.9%)
  • Bacteremia associated with high mortality
• ESBL’s
  • 1980s identified enzymes (beta-lactamase) produced by Klebsiella & E coli that destroyed the *extended spectrum* cephalosporins
  • Enzymes do not affect carbapenems
  • Many are also genetically resistant to multiple antibiotics
  • Difficult to detect in lab
  • Resistance is encoded by genes located on plasmids, resulting in easy transfer to other species
Most ESBL’s still susceptible to:
- Cefoxitin
- Cefotetan
- Meropenem
- Imipenem

Carbapenems are treatment of choice
Now there are carbapenem resistant organisms; commonly called KPC or CRE

Typically in the Enterobacteriaceae family
- Klebsiella species
- E. coli
- Proteus mirabilis
- Enterobacter cloacae

Several mechanisms to cause resistance
- Produce enzyme (carbapenemase) causes resistance to carbapenems (KPC)

Carbapenemase production not confined to one bacteria indicating that there is plasmid transfer capability
Colistin is one of the last efficacious antibiotics for the treatment of highly resistant bacteria. ... The gene is transferrable to other bacteria, which could worsen the current global crisis of antimicrobial resistance. An urgent public health response is underway to contain and prevent potential spread of mcr-1.

May 26, 2016
Impact on Oncology Patient

- High mortality—up to 50% if bacteremic
- Increase C.diff infections
- HAI cycle
  - LOS - Risk of Infection - Need for abx
- Delay treatment
- Increased cost/LOS
- Impact on prophylaxis/treatment options
Combating Resistance

• CDC Four Core Actions
  – Prevent infections - prevents spread of resistance
  – Track/Collect Information - rapid detection
  – Improve antibiotic use/stewardship
  – Develop drugs and diagnostic tests

• https://www.cdc.gov/drugresistance/index.html
The number of new antibiotics developed and approved has steadily decreased in the past three decades, leaving fewer options to treat resistant bacteria.

*Intervals from 1980–2009 are 5-year intervals; 2010–2012 is a 3-year interval. Drugs are limited to systemic agents. Data courtesy of FDA’s Center for Drug Evaluation and Research (CDER).*
• Personal Contributions
  – Prevent spread of infections/resistance
    • Learn proper techniques
    • Perform hand hygiene
    • Use PPE properly all of the time
  – Improve antibiotic use
    • Review drug – bug results in your pts
    • Don’t insist on abx when sick
    • Complete abx prescription as indicated
    • Educate your patients and your families
• Demo of Incorrect PPE
  – Donning
  – Doffing

• Special thanks to our model!!
Some experts say we are moving back to the pre-antibiotic era. No. This will be a post-antibiotic era. In terms of new replacement antibiotics, the pipeline is virtually dry. A post-antibiotic era means, in effect, an end to modern medicine as we know it. Things as common as strep throat or a child's scratched knee could once again kill.

Margaret Chan, Director General, World Health Organization

https://www.brainyquote.com/quotes/quotes/m/margaretc516579.html?src=t_antibiotics