

## Buzz Cue Reading Notes

### Antibiotic Resistance Threats in the US 2013

- In the USA, 2 million people/year fall sick with infections resistant to antibiotics, and 23,000 of which die; however, these are likely underestimates.
- Antibiotic Resistance costs an estimated \$20 billion/year extra in direct medical costs (trickier to treat), with an additional \$35 billion/year in lost labor productivity; likely an underestimate.
- Incorrect and excessive Antibiotic use considered the #1 contributor to resistance
- Up to 50% of current prescriptions are unnecessary!
- More and more commonly, resistant bacterial infections are transmitted within the community via person to person contact
- Excessive use of antibiotics on animals in factory farms plays a significant role in breeding and spreading resistant bacteria via food-borne illnesses
- Administration of antibiotics to animals for growth promotion should be discontinued
- Gram Negative bacteria (thinner cell wall than Gram Positive) "especially worrisome" because they are becoming resistant to nearly all available treatments
- 140,000 Emergency department visits/year due to adverse antibiotic reactions; 79% of which are allergic reactions
- CDC groups bacteria's resistance and virility into "Urgent, Serious, or Concerning"
- In the "Urgent" group, *C. difficile* causes 14,000 deaths/year with severe diarrhea

### Four Core Responses to Mitigate Resistance

1. Prevent infections from occurring and prevent resistant bacteria from spreading (i.e. promote regular hand washing and proper food handling)
2. Tracking Resistant Bacteria; better tracking technology needs to be developed.
3. Improving the use of antibiotics by health care providers and patients; referred to as "Antibiotic Stewardship," as promoted by the CDC's "Get Smart" initiative.

4. Promoting the development of new antibiotics and new diagnostic tests for resistant bacteria; we cannot entirely stop bacteria from developing resistance, only slow down the rate at which they do.

### **Mission Critical: Preventing Antibiotic Resistance**

- Bacteria that are resistant to several types of antibiotics are the most concerning
- What **Patients** can do:
  - practice good hygiene and make sure vaccinations are up to date
  - ensure infection is bacterial by requesting appropriate tests
  - do not skip doses nor stop taking antibiotics before required time; discard pills when treatment is completed
  - do not pressure physician into prescribing you antibiotics when he or she does not feel you need them
- What **Healthcare Providers** can do:
  - Practice good hygiene
  - Prescribe antibiotics prudently, after the appropriate cultures have demonstrated the patient is ill with a bacterial infection
  - Adhere to recommended dosages and treatment durations
  - Record each patient's antibiotic treatment plan and outcome
  - Remain alert to resistance patterns within the facility
- What **Healthcare Administrators** can do:
  - Enforce an Antibiotic Stewardship program
  - Collaborate with and learn from other healthcare facilities' stewardship initiatives

### **Viral Hemorrhagic Fevers and Bioterrorism**

- VHFs affect multiple organ systems, derailing normal homeostasis mechanisms, and damage entire system of blood vessels
- Although bleeding is a symptom, it rarely causes death

- Four families of viruses
  1. Arenavirus
  2. Filovirus (i.e. Ebola)
  3. Bunyavirus
  4. Flavivirus
- Can be used as bioterrorism weapon by "aerosolizing infected body fluids or rodent excrement"
- Viral vectors usually include rodents, fleas, and ticks. The host for ebola is unknown, though some speculate bush meat. Some viruses can be spread person to person via direct contact with body fluids.
- Symptoms, which appear 2-21 days after infection, include "sudden fever, weakness, muscle pain, tiredness, headache, and sore throat.... severe cases of VHF often show signs of bleeding under the skin, in internal organs or from the mouth, eyes or ears. Very ill patients may also have a nervous breakdown, delirium and seizures and may go into shock and a coma."
- Mortality rates are as high as 90% with Ebola!
- There is no treatment or cure for VHFs, save for supportive care; a vaccine only exists for yellow fever and Argentine hemorrhagic fever

### **Q's & A's on Experimental Treatments and Vaccines for Ebola**

- Created by Mapp Biopharmaceutical, Inc., ZMapp is an experimental treatment for Ebola that has not yet been tested in humans; planning for Phase 1 clinical trials underway
- Best way to prove efficacy of ZMapp is randomized controlled clinical trials comparing patient outcomes of those who receive treatment and those who do not
- The most effective way to curb the spread of Ebola in West Africa is to find as many Ebola cases as possible, isolate and care for infected persons, and tracing contacts to stem the flow of transmission.
- Investigational New Drug application: process whereby FDA grants permission, in emergency situations, to administer a "promising" experimental drug that has not been approved. **Will this happen in West African with ZMapp?**

