Key Components of an Infection Control Program

Infectious Disease Epidemiology Section
Office of Public Health
Louisiana Dept of Health
800-256-2748
www.infectiousdisease.dhh.louisiana.gov
Your taxes at work

Program Objectives

- List the key components of an infection control program
- Discuss factors associated with the spread of infection in a health care setting
- Describe common approaches to infection control
- Discuss types of procedures that should be in place to prevent the spread of infection
- Describe methods of surveillance and the objectives of surveillance
- Describe data collection methods used in an infection control program

Disclosure

I have no financial interests or other relationship with manufacturers of commercial products, suppliers of commercial services, or commercial supporters. This session will not include any discussion of a product unlabeled or under investigational use.

IC Program Components
Infection Control Key Components

**Scope of Infection Control**
Prevention of Hospital Acquired (Nosocomial) Infections

- **STANDARD PRECAUTIONS**
  - Handwashing
  - Barrier precautions
  - Sharps disposal

- **IC COMMITTEE IC POLICIES**

- **ISOLATION PRECAUTIONS**

- **ENVIRONMENTAL CONTROL**
  - Physical facility
  - Patient care equipment
  - Water, Air, Food
  - Solid waste, Liquid waste

- **EMLOYEE HEALTH**
  - CD Reporting
  - HBV screening & immunization
  - MMR, Varicella
  - Work restriction
  - Prophylactic Rx: Mng, Pert, TB, HAV, HBV

- **SURVEILLANCE**
  - Nosocomial infection
  - Surveillance system
  - Antibiotic sensitivity

- **COMMINICABLE DISEASE CONTROL IN HOSPITAL**
  - Reporting of disease
  - MRSA...
  - Preventive treatment of exposed

- **SPECIAL PROCEDURES**
  - Cardiovascular access lines
  - Wound care
  - Urinary catheter
  - Artificial ventilation ....

- **STERILIZATION**
  - IC supports CSS
  - (Central Sterilization & Supply)

- **HOUSEKEEPING LINENS**

**Source of Infections**

**Where do Nosocomial Infections come from?**

- Colonization
- Food & Water
- Hands: HCW, visitors

- Others:
  - Fomites
  - Environment

**Colonization: Definition**

- **Colonization** = presence of a microorganism on/in a host, with growth and multiplication of the organism, but without interaction between host and organism (no clinical expression, no immune response).

- **Carrier** = individual which is colonized + more

- **Subclinical or inapparent infection** = presence of microorganism and interaction between host and microorganism (sub clinical response, immune response). Often the term colonization is applied for relationship host-agent in which the immune response is difficult to elicit.

- **Contamination** = Presence of a microorganism on a body surface or an inanimate object.
Skin Hand Flora

- **RESIDENT FLORA**
  - Survives on the skin more than 24 hours
  - Not easily removed, hours of scrubbing
  - Complete sterilization impossible
  - Low virulence
  - Staphylococci, diptheroides,
    mostly Gram + ,
    very few Gram -

- **TRANSIENT FLORA**
  - Survive on skin less than 24 hours
  - Easily removed with soap and water
  - Acquired during contacts with contaminated areas mouth, nose, perineal area, genitals, anal area, catheter, bedpan, urinal, patient care, casual contact
  - May have high virulence: Enterobacteria, Gram - bacilli, Pseudomonas...

**Humans sheds # 300,000,000 squares/day (4 to 25 mm) able to carry bacteria**

Origin of Nosocomial Infection Microorganisms: WATER

- Splash from sink drain, toilet flushing
- Faucet aerator, faucet, water lines
- Plants harbor Aeromonas, Pseudomonas, Acinetobacter.
- Water from vase in surgical ward
- with 8.66 CFU/ml of water

- **ORIGIN OF NOSECOMIAL INFECTION MICROORGANISMS: FOOD**
  - Bacteria from food infect immunocompetent patients
  - Pseudomonas, Enterobacter, Klebsella, Citrobacter, Serratia
  - Frequently found on vegetables: typical kitchen salad from a hospital had 200,000 /g

Flora at Colonization Sites

- **OROPHARYNX**
  - Streptococcus viridans group
  - Streptococcus pyogenes
  - Streptococcus pneumoniae
  - Staphylococci
  - Moraxella catarrhalis
  - Neisseria spp
  - Corynebacterium spp
  - Haemophilus spp
  - Anaerobes: Bacteroides, Candida albicans

