Nosocomial Antibiotic Resistant Organisms

Course
Medical Microbiology

Unit II
Laboratory Safety and Infection Control

Essential Question
Does improved hand hygiene really reduce the spread of bacteria in healthcare settings?

TEKS
130.207(c) 4G 5A, 5G

Prior Student Learning
Intro to Microbes Gram Staining

Estimated time
3 hours

Rationale
Widespread use of antibiotics has been associated with the emergence of drug resistant microorganisms. According to the CDC, more than 70% of the bacteria now causing hospital-acquired infections are resistant to at least one of the drugs most commonly used to treat them. All health-care workers play a role in preventing the spread of these nosocomial infections.

Objectives
Upon completion of this lesson, the student will be able to:
- Analyze current public health data and draw inferences on what changes can be made in the field
- Protect themselves and their patients from nosocomial antibiotic resistant organisms
- Assess infection control measures needed in health care facility

Engage
Review the Threat Report created by the CDC (great graphics and pages to use, not just black and white text). Possibly print a few pages for students to examine or have them link directly to the PDF itself.

Website with PDF link: http://www.cdc.gov/drugresistance/threat-report-2013/index.html

Show page 13 – Stats on current cases and deaths from antibiotic resistant microbes (bacteria and fungus combined in these numbers) *2,049,499 illnesses and 23,000 deaths in the 2013 national summary. Have students brainstorm about why and how these illnesses and deaths may be different from other more typical infections.

Key Points
I. How Antibiotic Resistance Happens
   A. There are many bacteria and a few of them are drug resistant, naturally.
   B. Patient is given antibiotics that kill the infecting bacteria that is not resistant as well as the ‘good’ bacteria in the gut that help protect the body from infection.
   C. The drug resistant bacteria are now allowed to grow and take over.
   D. Some of the drug resistant bacteria share their resistance with other bacteria causing more problems.
II. Examples of How Antibiotic Resistance Spreads
   A. Animals get antibiotics and develop resistant organisms in their gut. Humans get prescribed antibiotics and develop resistant organisms in their gut.
   B. Drug resistant bacteria from animals can spread to crops through using manure as fertilizer or when cuts of meat are not cooked or handled properly.
   C. Humans can spread resistant bacteria in the community they are in or get treatment in a health care facility like a nursing home or hospital and spread the resistant organisms there.
   D. Once in a health care facility resistant organisms are spread through fomites or inanimate objects or by health care workers going between patients.

   As stated on page 14 of the Threat Report, 2013, from the CDC, nice graphics and flow chart on the page for students to see and follow.

   The quiz included in the lesson is based on the CDC.gov quiz at: http://www.cdc.gov/getsmart/resources/quiz.html and can be taken online. To ensure student success please review the difference between viruses and bacteria and the proper handling of antibiotics from a patient’s perspective, (i.e., why it’s important to finish the antibiotics even after you start feeling better).

III. Methicillin-resistant *Staphylococcus aureus* (MRSA) is becoming more prevalent in healthcare settings. MRSA is a type of staph bacteria that is resistant to certain antibiotics called beta-lactams. These antibiotics include methicillin and other more common antibiotics such as oxacillin, penicillin, and amoxicillin. According to CDC data, the proportion of infections that are antimicrobial resistant has been growing. In 1974, MRSA infections accounted for two percent of the total number of staph infections; in 1995 it was 22%; in 2004 it was 63%.