- Therapies are administered *in response* to present infection, whereas vaccines are administered *to prevent* the acquisition of infection.
- In early September 2014, the NIH's National Institute of Allergy and Diseases began initial human testing of a potential Ebola vaccine in Bethesda, Maryland.
- Trials will be conducted on healthy adults to see if the vaccine elicits the desired immune response

## Buzz Cue Lecture Notes

### BACTERIAL VS. VIRUSES, EXAMPLES AND GENOMICAL DIVERSITY

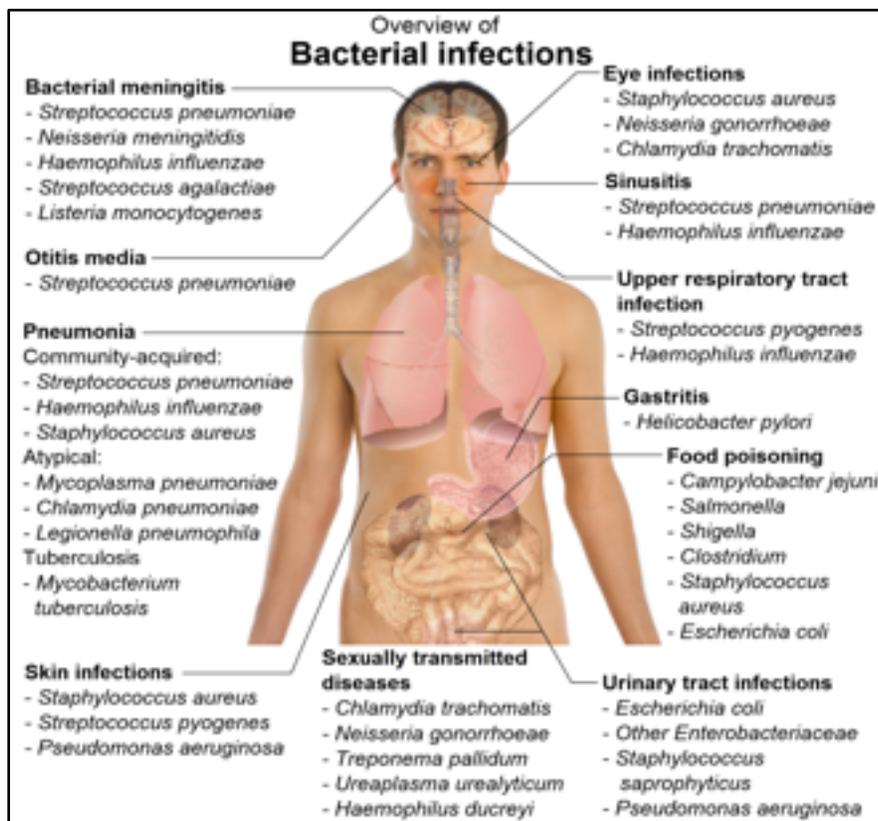


Image presented in lecture, illustrating different kinds of bacterial infections, the image was obtained from: [www.healthype.com](http://www.healthype.com)

