

Analysis of Current Infection Control Measures

Course

Medical
Microbiology

Unit VI

Concepts of
Medical
Microbiology

Essential Question

How can we
ensure infection
control
measures are
working?

TEKS

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Prior Student Learning

Standard
Precautions for
the Laboratory

Estimated time

Lab 45 min and
24hr growth in
incubator.
Terms/Key
points – 30-50
min.

Rationale

Following standard precautions and other infection control measures aids in preventing the spread of infection.

Objectives

Upon completion of this lesson, the student will be able to:

- Recognize commonly used chemical disinfectants and understand their effects on microbes
- Plan and implement descriptive, comparative, and experimental investigations, using the evaluation of disinfectants in lab investigation

Engage

We know that washing our hands is important to reduce unwanted bacteria and microorganisms but how do we KNOW that we have really cleaned them? Or a surface we are cleaning? How do we know that the procedure and product is really reducing unwanted bacteria?

Key Points

Teachers Note: This lesson is primarily for your class to get comfortable with the terminology used in infection control and the lab assignment to see which disinfectant is most effective. Please cover terms that will be used in your classroom.

- I. Key terms relating to the control of microorganisms
 - A. Bacteriostatic: inhibiting growth or multiplication of bacteria, or an agent that so acts.
 - B. Bacteriocidal: an agent that destroys bacteria, destructive to bacteria
 - C. Antiseptic: Capable of preventing infection by inhibiting the growth of infectious agents
 - D. Asepsis: procedures used to reduce the number of microorganisms and prevent their spread
 - E. Disinfect: the process of destroying pathogenic organisms or rendering them inert
 - F. Sanitation: the science of maintaining a healthful, disease-free, and hazard-free environment
 - G. Sterilization: a technique for destroying microorganisms or inanimate objects using heat, water, chemicals or gases

- II. Moist heat, dry heat, steam, and gas are the most common physical agents used for microbial destruction
 - A. Autoclave: a device for effecting sterilization by steam under pressure. It uses steam heated to 121° C (250° F), at 103 kPa (15 psi) above atmospheric pressure, for 15 minutes. The steam and pressure transfer sufficient heat into organisms to kill them. Often an automated system ranging in size from desktop device to a whole room.
 - B. Chemclave: the brand name for chemical vapor sterilizer that uses a mixture of alcohols, ketones, formaldehyde, and water heated to approximately 127°C under a pressure of at least 20 pounds per square inch. American Dental Association accepted.
 - C. Dry Heat: kills the organisms by causing destructive oxidation of essential parts of their cells. Killing of the most resistant spores by dry heat requires a temperature of about 160 °C for 60 minutes. Dry heat is employed for glassware; syringes, metal instruments and paper wrapped goods, which are not spoiled by high temperatures. It is also used for anhydrous fats, oils and powders that are impermeable to moisture.
 - D. Moist Heat: Moist heat kills the organisms by coagulating and denaturing their enzymes and structural proteins. Sterilization by moist heat to incapacitate the most resistant spores generally requires 121°C for 15-30 minutes. Moist heat is used for the sterilization of culture media, and all other materials through which steam can penetrate. Moist heat is more effective than dry heat and sterilization can be done at lower temperatures in a given time at a shorter duration at the same temperature.
- III. Chemical agents used depend on the type of material to be disinfected and the types of organisms present.
 - A. Chemical agents used
 - 1. Halogens: Includes chlorine and iodine used as antiseptics and disinfectants. Iodine is used as a tincture of iodine, an alcohol solution. Combinations of iodine and organic molecules are called iodophors. They include Betadine and Isodyne, both of which contain a surface active agent called povidone. Iodine combines with microbial proteins and inhibits their function. *Chlorine* also combines with microbial proteins. It is used as sodium hypochlorite (bleach). As calcium hypochlorite, chlorine is available to disinfect equipment in dairies, slaughterhouses, and restaurants. The chloramines contain chlorine together with ammonia. They are used to sanitize glassware and eating utensils and are effective in the presence of organic matter. Chlorine is also

used as a gas to maintain a low microbial count in drinking water.