- **NASOPHARYNX**
  - Staphylococci
  - Streptococci
  - Moraxella catarrhalis
  - Neisseria spp
  - Haemophilus spp

- **CONJUNCTIVA**
  - Staphylococci
  - Corynebacteria
  - Haemophilus

- **SKIN**
  - Staphylococci
  - Corynebacteria
  - Propionibacteria
  - Candida
  - Malassezia furfur

- **GENITOURINARY TRACT**
  - Staphylococci, Streptococci
  - Enterococci
  - Lactobacillus spp, Corynebacterium
  - Neisseria spp, Anaerobes
  - Candida albicans

- **UPPER INTESTINE**
  - Streptococci
  - Lactobacillus spp
  - Candida spp

- **LOWER INTESTINE**
  - Aerobic Gram - bacilli: E.coli, Klebs
  - Enterobacter, Proteus, Serratia
  - Providencia, Bacteroides, Anaerobic
  - Enterococci, Streptococci, Candida
Infection Control Key Components

Origin of Nosocomial Infection Microorganisms: Hands

- Activity: Number of Klebsiella on nurse's hand
- Pulse / Blood pressure: 100 - 1,000
- Touching hand: 10 - 100
- Touch shoulder: 7,000
- Oral Temperature: 100 - 1,000


Isolations Precautions

Standard Precaution: Ridiculously Simple

STANDARD PRECAUTIONS = Universal precautions: Any one may be infectious, there is no way of predicting who is infected and may transmit blood borne pathogens (HBV, HCV, HIV...) or other microorganisms (MRSA, Cdiff, MRKO...)

- Use STANDARD PRECAUTIONS WITH ALL PATIENTS ALL THE TIME

1. Wash * Touch * Wash
   - OK

2. If red, wet or dirty
   - Wash * Glove * Touch
   - Unglove * Wash

3. Know what is clean
   - Know what is dirty
   - Keep them apart

Use STANDARD PRECAUTIONS WITH ALL PATIENTS ALL THE TIME
And these other precautions may be added

AIRBORNE PRECAUTIONS
- Personal Respirator: N95
- Room with Ventilation Control
  - Negative pressure
  - > 6 air exchange
  - Air filtrated before recirculation or vented outside

CONTACT PRECAUTIONS
- Private room or 3ft separation between patients
- Gown when entering
- Gown IF extensive contact

DROPLET PRECAUTIONS
- Private room or 3ft separation between patients
- Mask when entering
- Gown when entering
- Gown IF extensive contact

We do not use these terms any longer: Strict Isolation, Blood & body fluids, Enteric and respiratory, Droplet, Respiratory
Infection Control Key Components

**Surveillance**

- Surveillance is the focal point for infection control activities. The term surveillance implies that the observational data are regularly analyzed.
- Surveillance provides valuable epidemiologic data such as:
  - Identification of epidemics,
  - Priorities for infection control activities,
  - Shifts in microbial pathogens,
  - Infection rates
  - Outcomes of hospital-acquired infection.
- Surveillance:
  - Increase in infection control team visibility
  - Opportunity for informal consultation and education to unit nurses & physicians.

**HAI Surveillance**

Ideally the surveillance of hospital-acquired infection should be a continuous process that consists of the following elements:

1. Definition of categories of infection;
2. Systematic case finding and data collection;
3. Tabulation of data;
4. Analysis and interpretation of data;
5. Reporting of relevant infection surveillance data to individuals and groups for appropriate action.

**HAI Surveillance**

- Infection control surveillance is:
  - NOT ABOUT FINDING CAUSE OF HAI
  - NOT ABOUT ASSIGNING BLAME
  - NOT ABOUT FAIRNESS
- Infection control surveillance is:
  - ABOUT EVALUATING A SYSTEM
  - ABOUT IDENTIFYING PREVENTIVE MEASURES
Infection Control Key Components

Scope/ Strategy of Surveillance

The first issue in case finding is determining a scope of surveillance. Choices can include on three major strategies:
• Hospital-wide surveillance;
• Surveillance by objective;
• Limited or targeted surveillance.

Strategies to focus on high risk patients are developed by many investigators despite a more limited scope.

Passive Surveillance

• Passive surveillance (PS) = identification and reporting of nosocomial infection by individuals other than IP
• PS use report forms completed by physicians, nurses, or other medical personnel when nosocomial infections are recognized.
• PS requires non-IC personnel to understand and to consistently apply definitions but also to take the time to notify infection control.
• PS is frequently fragmented, Definitions not consistently applied.

