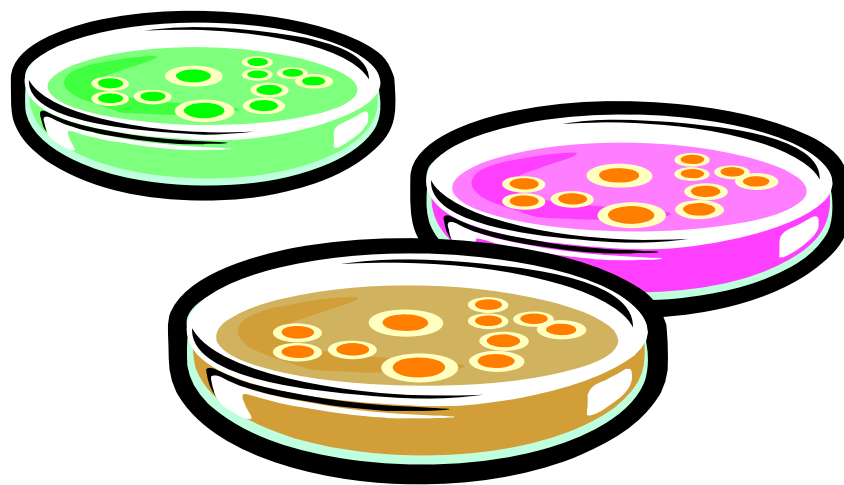


ANTIBIOTIC RESISTANCE

P.A.C.E.® APPROVED

COURSE INTRODUCTION

Antibiotics were the wonder drugs of the 1950's to 1970's. Almost all healthcare workers and the general public started to think that bacterial infections were no longer an issue about which to be concerned. Times have changed; now the United States and the world have great concern about the increasing numbers of bacteria that are resistant to the antibiotics that were once used to treat them. This CE course will review how antibiotic resistance occurs, the extent of the problem, and what is being done to help control the development of antibiotic resistance.



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2006 COURSE TITLE: ANTIBIOTIC RESISTANCE

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Course Objectives

Upon completion of this CE module, the professional will be able to:

1. Describe four methods used by antibiotics to kill bacteria or prevent bacteria from multiplying.
2. Describe three types of bacterial gene action that result the development of antibiotic resistance.
3. Identify the effects of antibiotic resistance on healthcare in general.
4. Describe two factors contributing to the rise in antibiotic resistance.
5. Identify four examples of overuse and misuse of antibiotics.
6. Describe seven efforts being used to help control the development of antibiotic resistance.
7. Describe information being given to the public to educate them about the proper use of antibiotics.

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INTRODUCTION

The mass production of penicillin in 1943 dramatically reduced illness and death from infectious diseases caused by bacteria. However, within four years, bacteria began appearing that could resist the action of penicillin. Pharmaceutical companies fought back by developing other types of antibiotics. After more than 50 years of widespread use of these “miracle drugs”, antibiotics are no longer as effective as they once were. Virtually all important bacterial infections in the United States and throughout the world are becoming resistant. Researchers feel that we may be nearing the end to the seemingly endless flow of antibiotics.

WHAT IS AN ANTIBIOTIC?

An antibiotic is a drug that kills or slows the growth of bacteria. Antibiotics vary widely in their effectiveness on various types of bacteria. Antibiotics can be categorized based on their specificity: narrow spectrum antibiotics target particular types of bacteria such as Gram negative or Gram positive bacteria, while broad spectrum antibiotics affect a larger range of bacteria. Some antibiotics actually kill the bacteria (bactericidal) and others prevent the bacteria from multiplying (bacterostatic) so that the host’s immune system can overcome them. Antibiotics are not effective in viral, fungal, and other nonbacterial infections.

Antibiotics work in the following ways:

- Prevent the bacterial cell wall from forming properly. Examples:
 - Penicillin
 - Penicillin derivatives such as Ampicillin and Methicillin
 - Cephalosporins
 - Vancomycin

- Prevent protein synthesis. Examples:
 - Tetracyclines such as Aureomycin
 - Erythromycin, and aminoglycosides such as Streptomycin

- Interfere with DNA synthesis. Examples:
 - Quinolones such as Ciprofloxacin

- Disrupt plasma and/or outer cell membrane. Examples:
 - Polymyxin B (Can only be given in the form of cream or ointment; if given internally it can disrupt the plasma membranes of our own cells.)
 - Sulfa drugs such as sulfanilamide and Trimethoprim.

