Transmission

Infectious Disease Epidemiology
Mode of Transmission
Classification by portal of entry

- Respiratory
- Gastrointestinal
- Skin
- Genital
- Intrauterine or transplacental
- Urinary
- Personal contact
- Water and food
- Arthropod borne
Transmission:
Source of Infectious Material

- **Blood**: splashed on medical employee...
- **Internal Body fluids** (cerebrospinal, pericardial, pleural, peritoneal, synovial, amniotic): medical setting.
- **Genital fluids** (vaginal, prostatic secretions, semen): sexual contact
  HBV, HSV to the newborn occurs during delivery.
- **Transplacental transfer** of blood: syphilis.
- **Secretions**: saliva, nasal discharge, sweat, tear, breast milk
- **Excretions**: urine (schistosomiasis, leptospirosis), feces (numerous enteropathogens)
- **Mucosal membranes** (nasal, oropharyngeal, rectal, genital): sexual contact, delivery
- **Skin**, squames
- **Tissue**: Transplant, grafts, blood transfusion, blood components
- **Bites**

Blood, internal fluids and genital fluids do contain blood borne pathogens (HIV, HBV, HCV, CMV)
Gastro Intestinal / Fecal Oral Route (Contact)

Transmission by the fecal-oral route is the second most important mode of transmission after the respiratory tract

- excreted by the feces
- transmitted to the oral portal of entry through
  - contaminated food,
  - contaminated water, milk, drinks
  - hands
  - flies
- Site of entry:
  - oropharynx for some microorganisms
  - intestinal tract for most viruses.
- Surviving through the upper GI tract is essential.

Viruses with envelopes do not survive exposure to hydrochloric acid in the stomach, bile acids in the duodenum, salts and enzymes of the gut.

Small enterovirus without envelope (Norovirus, rotavirus, polio & coxsackie) able to resist.

Hepatitis A and E also transmitted by fecal oral route.
Transmission by gastrointestinal route
Fecal oral route

- Typhoid fever
- Shigella
- Cholera
- Polio
- Coxsackie, Echo, Reo
- Norwalk agent
- Rotavirus
- Hepatitis A, Hepatitis E
Salmonellas infect a wide variety of domestic animals, birds and other wildlife. Food derived from salmonella infected animal (eggs, dairy product, meat) are the major source of infection if improperly prepared. Salmonella is less often transmitted by water or direct contact.
Sexual transmission
(mucous membrane transmission)

- Neisseria gonorrhoeae, Chlamydia trachomatis
- Treponema pallidum
- Hemophilus ducreyi
- Mycoplasma hominis, Ureaplasma urealyticum
- Calymmatobacterium granulomatis
- ± Shigella spp, Campylobacter spp
- ± Group B streptococci
- ± Bacterial vaginosis associated bacteria
- HSV Herpes simplex virus 1 and 2
- CMV Cyto megalovirus or herpes virus 5
- Hepatitis B virus
- Human papilloma virus
- Molluscum contagiosum virus
- HIV Human immunodeficiency virus 1 and 2
- Trichomonas vaginalis
- ± Entamoeba histolytica, Giardia lamblia
- Phtirius pubis
- Sarcoptes scabei
Perinatal transmission
(mucous membrane transmission)

Infections occur when the newborn goes through the birth canal, from the cervix or vagina to the newborn.

- Neisseria gonorrhoeae
- Chlamydia trachomatis
- HBV
- HSV
Microorganisms present in the blood of the mother go through the placenta to infect the fetus. In some cases it is difficult to differentiate between perinatal or transplacental transmission, since both modes of transmission are known to occur.

- Syphilis
- Toxoplasma
- CMV, HBV
- HIV
- HSV
- Rubella, Varicella
Sexual transmission (mucous membrane transmission)

- Bacteria and viruses present in the genital fluids and on the mucosal membranes.
- Transmitted to the mucosal membranes of the partner during sexual acts: membranes involved
  - vagina,
  - penis,
  - anus and rectum
  - oropharynx.
Arthropod borne transmission may transmit infections by two mechanisms:

- **Passive transmission:**
  - the insect acts as a live syringe
  - no incubation time,
  - no multiplication while carried by the arthropod
  - not specific, wide variety of microorganisms
  - not very inefficient.