Active Surveillance

• Active surveillance = trained personnel
• Use various data source to accumulate information
• Decide whether or not a HAI has occurred using standardized definitions
• Using active surveillance, increases the sensitivity of identifying infections to 0.85 to 1.0; whereas, using passive methods had produced a sensitivity of 0.15 to 0.35.

Prospective or Retrospective Surveillance

• Prospective or concurrent surveillance means monitoring the patient during hospitalization. Prospective surveillance may include the post-discharge period.
• Retrospective surveillance involves review of the medical record by either IC personnel or medical record technician after the patient has been discharged.
• Sensitivities: Both have similar sensitivities (0.75 to 0.95). The high sensitivity found with retrospective reviews along with their high consistency was excellent in several studies.
• HAI recorded by medical record technicians similar to those recovered by nurses surveillance.
Infection Control Key Components

Prospective Surveillance

- Identify clusters of infection that might not be detected.
- Sensitivity of prospective review limited when delivery of patient information to the chart is delayed.
- Increased visibility for IP
- Increase rapport and sense of team between the IP and the medical team.
- Timely analysis of data/feedback to clinical services.
- More expensive.

Patient or Lab Based Case Finding

Patient-based:
- Evaluates outcomes from HAI
- Adheres to guidelines for patient care.
- Increases IC visibility
- Provides more critical data
- Avoids false positive infections
- Includes counting HAI, assessing risk factors, and then assessing the procedures and practices related to patient care.

Laboratory based:
- Identifies epidemic and endemic pathogens
- Performs threshold analysis
- Assesses secular trends.

Surveillance Methods

<table>
<thead>
<tr>
<th>Surveillance Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital-wide surveillance</td>
<td>Collects data on all infections sites, and units. Identifies clusters</td>
<td>Expensive, labor intensive, no defined management objectives</td>
</tr>
<tr>
<td></td>
<td>Objective: Priority based</td>
<td>Adaptable to hospitals with special interests and resources; focuses on specific problems at the individual institution</td>
</tr>
<tr>
<td></td>
<td>Targeted Surveillance</td>
<td>Flexible, can be mixed with other strategies</td>
</tr>
<tr>
<td></td>
<td>Site-specific, unit-specific</td>
<td>Focus on patients at greater risk; requires less personnel; simplifies surveillance effort</td>
</tr>
<tr>
<td></td>
<td>Rotating</td>
<td>No baseline rates in other units; may miss clusters</td>
</tr>
<tr>
<td></td>
<td>Decreasing</td>
<td>Less expensive, less time-consuming</td>
</tr>
<tr>
<td></td>
<td>Outbreak</td>
<td>Can miss clusters of infection</td>
</tr>
<tr>
<td></td>
<td>Enhanced periodic surveillance</td>
<td>Valuable when used with all types of surveillance</td>
</tr>
<tr>
<td></td>
<td>Decreases possibility of missing an outbreak</td>
<td>Decreases time</td>
</tr>
</tbody>
</table>

HAI Definitions
What is a Nosocomial Infection?

- An infection which is acquired during hospitalization and which was not present or incubating at the time of admission
- An infection which is acquired in the hospital and becomes evident after discharge from the hospital
- A newborn infection which is the result of passage through the birth canal

What is a Nosocomial Infection?

Practically - to establish that an infection is hospital acquired,

SHOW THAT the patient:

1. HAS AN INFECTION, not a simple colonization
2. WAS NOT infected at the time of admission
3. HAD SUFFICIENT TIME to develop infection

True Infection NOT Colonization

1. Infections are accompanied by signs and symptoms:
   - → fever, malaise
   - → in localized infections: swelling due to inflammation, heat, pain, erythema (tumor, dolor, rubor, calor)
2. Use definitions which establish minimum characteristics for infection
3. Remember: Immunocompromised patients do not show signs of infection as normal patients. Neutropenic patients (≤ 500 neutrophils /mm³) show no pyuria, no purulent sputum, little infiltrate and no large consolidation on chest X-ray

NO Infection at Time of Admission

1. establish prior negativity
2. check history, symptoms and signs
3. documented at time of admission, lab tests & chest X-rays done
   - normal physical examination
   - absence of signs and symptoms
   - normal chest X-ray
   - negative culture or lack of culture