   A. MRSA - Methicillin resistant *Staphylococcus aureus*
      1. Resistant to most antibiotics
      2. Found in health care facilities
         a. hospitals
         b. long term care facilities
         c. other care facilities
      3. Not a threat to a healthy individual
   B. MRSA concerns
      1. MRSA is difficult to contain
      2. MRSA is easily spread
   C. MRSA risk factors
      1. Surgery
      2. Devices used in invasive procedures
      3. Burn wards or intensive care units (ICU)
4. Age
5. Treatment with multiple antibiotics
6. Severe illness or disability
7. Prolonged or repeated hospital stays
8. Compromised immune system

D. MRSA transmission
1. Direct contact between health-care workers and clients.
2. Health-care workers are the main carriers of MRSA
3. Colonization vs. Infection
   a. Colonization means that the organism is present or in the body, but is not causing illness.
   b. Infection means that the organism is present and causing illness.
4. MRSA is not usually spread through the air

E. Identifying MRSA infection
1. Symptoms
   a. Drainage from a wound
   b. Fever and chills
   c. Elevated white blood count
2. Common sites of infection
   a. Respiratory tract
   b. Surgical wounds
   c. Perineum or rectum
   d. Skin
   e. Urinary tract

F. MRSA prevention
1. Proper hand-washing
   a. Before caring for each patient
   b. After removing gloves
   c. Before leaving the patient's room
2. Follow facility protocol for standard precautions

G. Community Acquired MRSA
1. MRSA infections that are acquired by persons who have not been recently (within the past year) hospitalized or had a medical procedure (such as dialysis, surgery, catheters) are known as CA-MRSA infections.
2. Staph or MRSA infections in the community are usually manifested as skin infections, such as pimples and boils, and occur in otherwise healthy people.

IV. Vancomycin resistant enterococcus (VRE) – The majority of VRE infections occur in the hospital setting. Enterococci are bacteria that are normally present in the human intestines and in the female genital tract and are found in the environment. Vancomycin is an antibiotic used to treat infections caused by enterococci. In some instances, enterococci have become resistant to this drug and thus are called vancomycin-
resistant enterococci (VRE).

A. VRE concerns
   1. VRE is hard to treat
   2. VRE can pass on their drug-resistant genes

B. VRE risk factors
   1. Severe illness
   2. Treatment with multiple antibiotics
   3. Abdominal or cardiac surgery
   4. Devices used in invasive procedures
   5. Age
   6. Intensive care unit (ICU)
   7. Prolonged or repeated hospital stays
   8. Compromised immune system

C. Pathogenesis of VRE
   1. Opportunistic
   2. Bacteria transmitted between clients and health-care workers
      a. Colonized vs. infected persons

D. Signs of infection
   1. Drainage from a wound
   2. Fever and chills
   3. Elevated white blood count

E. Role of health care workers in prevention of VRE
   1. Hand-washing helps stop the spread of VRE
      a. Wash before caring for a patient
      b. After removing gloves
      c. Before leaving the patient's room
   2. Follow facility protocol for standard precautions

V. Gram-negative bacteria are those bacteria that do not retain crystal violet dye in the Gram staining protocol.

A. Gram-negative infections include those caused by Klebsiella, Acinetobacter, Pseudomonas aeruginosa, and E. coli, as well as many other less common bacteria.
   1. Klebsiella bacteria are normally found in the human intestines and in human stool. Patients whose care requires devices like ventilators or intravenous catheters, and those taking long courses of certain antibiotics are most at risk for Klebsiella infections.
   2. Acinetobacter is a group of bacteria commonly found in soil and water. Acinetobacter can also be found on the skin of healthy people, especially healthcare personnel.
   3. Serious Pseudomonas infections usually occur in people in the hospital, especially those with weakened immune systems, those on breathing machines, those with devices such as catheters, and those with wounds from surgery or burns.

B. Cause infections including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis in healthcare settings.
C. One of the several unique characteristics of Gram-negative bacteria is the structure of the outer membrane. This outer membrane protects the bacteria from several antibiotics, dyes, and detergents which would normally damage the inner membrane or cell wall.

**Activity**

I. Complete the Laboratory Investigation on Transformation of Bacteria. Suggested kits include those with pGlo (where the bacteria are altered to glow like fireflies) or pGal (where bacteria are altered to gain antibiotic resistance and grow with a blue color) Available from many major retailers, specific DNA genes needed so home kits are difficult to make.