2. Alcohols: Useful chemical agents when employed against bacteria and fungi, but they have no effect on bacterial spores. The type of alcohol most widely used is 70 percent ethyl alcohol (ethanol). Isopropyl alcohol (rubbing alcohol) is also useful as an antiseptic and disinfectant. Because alcohols evaporate quickly, they leave no residue and are useful in removing microbes from the skin before injections.
3. Heavy metal compounds: Copper Sulfate used in swimming pools and ponds, Silver Nitrate used to guard against gonorrhea in infant's eyes and Zinc Chloride in mouthwashes are a few examples.
4. Oxidizing agents: such as hydrogen peroxide kill microorganisms by releasing large amounts of oxygen; this contributes to the alteration of microbial enzymes.
5. Alkylating agents: Formaldehyde and glutaraldehyde, inactivate microbial proteins by cross linking the functional groups in the proteins. Formaldehyde gas is commonly used as formalin, a 37 percent solution of formaldehyde gas. It is widely employed for embalming purposes. Glutaraldehyde is used as a liquid to sterilize; however, several hours are required to destroy bacterial spores. Ethylene oxide is a gaseous chemosterilizer that is especially useful due to its extraordinary penetrating power; this allows it to penetrate all sorts of nooks and crannies. Ethylene oxide is employed to sterilize prepackaged laboratory equipment that is otherwise destroyed by heat.
6. Surface-active agents: decreases the surface tension among molecules of a liquid; soaps and detergents are examples. Soaps have limited germicidal action but assist in the removal of microorganisms through scrubbing. They emulsify fats and acid-anionic detergents are used to clean dairy equipment. They interact with plasma membrane and may cause damage to enzymes.
7. Phenolics: One of the first chemicals to be used for disinfection was phenol. The derivatives of phenol, phenolics, damage cell membranes and inactivate enzymes of microorganisms, while denaturing their proteins. They include cresols, such as Lysol, as well as several bisphenols, such as hexachlorophene, which is particularly effective against staphylococci bacteria.

- IV. The effectiveness of chemical agents used inhibit microbial growth is dependent on:

- A. Types of organisms
 - B. Number of organisms present
 - C. Concentration of disinfecting agent
 - D. Amount of organic soil present
 - E. Nature of surface to be disinfected
 - F. Bacterial cell resistance
- V. The use of chemical agents can pose health risks for those exposed to toxic levels and can result in environmental contamination. Therefore it is very important that the least hazardous, lowest concentration option that is still effective be used.

Activity

- I. Complete the Infection Control Key Terms
- II. Complete the Disinfectants Worksheet
- III. Complete the Evaluation of Disinfectants Laboratory Investigation

Assessment

Successful completion the Disinfectants Worksheet
Laboratory Investigation Rubric

Materials

Infection Control Definitions
4 Sterile swabs
4 Agar plates or 1 plate divided into 4 quadrants
Incubator 37C
Three disinfectant solutions of choice, (Alcohol, Lysol, Scope, Bleach, etc.)
Paper towels
Gloves
Goggles
Lab coat

Microbiology - Principles and Health Science Applications, Lois M. Bergquist, PhD. and Barbara Pogolian; W.B. Saunders Co., 2000; unit 6, chapter 21.

Accommodations for Learning Differences

For reinforcement, the student will conduct an inventory of disinfecting agents used at home. Students should note the purpose each is used, its intended purpose, and the hazards of using the various disinfecting agents.

For enrichment, the student will write a report analyzing a case in which the improper use of a chemical or physical agent resulted in disease transmission.

National and State Education Standards

TEKS

- (2) The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:
- (B) know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;
- (E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;
- (F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;
- (G) analyze, evaluate, make inferences, and predict trends from data; and
- (H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

National Health Care Foundation Standards and Accountability Criteria

Foundation Standard 1

1.23 Investigate biomedical therapies as they relate to the prevention, pathology and treatment of disease.

Foundation Standard 7

7.11 Explain principles of infection control.

7.12 Describe methods of controlling the spread and growth of microorganisms. 7.21 Apply personal safety procedures based on Occupational Safety and Health Administration (OSHA) and Centers for Disease Control (CDC) regulations.

Texas College and Career Readiness Standards

Mathematics Standards VI. Statistical Reasoning B. Describe data 2. Select and apply appropriate visual representations of data.