Excluded:
- Transplacental infections
- Reactivation of old infections (ex Shingles)
- Infections considered extensions of infections present at admission

Example: If urine cultures are collected at day 7 of hospitalization and none was collected before, it implies that no signs of infection were present in urine before
Sufficient Time to Develop Infection

- diseases with specific incubation period: stay in hospital ≥ incubation period
- numerous infections do not have well set incubation periods (for example, staphylococci, E.coli infections)
  - these infections rarely develop in less than 2 days

To establish a nosocomial infection, meeting the definition criteria is sufficient. There is no need to have proof *beyond the shadow of a doubt*

Case Definitions

CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting

CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting

Teresa C. Horan, MPH, Mary Andrus, RN, BA, CIC, and Margaret A. Dudeck, MPH

Atlanta, Georgia


The 4 BIG Ones

- BSI Bloodstream infection
- PNEU Pneumonia
- UTI Urinary tract infection
- SSI Surgical site infection
Example: Primary Lab Confirmed BSI: Pathogen

- Recognized pathogen from 1 or more blood cultures
- Not related to infection at other site

Specimen collection considerations
Ideally, blood specimens for culture should be obtained from 2 to 4 blood draws from separate venipuncture sites (e.g., right and left antecubital veins), not through a vascular catheter. These blood draws should be performed simultaneously or over a short period of time (i.e., within a few hours). If the facility does not currently obtain specimens using this technique, work with appropriate personnel to facilitate better specimen collection practices for blood cultures.

Example: Primary Lab Confirmed BSI with Contaminant

- One of following:
  - fever >38°C
  - or chills
  - or hypotension <90 mm
- AND Common skin contaminant
  - from 1 or more blood cultures
  - with intravascular line
  - tx prescribed for infection
- AND Common skin contaminant
  - from 2 or more blood cultures
  - drawn on separate occasions
- AND positive antigen in blood for
  - *Haemophilus influenzae*
  - or *Neisseria meningitidis*
  - or group B streptococci

Skin Contaminants:
- Diphtheroids,
- Corynebacterium spp,
- Actinobacillus actinomycetemcomitans spp,
- Propionibacterium spp,
- coagulase-negative staphylococci [including *S. epidermidis*],
- Viridans group streptococci,
- Aerococcus spp, *Micrococcus* spp)

Rates: Numerator / Denominators

- Number of infections
- Or Number of patients infected
  * 100
  * or 1,000

- Number of patients admitted (or discharged)
- Number of hospital days
- Number of device days

Example: Hospital wide patient infected rate /100 Admissions for a given period: month, quarter, year
= Number of patients infected *100
Number of patients admitted

The Best Hospitals have the highest rates
**Ward Specific Rates**

- **Rate of infection /1,000 HD**
  \[ \text{Rate of infections} \times 1000 \]
  \[ \text{Number of hospital days} \]

- **Rate of Patients infected /1,000 HD**
  \[ \text{Number of patients infected} \times 1000 \]
  \[ \text{Number of hospital days} \]

**Device Specific Rates, Procedure Specific Rates**

- **Surgical Site Infection rate:**
  \[ \text{Number of surgical site infections} \times 100 \]
  \[ \text{Number of patients operated on} \]

- **Ventilator Associated Pneumonia rate:**
  \[ \text{Number of ventilator associated pneumonia} \times 1000 \]
  \[ \text{Number of patients on ventilator-days} \]

- **Catheter Related Blood Stream Infection rate:**
  \[ \text{Number of Catheter related BSI} \times 100 \]
  \[ \text{Number of patients on IV line-days} \]

**Risk Adjustment**

- For comparison: rates should be adjusted for risk factors
- Risk adjustment is labor intensive because data must be collected on the entire population at risk (denominator) rather than only the fraction with infections (numerator)
- Risk adjustment cannot correct for variability among data collectors in accuracy of finding and reporting events
- Current risk-adjustment methods improve but do not guarantee the validity of inter-hospital comparisons, especially comparisons involving facilities with diverse patient populations (e.g., community versus tertiary-care hospitals)