WHAT IS ANTIBIOTIC RESISTANCE?

- Antibiotic resistance is the ability of bacteria to repel the effects of an antibiotic. Where once an antibiotic was effective in killing a particular type of bacteria, the antibiotic now has no effect on the bacteria. The development of antibiotic resistance is a bacteria’s way of surviving in its environment. The antibiotic does not technically cause the resistance, but allows it to happen by creating a situation where an already existing variant bacterium can flourish and grow.

- Antibiotic resistance results from one of three types of gene action: spontaneous DNA mutation, transformation, and plasmid transfer.
- Spontaneous DNA mutation
 - Bacteria are one-celled organisms with relatively few genes. Any population of bacteria may have one variant bacterium with unusual traits such as the ability to be resistant to an antibiotic.
 - After the antibiotic treatment, this one bacterium remains, multiplies, and eventually becomes the predominant bacteria.
- Transformation
 - In a form of microbial reproduction, one bacterium takes up DNA from another bacterium. If the DNA contains a gene for antibiotic resistance, it can be transferred from one bacterium to another by this method.
- Plasmid transfer
 - Plasmids are small circles of DNA that replicate independently of the chromosome and can jump from one species of bacteria to another. Plasmids theoretically could carry the resistance to every antibiotic created.
 - Plasmid transfer is considered the biggest threat in the antibiotic resistance battle. Plasmids may carry any number of resistance genes across **species** of bacteria.
 - An example of the severe threat of plasmid transfer occurred in 1968 in Guatemala. A strain of *Shigella* that carried one plasmid containing antibiotic resistance to four antibiotics killed 12,500 people following an epidemic of diarrheal illness.

IS ANTIBIOTIC RESISTANCE REALLY A PROBLEM?

The Centers for Disease Control and Prevention (CDC), the Food and Drug Administration (FDA), and the National Institute of Allergy and Infectious Diseases (NIAID) all state that antibiotic resistance is one of the world's most pressing health problems. Diseases such as tuberculosis, gonorrhea, bacterial pneumonia, and enterococcal, staphylococcal, and streptococcal infections are now more difficult to treat than they were decades ago. Antibiotic resistance is an increasingly difficult problem in hospitals because they care for critically ill patients who are more susceptible to infections than the general public and therefore they require more antibiotics. The heavy use of antibiotics in these patients causes more gene mutations in bacteria that bring about more drug resistance. The resulting stronger drug resistant bacteria continue to prey on hospital patients.

According to statistics from the Centers for Disease Control and Prevention:

- Nearly two million patients in the United States get an infection in the hospital each year.
- Of those patients, about 90,000 die each year because of their infection. This is up from 13,300 patient deaths in 1992.
- More than 70% of the bacteria that cause hospital-acquired infections are resistant to at least one of the drugs most commonly used to treat them.
- Some bacteria are resistant to all approved antibiotics and must be treated with experimental and potentially toxic drugs.
- Persons infected with drug-resistant bacteria are more likely to have longer hospital stays and require treatment with second or third choice drugs that may be less effective, more toxic, and more expensive.

In summary, antibiotic resistance is driving up health care costs, increasing the severity of disease, and increasing the death rates from certain diseases. The terms Methicillin resistant *Staphylococcus aureus* (MRSA), Vancomycin resistant enterococci (VRE), and multi-drug resistant tuberculosis are heard all too often in today's world.

A TIMELINE OF ANTIBIOTIC RESISTANCE

YEAR	BACTERIA	ANTIBIOTIC
1947	<i>Staphylococcus aureus</i>	Penicillin
1967	<i>Streptococcus pneumoniae</i>	Penicillin
1967	<i>Neisseria gonorrhoea</i>	Penicillin
1970	<i>Staphylococcus aureus</i>	Methicillin
1983	<i>Enterococcus faecium</i>	Penicillin
1983	<i>Shigella</i>	Multi-drug
1983	<i>Escherichia coli</i>	5 types of fluoroquinolones
1984	<i>Mycobacterium tuberculosis</i>	Multi-drug
1989	<i>Enterococcus</i>	Vancomycin
2001	<i>Campylobacter</i>	fluoroquinolones
2002	<i>Staphylococcus aureus</i>	Vancomycin

WHY IS THIS HAPPENING?