Science Standards I. Nature of Science: Scientific Ways of Learning and Thinking B. Scientific inquiry 1. Design and conduct scientific investigations in which hypotheses are formulated and tested. C. Collaborative and safe

working practices 1. Collaborate on joint projects. 2. Understand and apply safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms. 3. Demonstrate skill in the safe use of a wide variety of apparatuses, equipment, techniques and procedures.

Cross-Disciplinary Standards 1. Key Cognitive Skills C. Problem Solving 1. Analyze a situation to identify a problem to be solved. 3. Collect evidence and data systematically and directly relate to solving a problem.

Infection Control Definitions

Alcohols	Useful chemical agents when employed against bacteria and fungi, but they have no effect on bacterial spores. The type of alcohol most widely used is 70 percent ethyl alcohol (ethanol). Isopropyl alcohol (rubbing alcohol) is also useful as an antiseptic and disinfectant. Because alcohols evaporate quickly, they leave no residue and are useful in removing microbes from the skin before injections.
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Antiseptic	Capable of preventing infection by inhibiting the growth of infectious agents
Asepsis	Procedures used to reduce the number of microorganisms and prevent their spread
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Chemclave	The brand name for chemical vapor sterilizer that uses a mixture of alcohols, ketones, formaldehyde, and water heated to approximately 127°C under a pressure of at least 20 pounds per square inch. American Dental Association accepted.
Disinfect	The process of destroying pathogenic organisms or rendering them inert
Dry Heat	Kills the organisms by causing destructive oxidation of essential parts of their cells. Killing of the most resistant spores by dry heat requires a temperature of about 160 °C for 60 minutes. Dry heat is employed for glassware; syringes, metal instruments and paper wrapped goods, which are not spoiled by high temperatures. It is also used for anhydrous fats, oils and powders that are impermeable to moisture.
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	contain a surface active agent called povidone. Iodine combines with microbial proteins and inhibits their function. <i>Chlorine</i> also combines with microbial proteins. It is used as sodium hypochlorite (bleach). As calcium hypochlorite, chlorine is available to disinfect equipment in dairies, slaughterhouses, and restaurants. The chloramines contain chlorine together with ammonia. They are used to sanitize glassware and eating utensils and are effective in the presence of organic matter. Chlorine is also used as a gas to maintain a low microbial count in drinking water.
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Oxidizing agents	Such as hydrogen peroxide kill microorganisms by releasing large amounts of oxygen; this contributes to the alteration of microbial enzymes.
Phenolics	One of the first chemicals to be used for disinfection was phenol. The derivatives of phenol, phenolics, damage cell membranes and inactivate enzymes of microorganisms, while denaturing their proteins. They include cresols, such as Lysol, as well as several bisphenols, such as hexachlorophene, which is particularly effective against staphylococci bacteria.
Sanitation	The science of maintaining a healthful, disease-free, and hazard-free environment.
Sterilization	A technique for destroying microorganisms or inanimate objects using heat, water, chemicals or gases.
Surface-active agents	Decreases the surface tension among molecules of a liquid; soaps and detergents are examples. Soaps have limited germicidal action but assist in the removal of microorganisms through scrubbing. They emulsify fats and acid-anionic detergents are used to clean dairy equipment. They interact with plasma membrane and may cause damage to enzymes.

Infection Control Key Terms

Alcohols	
Alkylating agents	
Antiseptic	
Asepsis	
Autoclave	
Bacteriocidal	
Bacteriostatic	
Chemclave	
Disinfect	
Dry Heat	

Halogens	
Heavy metal compounds	
Moist Heat	
Oxidizing agents	
Phenolics	
Sanitation	
Sterilization	
Surface-active agents	

Disinfectants Worksheet

Explain how you would disinfect each of the following items:

- a. Latex ice bag
- b. Bandage scissors
- c. Scalpel
- d. Linen
- e. Bathroom sink and toilet

Disinfectants Worksheet -- KEY

Explain how you would disinfect each of the following items:

NOTE: From CDC.GOV: Disinfect spills with household bleach or an appropriate dilution of mycobactericidal disinfectant. Note: Organic matter will reduce the ability of bleach to disinfect infectious agents. NCCLS recommendations regarding how to disinfect specific areas should be followed. For use on smooth, hard surfaces, a 1% solution of bleach is usually adequate for disinfection; for porous surfaces, a 10% solution is needed.