**Risk Adjustment By Stratification**

- Stratification = calculation of rates separately in multiple categories for risk adjustment
- NHSN Example: device-associated infections are risk adjusted by:
  - rates/1,000 device-days (SSI/1,000 central line-days)
  - stratifying by unit type
  - SSI risk adjustment of SSIs done by calculating of operation-specific rates stratified by a standardized risk index
  - do not incorporate all potential confounding variables
  - but acceptable level of risk adjustment
  - avoids data collection burden required to adjust for all variables
- Drawback:
  - small numbers of infections in any one category
  - unstable rates (small hospital with low surgical volume)
National Healthcare Safety Network

- Secure web-based reporting and knowledge system for patient and healthcare worker safety information
- Provide comparative data
- Access to guidelines, prevention tools
- Integrated data repository at CDC
- NHSN comprises data on
  - Healthcare Associated Infections
  - Health Care Worker Health
  - Dialysis surveillance
  - Blood & Blood products associated adverse reactions and incidents
- Open to all US HCF: acute care hospitals, long term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centers, ambulatory surgery centers, and long term care facilities.
- Voluntary, secure, internet-based surveillance system

SSI Rates
By Operative Procedure & Risk Index, 2007/08

Table 22. SSI rates by operative procedure and risk index category, PA module, 2006 through 2007

<table>
<thead>
<tr>
<th>Procedure code</th>
<th>Operative procedure description</th>
<th>Duration cut point (cm)</th>
<th>Risk index category</th>
<th>No. of procedures</th>
<th>No. of SSI</th>
<th>Pooled mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>Abdominal surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>AAA</td>
<td>Abdominal surgery</td>
<td>225</td>
<td>2</td>
<td>500</td>
<td>13</td>
<td>1.32</td>
</tr>
<tr>
<td>APP</td>
<td>Appendectomy</td>
<td>600</td>
<td>3</td>
<td>249</td>
<td>42</td>
<td>3.44</td>
</tr>
<tr>
<td>APP</td>
<td>Appendectomy</td>
<td>600</td>
<td>4</td>
<td>249</td>
<td>42</td>
<td>3.44</td>
</tr>
<tr>
<td>AVSD</td>
<td>Arteriovenous shunt surgery</td>
<td>1</td>
<td>5.1-2.5</td>
<td>846</td>
<td>6</td>
<td>0.99</td>
</tr>
<tr>
<td>BLI</td>
<td>Blind loop, ileal or proximal</td>
<td>320</td>
<td>6</td>
<td>822</td>
<td>37</td>
<td>0.71</td>
</tr>
<tr>
<td>BLI</td>
<td>Blind loop, ileal or proximal</td>
<td>320</td>
<td>7</td>
<td>822</td>
<td>37</td>
<td>0.71</td>
</tr>
<tr>
<td>BST</td>
<td>Breast surgery</td>
<td>200</td>
<td>8</td>
<td>907</td>
<td>6</td>
<td>0.60</td>
</tr>
<tr>
<td>BST</td>
<td>Breast surgery</td>
<td>200</td>
<td>9</td>
<td>907</td>
<td>6</td>
<td>0.60</td>
</tr>
<tr>
<td>CABD</td>
<td>Cardiac surgery</td>
<td>300</td>
<td>10</td>
<td>10,385</td>
<td>117</td>
<td>1.17</td>
</tr>
<tr>
<td>CABD</td>
<td>Cardiac surgery</td>
<td>300</td>
<td>12</td>
<td>10,385</td>
<td>117</td>
<td>1.17</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass without and donor insertion</td>
<td>300</td>
<td>0</td>
<td>1003</td>
<td>3</td>
<td>0.30</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass without and donor insertion</td>
<td>300</td>
<td>0</td>
<td>1003</td>
<td>3</td>
<td>0.30</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass without and donor insertion</td>
<td>300</td>
<td>0</td>
<td>1003</td>
<td>3</td>
<td>0.30</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass without and donor insertion</td>
<td>300</td>
<td>0</td>
<td>1003</td>
<td>3</td>
<td>0.30</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass with sheath insertion</td>
<td>285</td>
<td>3</td>
<td>748</td>
<td>57</td>
<td>1.63</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass with sheath insertion</td>
<td>285</td>
<td>3</td>
<td>748</td>
<td>57</td>
<td>1.63</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass with sheath insertion</td>
<td>285</td>
<td>3</td>
<td>748</td>
<td>57</td>
<td>1.63</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass with sheath insertion</td>
<td>285</td>
<td>3</td>
<td>748</td>
<td>57</td>
<td>1.63</td>
</tr>
<tr>
<td>CDBS</td>
<td>Coronary bypass with sheath insertion</td>
<td>285</td>
<td>3</td>
<td>748</td>
<td>57</td>
<td>1.63</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CML</td>
<td>Carotid surgery</td>
<td>250</td>
<td>1</td>
<td>88</td>
<td>14</td>
<td>0.82</td>
</tr>
<tr>
<td>CRAN</td>
<td>Cranial surgery</td>
<td>214</td>
<td>3</td>
<td>1048</td>
<td>49</td>
<td>4.68</td>
</tr>
</tbody>
</table>