- **Active transmission:**
  - multiplication of microorganisms in arthropod
  - may be very effective: multiplied 1000 to million
  - requires a period of multiplication in the arthropod
  - very specific: some microrganisms & arthropods

Mosquitoes, flies, fleas, true bugs, ticks, lice
Food poisoning overlaps both classes of gastrointestinal transmission.

- Food from infected animal & improperly prepared: eggs, chicken with Salmonella, listeria in unpasteurized milk
- Food contaminated in environment: Vibrio vulnificus or Vibrio cholerae in raw oysters,
- Food contaminated during preparation from an infected food item: potato salad contaminated by Salmonella from raw chicken
- Food contaminated by human source: typhoid fever carrier.
Break in the skin barrier may result from:

- Needle injection, cut during a surgical procedure, accidental cut, crushing injury...
- Bite: rabies
- Arthropod bite for vector borne infections: malaria, filariasis...

Some parasites are able to penetrate directly through the intact skin: larvae of hookworm, cercariae of schistosoma.
Isolation guidelines in Institutions are based on these main modes of transmission:

- **AIRBORNE**
- **DROPLET**
- **CONTACT**

**AND** Vectorborne,
Common source:
Water, Food,
Equipment, Rx

Direct
Indirect
### Droplet Transmission

<table>
<thead>
<tr>
<th>Droplet Size (μm)</th>
<th>Time to Fall</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>10 seconds</td>
<td>Direct hit 3 ft</td>
</tr>
<tr>
<td>40</td>
<td>1 minute</td>
<td>Droplets above 10 μm are trapped in the nose and usually do not make it to the bronchi</td>
</tr>
<tr>
<td>20</td>
<td>4 minutes</td>
<td>May reach lower respiratory tract</td>
</tr>
<tr>
<td>10</td>
<td>20 minutes</td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>30-45 minutes</td>
<td></td>
</tr>
<tr>
<td>≤ 5</td>
<td></td>
<td>May be inhaled to alveoli</td>
</tr>
</tbody>
</table>

**Direct Hit:** If the droplet is inhaled directly, it will not fall out of the respiratory tract and can cause severe respiratory issues.
Transmitted by Droplets

- Hemophilus influenzae
- Meningococci
- Pneumococcal infections (invasive, resistant)
- BACTERIAL RESPIRATORY Infections
  - Diphtheria, Pertussis, pneumonic plague, Mycoplasma pneumoniae
  - Streptococcal pharyngitis, pneumonia, scarlet fever
- VIRAL RESPIRATORY Infections
  - Adenovirus, Influenza, Mumps, Parvovirus, Rubella
- ANY PAROXYSMAL COUGH (Pertussis?)
Airborne Transmission

- Droplet nuclei = droplets less than 5 µ in diameter
  - from evaporation of larger droplets
  - or from direct formation during coughing, speaking, singing
- Transmission may occur over long distance

Transmitted by D.N.
- Tuberculosis (Infectious)
- Suspects of TB: request sputum smear
- Measles
- Varicella
- Smallpox (hemorrhagic)
Cough produces good droplet nuclei

- **Cough**
  - 1 good cough produces 465 DN
  - after 30 minutes left: 228 DN (49%)

- **Speech:**
  - count from 1 to 100 1764 DN
  - after 30 minutes left 106 DN (6%)
Transmitted by Contact

- Gastrointestinal, respiratory, skin, wound infections
- Colonization with multidrug resistant bacteria
- Enteric infections, enteroviral infections in infants
- RSV, parainfluenza,
- Infectious skin infections: HSV, impetigo, cellulitis, scabies, staphylococcal furunculosis,
- Viral hemorrhagic conjunctivitis, viral fevers
- Some respiratory infections, bronchiolitis in infants, children
- Abscess, draining wound
BBP & Skin Penetration

- Blood borne pathogens (HBV, HCB, HIV) does not penetrate if blood was splashed exclusively on intact skin.
- Need injury to the skin: with a hollow bore needle or other sharp object (lancet, glass, scalpel) contaminated with blood to cause an infection.
- Solid needle do not carry sufficient quantities of blood to cause an infection (±).
- Viral titer is best predictor of risk of infection.
- Mucosal membranes allow BBP penetration.

