Chemical Disinfectants

Unraveling the Mystery

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Agenda

- Cleaning vs Disinfection
- 1-Step vs 2-Step Products
- Persistence
- Hierarchy of resistance
- Categories of liquid chemical disinfectants
- Levels of disinfection
- Classes of chemicals
- Contact time
- Concentration
- Label claims and kill claims
- Exercises
Cleaning vs Disinfection

• **Cleaning:**
  – Cleaning = Physical removal
  – It is accomplished with water, **detergents** and mechanical action (reference number #1, page 3).
  – Water, soap, scrub
  – Result = Reduces the reservoir

• **Disinfection:**
  – The inactivation of disease-producing microorganisms
Disinfectant vs Antiseptic

• **Disinfectant:**
  - An agent that is used on environmental surfaces or medical equipment which results in the *inactivation of disease-producing microorganisms*.
  - Disinfectants are applied only to inanimate objects.
  - (#1, page 3).

• **Antiseptic:**
  - An agent that can kill microorganisms and is applied to living tissue and skin (#2).
  - *Not* for medical equipment or environmental surfaces.
1-Step vs 2-Step Products

• Visible soil must always be removed first

• 1-Step
  – Pre-cleaning is not required because these products include soap (detergent or emulsifier) to break up oil
  – 1-step products are preferred

• 2-Step
  – Cleaning is required first
  – Once the surface or object has been cleaned, the disinfectant chemical can be applied to kill the remaining microbes

• Follow the manufacturer’s instructions
How persistent are common pathogens?

- Persistence in the environment (on hard non-porous surfaces)
- Survival outside of host creates a reservoir
- Opportunity for transmission and infection
- (#3)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clostridium difficile spores</td>
<td>5 months</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1 day – 4 months</td>
</tr>
<tr>
<td>Norovirus</td>
<td>8 hours – 7 days</td>
</tr>
<tr>
<td>Candida</td>
<td>1 – 120 days</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>7 days – 7 months</td>
</tr>
<tr>
<td>Influenza</td>
<td>1 – 2 days</td>
</tr>
</tbody>
</table>

Public Health
Why are some pathogens harder to kill?

- Resistance to disinfectants related to the organism’s cell wall / envelope.
- Like the shell of a nut...some nuts are harder to crack.
- (#4)

(non-enveloped) Norovirus

(Enveloped)
Why are some pathogens harder to kill?

• Spores
  – The durability of spores is hard to comprehend.
  – Most durable form of life on earth.
  – Clostridium spores from Greenland ice cores from a depth of 834 m (4,000 years old) started to germinate within the first 5 min (#5)

• Mycobacteria
  – Lack an outer cell membrane
  – Thick waxy cell wall (#6)
Why are some pathogens harder to kill?

- **Viruses**
  - Not all viruses are created equal
- **Lipid = Enveloped**
  - Soft envelope is an easy target for disinfectants
  - Examples: HIV, HBV, HCV, Influenza, RSV, Ebola, SARS (#7)
- **Non-lipid = Non-enveloped**
  - Examples: Norovirus, Rhinovirus, Hepatitis A, Adenovirus, Rotavirus, Enterovirus (#7)
What are the categories of liquid chemical disinfectants?

1. Sterilants
2. High Level Disinfectants
3. **Low Level Disinfectants**
   - Hard surfaces and objects
   - Official definition: Low-level disinfection eliminates vegetative (‘live’) bacteria, some fungi and *enveloped* viruses (#1)
   - In LTCH and RH we need a product that kills non-enveloped viruses (norovirus)
4. Sanitizers
   - Kitchens
What is a DIN?

• What is a DIN?
  – Drug Identification Number

• Why is it critical?
  – Proves the product has been tested according to the standards set by Health Canada
  – Allows us to trust the label claims
    – Every product used in healthcare must have a DIN

• Health Canada DIN Search:
  – http://webprod5.hc-sc.gc.ca/dpd-bdpp/index-eng.jsp
How do we determine what level of disinfection is required?

• Spaulding’s classification system:
  – Divides medical equipment/devices into three categories, **based on the potential risk of infection involved in their use** (#1)

• PIDAC has done most of the work for us:
  – Appendix G, PIDAC: Best Practices for Environmental Cleaning for Infection Prevention and Control (#2)
  – Appendix B, PIDAC: Best Practices for Cleaning, Disinfection and Sterilization in All Health Care Settings (#1)
# How do we determine what level of disinfection is required?

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
<th>Level of Processing</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Equipment/ Device</td>
<td>Equipment/device that enters sterile tissues, including the vascular system</td>
<td>Cleaning followed by Sterilization</td>
<td>Surgical instruments - Foot care equipment - Eye and dental equipment</td>
</tr>
<tr>
<td>Semicritical Equipment/ Device</td>
<td>Equipment/device that comes in contact with non-intact skin or mucous membranes but does not penetrate them</td>
<td>Cleaning followed by High-Level Disinfection (as a minimum) Sterilization is preferred</td>
<td>Respiratory therapy equipment - Anaesthesia equipment</td>
</tr>
<tr>
<td>Noncritical Equipment/ Device</td>
<td>Equipment/device that touches only intact skin and not mucous membranes, or does not directly touch the client/patient/resident</td>
<td>Cleaning followed by Low-Level Disinfection (in some cases, cleaning alone is acceptable)</td>
<td>ECG machines - Oximeters - Bedpans, urinals, commodes</td>
</tr>
</tbody>
</table>
What are the characteristics of an ideal disinfectant?