Sterilization

- = the complete removal or destruction of all forms of microbial life
- bacteria,
- viruses,
- fungi,
- Spores

- Probabilistic notion
- No absolute assurance that there is 0 microorganism
- Sterility assurance level (SAL) used as measure of sterility
- SAL = probability of survival of a microorganism after sterilization process
- Expressed as log10 (probability of survival)
- SAL of 6 = <= 1 chance in a million (10^-6) that a particular item is contaminated
- SAL = 6 acceptable for critical item.
Disinfection

- Process that eliminates defined pathogens
- Not all microbial forms
- Main difference with sterilization = the lack of sporocidal activity
- Categorized into 3 levels:
  - High
  - Intermediate
  - Low

Resistance of Microorganisms

- **Sterilization**
  - Bacillus stearothermophilus
  - Bacillus subtilis
  - Clostridium sporogenes

- **High Level Disinfection**
  - Mycobacteria, TB bacilli

- **Intermediate Disinfection**
  - Polio, Coxsackie, Rhino

- **Low Disinfection**
  - Trichophyton, Cryptococcus, Candida
  - Pseudomonas, Staphylococcus, Salmonella
  - HSV, CMV, RSV, HBV, HIV

Other Stuff

- **Cleaning** = the removal of adherent visible soil (blood, protein substance and debris), dust or other foreign material by manual or chemical process
- **Sanitizing** = process that reduces microbial population on object to a safe level
- **Decontamination** = process that removes pathogenic microorganisms from an object to make it safe to handle

What needs to be Sterilized, Disinfected & Sanitized? At which level?
Spaulding Classification

<table>
<thead>
<tr>
<th>Item</th>
<th>comes in contact with</th>
<th>Type recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>Tissue, vascular space</td>
<td>Sterilization</td>
</tr>
<tr>
<td>Semicritical</td>
<td>Mucous membrane</td>
<td>High level disinfection</td>
</tr>
<tr>
<td></td>
<td>Non intact skin</td>
<td>High level disinfection</td>
</tr>
<tr>
<td>Noncritical</td>
<td>Intact skin only</td>
<td>Intermediate or low level disinfection</td>
</tr>
</tbody>
</table>

Use Spaulding with a Grain of Common Sense

- Interpret with common sense
  - Mouth pieces have to be disinfected to a high level
  - Silverware simply cleaned
  - However both come into contact with mouth mucosa

- Other considerations:
  - Feasibility of the disinfection method
  - Effect of disinfectant on instrument (for example tonometer tips do not take well to heavy use of disinfectants)
  - Safety to employee

Factors Affecting Effectiveness of Disinfection

- Cleaning
  - Residual particles harbor & shelter from disinfectant
  - Organic load restrict disinfectants effectiveness of alcohol, phenols, chlorine & iodines
- Nature of object: crevices, hinges, lumens more difficult to disinfect.
- Concentration of disinfectant:
  - Diluted during application
  - Lose potency with time
- Time of contact
- Physical and chemical environment: temperature, water hardness, pH.

Wiping / Soaking / Contact time

- Using a germicide soaked cloth:
  - Consider time needed to kill
  - All germicides require minimum time
  - If wiped surface is dry before required disinfection time: disinfection cannot be assured
  - Wiping would remove a large amount of contamination and the germicide may kill some left over microorganisms but their is no assurance that all microorganisms were killed
Steam Sterilization

Saturated steam under pressure.
- Cheap & nontoxic
- Penetrates fabric
- Method of choice for all items except those which are moisture or heat sensitive.
- 4 parameters of importance
  1. Steam
  2. Pressure
  3. Temperature
  4. Time
- Air must be removed and steam must reach the item for required time at required temperature
- Anhydrous materials (oil, greases, powders) cannot be sterilized by steam
- Steam cannot penetrate hollow needles or instruments packed in moisture resistant materials (test tube, glass