II. Have students explore the 'Get Smart' campaign from the CDC at: [http://www.cdc.gov/drugresistance/campaigns.html](http://www.cdc.gov/drugresistance/campaigns.html)

There are applications for Healthcare workers, public and livestock. Have students research a selected area and create a poster or presentation geared toward a specific audience.

**Assessment**

Antibiotics quiz from CDC.gov (also transcribed below)

Laboratory Investigation Rubric

**Materials**

Internet Access

Video: Myths about antibiotics: Healthcare Triage #11 at: [http://youtu.be/6IBArwEOhFM](http://youtu.be/6IBArwEOhFM)


MRSA Photos:
MRSA Podcast – CDC, Search for MRSA -
http://www2a.cdc.gov/podcasts/player.asp?f=6936

Health Care Associated Infections Resource page at CDC.gov
http://www.cdc.gov/hai/

**Accommodations for Learning Differences**
For reinforcement, the student will design a chart of standard precautions for preventing further antibiotic resistant infections.

For enrichment students will write up a lab report on the findings from the pGal or pGlow lab.

**National and State Education Standards**
National Health Science Cluster Standards
HLC06.01
Health care workers will understand the existing and potential hazards to clients, co-workers, and self. They will prevent injury or illness through safe work practices and follow health and safety policies and procedures.

HLC06.02
Health care workers will understand the fundamentals of wellness and the prevention of disease processes. They will practice preventive health behaviors among their clients
TEKS
130.207(c)(4)(G) explain how pathogens affect the human body systems
130.207(c)(5)(A) outline the infectious process;
130.207(c)(5)(G) investigate drug-resistant microorganisms, including methicillin-resistant *Staphylococcus aureus*, vancomycin resistant *enterococci*, and superbugs.

Texas College and Career Readiness Standards
English Language Arts
II. B. Understand new vocabulary and concepts and use them accurately in reading writing and speaking.
III. B. Develop effective speaking styles for both group and one on one situations.
IV. A. Apply listening skills as an individual and as a member of a group in a variety of settings.

Science
I. A. 1. Utilize skepticism, logic and professional ethics in science
I. C. 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.

Cross-Disciplinary
I. C. 1. Analyze a situation to identify a problem to be solved.
I. C. 3. collect evidence and data systematically and directly relate to solving a problem
Antibiotics Quiz

Students can also take this quiz online at: http://www.cdc.gov/getsmart/resources/quiz.html

1) Antibiotics fight infections caused by:
   a) Viruses
   b) Bacteria
   c) Viruses and Bacteria
2) Bacteria are germs that cause colds and flu.
   a) True
   b) False
3) Which of these illnesses should be treated with antibiotics?
   a) Runny Nose
   b) The Flu
   c) Cold
   d) Strep Throat
4) Bacteria that cause infections can become resistant to antibiotics.
   a) True
   b) False
5) I can prevent antibiotic – resistant infections when I: (Hint: more than one may apply)
   a) Don’t take an antibiotic for a viral infection
   b) Don’t save an antibiotic for the next time I am sick
   c) Don’t take an antibiotic prescribed for someone else
   d) Take my antibiotic exactly as my healthcare provider tells me
6) What can happen if I get an antibiotic-resistant infection? (Hint: more than one may apply)
   a) I may have a longer-lasting illness
   b) I may have to visit my doctor more
   c) I may require hospitalization
   d) I may need more costly medicine that may cause side effects
7) Alexander Fleming discovered the first antibiotic in 1928. What was the antibiotic named?
   a) Mold
   b) Penicillin
   c) Vancomycin
   d) Doxycycline
8) Antibiotic resistance has been called one of the world’s most pressing public health problems.
   a) True
   b) False
Antibiotics Quiz KEY

1. B – Bacteria
2. False (those are viruses)
3. Strep Throat (the others are viral or allergy induced)
4. True
5. All options are correct and should be selected
6. All options are correct and should be selected
7. B – Penicillin
8. True

*If students take the quiz online it will grade them and give links to more information on each topic.
## Laboratory Investigation Rubric

**Student:** ____________________________  **Date:** ____________________________

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