- Characteristics:
  - Kills everything
  - Perfect material compatibility
  - No PPE required
  - Short contact time
  - Non-toxic
  - No residue

- The ideal disinfectant does not exist
- Characteristics: We need to find a balance
- Critical thinking: In our setting, what pathogens are we most concerned about?
  - Determine the goals for our disinfectant
What are the keys to analyzing a disinfectant?

- Chemical class (active ingredients)
  - E.g. Hydrogen peroxide, sodium hypochlorite
- Contact time
  - How long the surface must remain wet
- Dilution (if applicable)
  - Liquid concentrate
- Label claims or technical sheet
  - Technical sheet may be available online
What are the main classes of chemicals used in disinfectants?

• Different chemicals have different strengths and weaknesses

• Chemical class:
  – Alcohols
  – Chlorines
  – Hydrogen peroxide enhanced action
    • AKA: Accelerated Hydrogen peroxide
    • AKA: Stabilized Hydrogen peroxide
  – Quaternary ammonium compounds (QUATs)

• Uncommon:
  – Hydrogen peroxide (standard, not enhanced action), Iodophors, Phenolics
Alcohols (70-95%)

• Advantages/Comments
  – Effective on clean equipment/devices that can be **immersed** (submerged)

• Disadvantages/Comments
  – Evaporates quickly - not a good surface disinfectant
  – A poor cleaner
  – Inactivated by organic material

• Poor effectiveness against non-enveloped viruses (#8)

• (#2 Appendix E)
Chlorines (e.g. bleach)

- **Chemical:** Sodium hypochlorite

  - **Advantages/Comments**
    - Kills everything (depending on the concentration)
    - Sporicidal at higher concentrations
    - Available in a wipe

  - **Disadvantages/Comments**
    - Inactivated by organic material - for blood spills, blood must be removed prior to disinfection
    - Must be stored in closed containers away from light & heat to prevent deterioration

- (#2 Appendix E)
Hydrogen peroxide enhanced action formulation (HP-EAF) 0.5%

• HP-EAF
  – Contains surfactants, wetting agents and chelating agents (#2)
  – Drastically improves results over traditional hydrogen peroxide

• Advantages/Comments
  – Available in a wipe or liquid concentrate
  – Active in the presence of organic materials
  – Excellent cleaning ability

• Disadvantages/Comments
  – Material compatibility can be a challenge

• (#2 Appendix E)
Hydrogen peroxide enhanced action formulation (HP-EAF) 4.5%

- Example: Virox Rescue
- Advantages/Comments
  - Sporicidal
  - Commonly used against C. difficile
  - Also available in a gel format
- Disadvantages/Comments
  - Expensive
  - Material compatibility
- (#2 Appendix E)
Quaternary ammonium compounds (QUATs)

- **Chemical:** Ammonium chloride
- **Advantages/Comments**
  - Good cleaning ability
  - Some may be used on food prep surfaces
- **Disadvantages/Comments**
  - **Do not use to disinfect instruments**
  - Limited use as disinfectant because of narrow microbicidal spectrum
- Generally not tuberculocidal or virucidal against hydrophilic (non-enveloped) viruses, does not kill spores (#8)
- (#2 Appendix E)
QUATs and cotton cloths

- Quaternary ammonium compounds (QUATs) CANNOT be used with cotton cloths
- When used with cotton, QUAT disinfectants bind to the cotton rendering the disinfectant ineffective
- When using QUAT disinfectants, microfiber cloths are recommended
- (#8 & #9)
QUAT + Alcohol Combination

- QUAT Alcohols
  - Cavicide
  - Sani-Cloth Plus

- Mycobacterium Tuberculosis is highly susceptible to alcohol (#8)

- Adding alcohol to a QUAT often makes it effective against TB
QUAT Alcohols

- Kill TB but not non-enveloped viruses
- Skip a step in the hierarchy of resistance

Public Health

Non-enveloped: Norovirus
Enveloped: Lipid Viruses (Hepatitis B virus, Human immunodeficiency virus, Herpes simplex virus)

Level of Resistance:
- Least Resistant
- Most Resistant
Uncommon chemicals used in disinfectants

- Uncommon Chemicals:
  - Iodophors
  - Phenolics
  - Hydrogen peroxide 3% (standard, not enhanced action)

- These chemicals may be disinfectants or antiseptics

- Always follow the manufacturer’s instructions

- DO NOT use antiseptics as hard surface / medical equipment disinfectants

- (#2 Appendix E)
What happens if the contact time is not achieved?

- **Common problem:**
  - Disinfectants *often* dry out before achieving the full contact time established on the label

- **Recommendations:**
  - More wipes, surface stays wet longer
  - Double clean (C. difficile)
  - During an outbreak we want to clean and disinfect the environment more than once per day
Why is concentration important?

- Liquid disinfectants may be sold read-to-use (RTU) or as a concentrated liquid for dilution
- Always follow the manufacturer’s instructions
- Label claims are based on a specific concentration
- Automatic dispensers are recommended, no hand mixing
- Dilution ratio (e.g. 1:10) (liquid concentrate)
  - 1:10 = parts of concentrate to parts of water
  - 1:10 = 100 ml of concentrate added to 1L of water
  - Final volume = 1100 ml
What are the important label claims and kill claims?

• Beware of marketing
  – More kill claims does not mean better
• Canadian vs American technical sheets
  – Different licensing rules in the United States
  – DIN vs EPA#
  – Great to see DIN on technical sheet
• Always follow the manufacturer’s instructions
  – Check material compatibility
• Handout: Sherlock’s Guide to Label Claims (#10)
References


References


Exercise

• What are the active ingredients?
• What are the label claims?
• Does the product kill norovirus?
• Is the product a broad-spectrum virucide?
• What is the contact time?