Ethylene Oxide Sterilization (ETO)

- Used almost exclusively to sterilize medical products that cannot be steam sterilized
- Colorless gas
- Flammable & explosive
- Mixtures of ETO (10-12%) with CO2 or the fluoridated hydrocarbons reduce risk
- Because of implications of effect of halocarbons on ozone layer, restrictions are emerging
- Disadvantages
  - Lengthy cycle time
  - Cost
  - Potential hazards to patients & staff
- Advantage:
  - Can sterilize heat or moisture sensitive medical equipment without deleterious results
- ETO toxicity to employees: OSHA reduced permissible exposure limit (PEL) for ETO to a time-weighted average (TWA) of 1ppm

Other Sterilization Methods

- LIQUID PERACETIC ACID (STERIS®)
  - Uses a solution of peracetic acid with H2O2
  - Peracetic acid disrupts and denaturates proteins
  - Extra oxygen rapidly inactivates many cell systems.
  - Harmless to environment & very safe for personnel
  - System fully automated

- HYDROGEN PEROXIDE PLASMA STERILIZATION (STERRAD®)
  - Radio frequency emissions applied to the H2O2
  - Electric field creates gas plasma
  - No harmful substances
  - Fully automated

Other Sterilization Methods

- Glutaraldehyde 10 hrs
- ClO2 = Demand Release Chlorine 6 hrs
- H2O2 = Hydrogen peroxide (6%) 6 hrs
High Level Disinfection
- Glutaraldehyde (2%) 45 min
- Demand relechlorine dioxide 20 min
- Hydrogen peroxide (6%) 20 min
- Wet pasteurization 75°C 30 min
- Chlorine 1000 ppm 20 min

Intermediate Level Disinfection
- Ethyl alcohol 10 min
- Isopropyl alcohol 10 min
- Chlorine 100 ppm 10 min
- Phenolic germicidal solution 10 min
- Iodophor germicidal solution 10 min

Low Level Disinfection
- Ethyl alcohol ≤ 10 min
- Isopropyl alcohol ≤ 10 min
- Chlorine 100 ppm ≤ 10 min
- Phenolic germicidal solution ≤ 10 min
- Iodophor germicidal solution ≤ 10 min
- Quaternary germicidal ≤ 10 min

Microbes

CR-BSI Agents
- Staph. epidermidis (coag neg) 28%
- S. aureus 26%
- Candida 17%
- Enterobacter 7%
- Serratia 7%
- Enterococci 5%
- Klebsiella 4%
- Pseudomonas 3%

- Association cath colonization / BSI vary
  - Candida 68%
  - S. aureus 60%
  - S. epi 32%
**SSI Agents**

- *S. aureus* and Staph CoagNeg from clean sites
- Polymicrobial from respiratory, GI, gyneco, ... with aero/anaerobic mix
- Shift to antibiotic resistant strains
- Shift to fungi and unusual bacteria:
  - Candida, Rhizopus
  - Mycobacteria
  - Rhodococcus

**UTI Agents**

- Patient fecal flora in OP:
  - E.coli 80%
- Hospitalization:
  - Shift to hospital flora
  - Klebsiella, Pseudomonas, Proteus, Enterobacter, Candida
  - More resistant strains
- Shift with duration of:
  - Catheter
  - Hospitalization

**HA Pneumonia Agents**

- Large variations in etiologic agents according to
  - hospital,
  - patients,
  - unit

**NNIS 1990-1992**

- *E. coli* 8%
- Enterococci 12%
- Pse.aeruginosa 8%
- Candida 3%
- Klebs.pneumo 3%
- Enterobacter 7%
- Proteus 3%
- StaphCoagNeg 14%
- *S. aureus* 19%
- Strep 3%

**NNIS 1992-1997**

**Pneumonia**

- *Pse.aeruginosa* 21%
- *S. aureus* 20%
- Enterobacter 9%
- Klebs.pneumo 8%
- *E. coli* 4%
- *S. pneumoniae* 8%
- *H. flu* 4%
- *S. aureus* 20%
- Enterobacter 20%
- Acinetobacter 20%
- Polymicrobial

**Early VAP**

- *S. pneumoniae* 20%
- *S. aureus* 20%
- *H. flu* 4%

**Late VAP**

- *Pse.aeruginosa* 20%
- *S. aureus* 20%