- A. **Latex ice bag:** Wipe down with a diluted bleach solution (see guidelines above) and allow to sit for 10 minutes. Then wipe with water and air dry.
- B. **Bandage scissors:** Soak in a diluted bleach solution (see guidelines above) for 10 minutes. Then rinse with water thoroughly to avoid corrosion and dry. Alternatively remove all solid debris and run through a full cycle of an autoclave.
- C. **Scalpel:** If used on humans – use disposable whenever possible. If they must be reused remove all solid debris and run through a full cycle of an autoclave.
- D. **Linen:** Wash in the hottest water possible with detergent and chlorine bleach and dry thoroughly.
- E. **Bathroom sink and toilet:** Use a 1 to 10 dilution of household bleach and remove solid debris. Then allow area to sit for 10 minutes. Rinse with water and dry as needed.

Background information for the Evaluation of Disinfectants Lab:

Phenol, the first disinfectant, is considered the disinfectant standard against which all other disinfectants are compared. These comparisons give rise to the phenol coefficient where a disinfectant that: A) is more efficacious than phenol is given a phenol coefficient that is greater than 1; B) one of equal efficacy to phenol is given a phenol coefficient of 1 (i.e., efficacy of disinfectant divided by efficacy of phenol); C) two organisms, *Salmonella typhi* and *Staphylococcus aureus* are commonly used to determine phenol coefficients. Note that phenol coefficients are determined under an "ideal" condition and therefore may not be indicative of disinfectant performance under other conditions.

Our test is going to be a use-dilution test, a method of determining how effective a disinfectant can be, and one that is especially useful for determining the ability of disinfectants to kill microorganisms dried onto a typical clinical surface. We will use organisms already present from daily use and then exposed to disinfectant. After allowing them to dry we will swab the section and inoculate on to an agar plate. Successful disinfection results in no bacterial growth on the plate.

Evaluation of Disinfectants Laboratory Investigation

Purpose:

In this laboratory investigation, the student will recognize commonly used chemical disinfectants and understand their effects on microbes.

Background Information:

Materials:

4 Sterile swabs
4 Agar plates or 1 plate divided into 4 quadrants
Incubator 37C
Three disinfectant solutions of choice -- (Alcohol, Lysol, Scope, Bleach, etc.)
Paper towels
Gloves
Goggles
Lab coat

Procedure:

1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Swab one corner of desk with sterile swab. This is the control corner.
4. Remove cover from agar plate.
5. Gently, rub the swab across the surface of the agar. Label the plate control.
6. Place the cover on the agar plate.
7. Choose a solution to wipe down different corner. Allow to dry.
8. Using a new sterile swab, swab this corner of desk.
9. Repeat steps 2, 3, and 4.
10. Repeat steps 5, 6, and 7.
11. Place plates in a 37C incubator for 24 hours.
12. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.

Data:

Observe the cultured plates after 24 hours. Count the colonies grown on each plate. Design a bar graph to depict the effect of disinfectants on microbial growth using the data you have collected.

Conclusions:

1. Research and list in order of effectiveness, the products responsible for the antimicrobial action.
2. Research the chemical ingredients in each product responsible for the antimicrobial action.
3. Place solutions chosen in the appropriate category of action. (Bacteriostatic, Bacteriocidal, Antiseptic, Asepsis, Sanitizer, Sterilization, Disinfectant)
4. Identify any hazardous warnings for each disinfectant.
5. Locate the material safety data sheets (MSDS) for each disinfectant and identify the precautions.
6. Why is one product more effective than another?

7. Based on your experience, explain how advertising influences consumer choices of disinfectant products. How can you verify the advertising information is reliable?

Laboratory Investigation Rubric

Student: _____

Date: _____

Scoring Criteria	4 Excellent	3 Good	2 Needs Some Improvement	1 Needs Much Improvement
Problem is appropriately identified.				
Problem is precise, clear, and relevant.				
Association between the problem and the predicted results is direct and relevant.				
All variables are clearly operationalized.				
Demonstrates comprehension of the use of scientific concepts and vocabulary.				
All significant data is measured.				
Data is recorded effectively and efficiently.				
Data table is well designed to the task requirements.				
All graphs are appropriate.				
All data accurately plotted.				
Graph visually compelling; highlights conclusions of the study.				
Conclusion relates directly to the hypothesis.				
Conclusion has relevancy in resolution of the original problem.				
Conclusion relates the study to general interest.				