Data from 21 studies worldwide on mucosal membrane exposure of 1107 HCW to HIV showed only one conversion: risk of 0.09%, 95%CI = 0.006% to 0.5%.
Isolation

Precaution

Infectious Disease Epidemiology
Isolation Precaution System for Institutions

IS AN EXPANSION OF
UNIVERSAL PRECAUTIONS
Standard Precautions

- Same concept as UNIVERSAL PRECAUTIONS
  - Precautions should be taken for any contact with Blood and Body Fluid (UP)
  - AND for any contact with secretions and excretions, mucous membranes, damaged skin, contaminated environment and equipment
Handwashing

- BEGINNING AND END OF DAY
- BEFORE & AFTER EACH PATIENT CONTACT
- BEFORE AND AFTER GLOVING
- ANYTIME AFTER CONTACT WITH
  - BLOOD & BODY FLUID
  - SECRETIONS / EXCRETIONS
  - MUCOUS MEMBRANES
  - DAMAGED SKIN
  - CONTAMINATED ENVIRONMENT
  - CONTAMINATED EQUIPMENT

10-15s
### Handwashing

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of Klebsiella on nurse’s hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse /Blood pressure</td>
<td>100 - 1,000</td>
</tr>
<tr>
<td>Touching hand</td>
<td>10 - 100</td>
</tr>
<tr>
<td>Touch shoulder</td>
<td>7,000</td>
</tr>
<tr>
<td>Oral Temperature</td>
<td>100 - 1,000</td>
</tr>
</tbody>
</table>


- **Hands of nurses washed and cultured:**
  - ➔ no Klebsiella

- **Patient care Activity**
  - 10-15s
Gloves

- FOR ANY CONTACT WITH
- Blood and Body Fluids
- Secretions & excretions
- Mucous membranes
- Damaged skin
- Contaminated environment or equipment

If it is wet, red or dirty
Wash, glove then wash

Gloves DO NOT REPLACE HANDWASHING
Eye Protection
Face Shield

- RISK OF SPRAY
- RISK OF SPLASH
- of blood, body fluid, secretion or excretion
- in FACE OR EYE
Surgical Masks

- **STANDARD PRECAUTIONS**
  - For personnel to protect from splashes / sprays of BBF / SE

- **DROPLET PRECAUTIONS**
  - To prevent large droplets (>5 μm) on/from patient
  - For patients
    - To prevent emission of droplet (large and droplet nuclei)
Gown

- **STANDARD PRECAUTION**
  - To protect from splashes/sprays of large quantities of BBF/S E
- **CONTACT PRECAUTION**
  - To protect contamination of personnel clothing
Patient Placement

- **AIRBORNE**
  - Private room with ventilation control

- **DROPLET & CONTACT**
  - Private room preferred
  - or cohort with same infection
  - or at least 3 feet between beds
  - Use common sense: do not mix in immunocompromised patient with infected one
Small droplets (<5μ) emitted when coughing, & performance of procedures

- **ROOM WITH VENTILATION CONTROL**
  - Negative air pressure
  - >6 air exchange /hour
  - HEPA filtered or exhaust out
- **PERSONAL RESPIRATOR**
- **PATIENT** wears surgical mask if coughing & when transported
Airborne Precautions
Personal Respirator

- For Personnel
- In AIRBORNE ISOLATION ONLY
- To prevent inhalation of droplet nuclei
- Main leak comes from poor fit around face
Droplet Precautions

Large particle droplets (>5μ) emitted when coughing, sneezing, talking & performance of procedures

- Private room (*)
- Mask when entering room

use STANDARD PRECAUTIONS at ALL times for ALL patients
Contact Precautions

- Private room (*)
- Gloves when entering room,
- change glove after infectious contact
- Gown when entering room if substantial contact will occur

use STANDARD PRECAUTIONS at ALL times for ALL patients