Antibiotic resistance is a natural phenomenon; i.e., survival of the fittest. However, other factors contribute to the problem. Studies have identified two factors that have lead to an increase in antibiotic resistance: more people are contracting bacterial infections and antibiotics are overused and misused.

Increasing Numbers of Bacterial Infections

Causes for the increase in reported infections are diverse. Studies have shown the following have contributed to increased numbers of bacterial infections:

- Increased use of day care centers: Between 1975 and 1990, the number of doctor office visits for preschoolers with ear infections doubled. In 1992, 23.6 million prescriptions were written for ear infections compared with 15 million in 1985.
- Homelessness: Poor nutrition, lack of sanitary facilities, and inadequate healthcare resources increase the number of infections seen in homeless people.
- Advances in modern medicine:
 - Increased numbers of patients are undergoing and surviving chemotherapy and transplants. These patients take drugs that suppress their immune systems, thus making them more susceptible to infectious diseases.
 - Increasing numbers of patients are living with chronic diseases. Often the chronic diseases leave the patients with increased susceptibility to infections.

Overuse and Misuse of Antibiotics

- Patients often put pressure on their physicians to provide them with antibiotics for coughs, colds, and the flu. Most of the time, these infections are caused by viruses and viruses do not respond to treatment with antibiotics. However, physicians want their patients to be satisfied with the care they provide and often prescribe antibiotics to make their patients happy.
- Patients sometimes stop taking antibiotics for bacterial infections as soon as they start feeling better. By not finishing the entire dose of antibiotics, resistant bacteria not killed in the first days of antibiotic treatment will continue to multiply.
- People often take antibiotics that were left over from a previous illness to treat a current illness. Sometimes an antibiotic prescribed for one person is “loaned” to another person to treat an infection. These practices increase the likelihood of antibiotic resistance.
- Antibiotics are added to feed for livestock and poultry to increase herd and flock sizes.
 - Poultry growers use antibiotics called fluoroquinolones to make sure the birds do not die from *Escherichia coli*, a disease they can pick up from their own droppings. However, another kind of bacteria, *Campylobacter*, which lives in the gut of the birds, has built up a resistance to these drugs. People who eat poultry contaminated with *Campylobacter* can develop a diarrheal illness that is very difficult to treat. It is estimated that over 2 million persons get *Campylobacter* infections every year. *Campylobacter* infections can be life threatening in people with weakened immune systems.
 - Although thorough cooking reduces the likelihood of antibiotic-resistant bacteria surviving in meat to infect humans, it does happen. In 1983, 18 people in four Midwestern states developed multi-drug resistant *Salmonella* food poisoning after eating beef from cows fed antibiotics. Eleven of the people were hospitalized and one died.

WHAT IS BEING DONE ABOUT THE PROBLEM OF ANTIBIOTIC RESISTANCE?

Many efforts are underway to help control the development of antibiotic resistance.

- Hospitals are improving infection control practices. Patients with infections that are resistant to antibiotics are handled in ways to assure the infection is not spread from the patient to the healthcare worker and from the healthcare worker to other patients.
- Medical schools are changing their curriculums to assure medical students learn when and how to prescribe antibiotics.
- Physicians are receiving updated information on proper antibiotic use.
 - Routine use of antibiotics in certain surgical patients is being re-examined.
 - Physicians are encouraged to assure an infection is bacterial before prescribing antibiotics.
 - Physicians are being encouraged to provide “narrow spectrum” antibiotics, those that target only a few bacterial types, whenever possible. This is a change from the use of “broad spectrum” antibiotics, which are effective against a whole host of bacteria types.
- The public is being educated about the proper use of antibiotics and methods to use to minimize the potential of food poisoning. Information such as the following is being given to patients.

- **Don't insist** on antibiotics for yourself or your children.
- **Ask your doctor**, "Is this antibiotic really necessary?"
- **Take only with a doctor's instructions.** Don't take antibiotics left over from old prescriptions, given to you by friends or family, or purchased outside of the U.S. without a prescription.
- **Finish each antibiotic prescription** even if you feel better. If you don't, some resistant bacteria may stay with you and multiply, requiring a different and likely stronger antibiotic when the infection returns weeks later.
- **Keep immunizations up-to-date** especially for influenza and pneumonia if you are a senior citizen or have a chronic illness.
- **Prevent infections** by washing hands thoroughly. Wash fruits and vegetables thoroughly. Avoid raw eggs and undercooked meats, especially ground meats.
- The Food and Drug Administration is doing all it can to speed the development of new antibiotics. Pharmaceutical companies became complacent in the 1980's thinking that they had developed so many antibiotics that bacterial infections were "a thing of the past". Pharmaceutical companies are also investigating novel methods of killing bacteria, methods that do not require the use of antibiotics.
- CDC is encouraging local health officials to track cases of antibiotic resistance. The World Health Organization (WHO) has initiated a global computer database for physicians to report outbreaks of antibiotic resistant bacterial infections.
- The Food and Drug Administration's Center for Veterinary Medicine is putting into place a regulatory system to assure the safe use of antibiotics in livestock and poultry.

WHEN ARE ANTIBIOTICS REALLY NEEDED?

Antibiotics **are** needed for many serious illnesses such as bacterial pneumonia, bacterial meningitis, septicemia, and even Strep throat. These illnesses can be life threatening or can lead to serious complications.

Bacteria also cause more common ailments such as ear, urinary, and sinus infections. An antibiotic may reduce the symptoms of these kinds of infections by a day or two. However, if symptoms are not serious and the risk of complications from the infection is low, antibiotics may not be necessary, as the human body is capable of fighting off many infections on its own.

CONCLUSION

Antibiotics have saved millions of lives since the 1940's. However, overuse and misuse of antibiotics have led to the development of strains of bacteria that are resistant to the antibiotics. If the spread of antibiotic resistance is not brought under control, common bacterial infections may once again be responsible for the deaths of untold numbers of people.

ANTIBIOTIC RESISTANCE

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TEST QUESTIONS
ANTIBIOTIC RESISTANCE
Course # 1220806

Directions: Please answer these questions from the information in the article presented.

1. Which of the following antibiotics works by preventing the bacterial cell wall from forming properly?
 - a. Ciprofloxacin
 - b. Streptomycin
 - c. Trimethoprim
 - d. Vancomycin

2. The type of gene action considered to be the biggest threat to the antibiotic resistance battle is _____.
 - a. conjugation
 - b. plasmid transfer
 - c. spontaneous DNA mutation
 - d. transformation

3. CDC's statistics indicate that nearly _____ patients get an infection in the hospital each year.
 - a. 13,300
 - b. 70,000
 - c. 90,000
 - d. 2,000,000

4. More than _____ % of hospital acquired bacterial infections are resistant to at least one of the drugs most commonly used to treat them.
 - a. 50
 - b. 60
 - c. 70
 - d. 80

5. All of the following are causes of the increasing numbers of bacterial infections EXCEPT _____.
 - a. advances in modern medicine
 - b. increased numbers of people in prison
 - c. increased use of day care centers
 - d. homelessness

6. Which of the following requires treatment with an antibiotic?
 - a. common cold
 - b. influenza
 - c. viral pneumonia
 - d. strep throat

7. Which of the following is a FALSE statement regarding the use of antibiotics?
 - a. Do not insist that your doctor prescribe antibiotics for your child who appears to have a cold.
 - b. Finish each antibiotic prescription even if you feel better.
 - c. If your doctor prescribes an antibiotic for you, ask your doctor if the prescription is really necessary.
 - d. Use your antibiotic prescription to treat your spouse who seems to have the same illness.

8. Antibiotics added to the feed for livestock and poultry can cause antibiotic resistance in humans.
 - a. True
 - b. False

9. Antibiotic resistance is a natural phenomenon but other factors contribute to the problem.
 - a. True
 - b. False

10. Antibiotic resistance is a problem only in the United States.
 - a. True
 - b. False

end of test

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Course Number: 1220806

OBJECTIVES

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COURSE CONTENT

___ Yes ___ No

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VALUE

___ Yes ___ No

6. Did you learn anything new?

___ Yes ___ No ___ Maybe

7. Did you learn anything you might use at work?

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