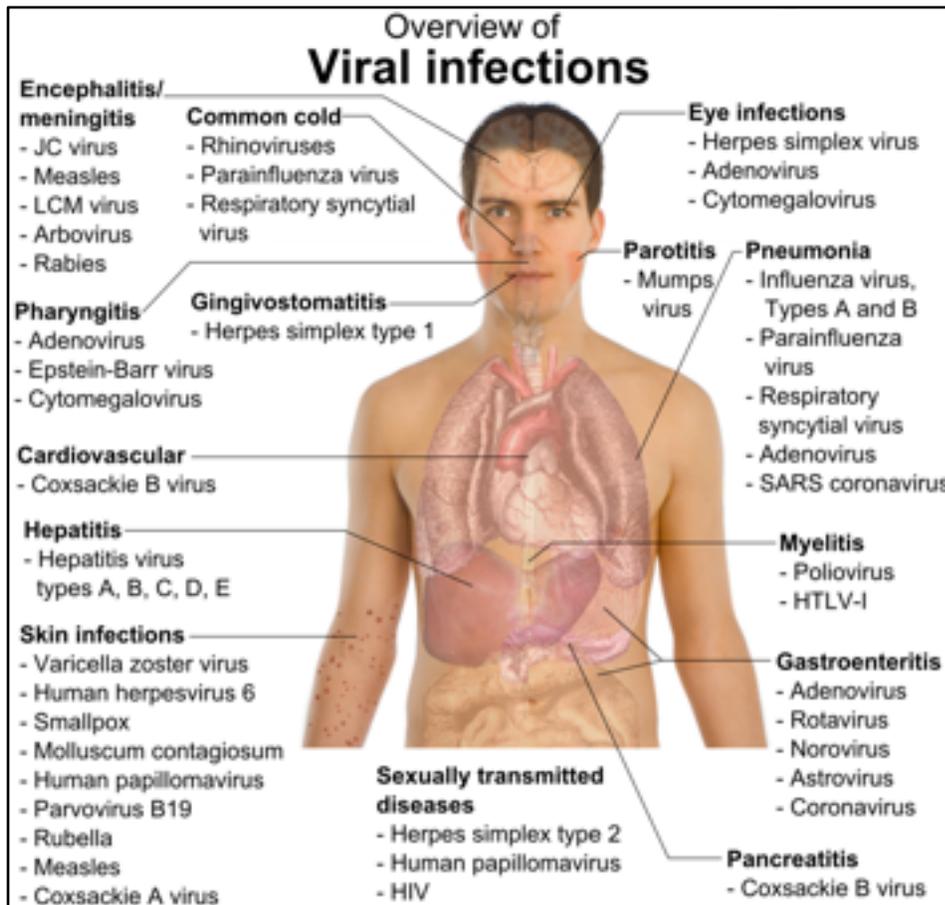


Image presented in lecture, illustrating different kinds of viral infections, the image was obtained from: [www.healthype.com](http://www.healthype.com)

There are a lot of similarities between bacterial and viral infections and it is one of the causes that leads doctors to mis-prescribe antibiotics.

### **AN OVERVIEW OF ANTIMICROBIAL THERAPY: CIDAL VS. STATIC DRUGS**

**Bacteriocidal:** This kind of drug kills all susceptible bacteria.

**Bacteriostatic:** This kind of drug inhibits/slows the growth of bacteria until host's immune system takes over.

## **WHAT CAUSES DRUG RESISTANCE?**

- Bacteria can become resistant to antibiotics by mutating (changing) their genes after being in contact with an antibiotic.
- These changes allow the bacteria to survive or resist the antibiotic.
- Bacteria can also develop resistance through contact with other bacteria resistant bacteria

## **HOW ANTIBIOTIC RESISTANCE HAPPENS?**

Four (4) steps:

1. Lots of germs, a few are drug resistant.
2. Antibiotics kill bacteria causing the illness, as well as good bacteria protecting the body from infection.
3. The drug-resistant bacteria are now allowed to grow and take over.
4. Some bacteria give their drug-resistance to other bacteria, causing more problems.

Note: It is usually the secondary infections that kill a patient, for example if a patient has HIV, then they are most likely taking antibiotics that make their body weak, so other infections can occur and actually kill the sick individual with that secondary infection.

## **WHAT CAUSES ANTIBIOTIC RESISTANCE?**

- The more antibiotics are used, the more chances bacteria have to become resistant to them.
- Major causes of antibiotic resistance include using antibiotics when they are not needed.
- Not taking antibiotics at the doses and times that a doctor prescribes - this allows time for the bacteria in your system to become resistant.
- Antibiotics are also often overused in animals (in veterinary medicine and in agriculture).

Note: There is an issue with the use of antibiotics, viruses, and bacterial infections in the food industry. The farm animals that we consume are exposed to bad and unkept environments that cause viruses and bacterial infections due also mainly by the way they are kept in such close proximity to one another. To try and improve this issue we need to reevaluate profitability in the farm and agricultural system. Mainly these farmers don't have the means to improve or provide a safe environment for their animals, so they have to work with what they have in order to maintain a meaningful profit.

## **EARLY ANTIBIOTICS**

Early antibiotics were very far spectrum meaning that they could kill off different kinds of infections using just one drug. Now a days, it is opposite, we have a more specific approach to antibiotics meaning that we have different kinds of antibiotics killing different kinds of infections. In the future, specialists in the field think that we would need to go back to the large spectrum approach.

Note: In hand sanitizers, it states that it kills 99.5% germs, so the .5% germs are the ones that cannot be fought off because they are resistant.

The earliest source of antibiotics came from soil samples. Back in the day they would screen soil for antibiotics. Now it is more synthetic.

## **PENICILLIN ACCIDENT DISCOVERY**

Penicillin was accidentally discovered by Alexander Fleming and became a weapon against fighting bacterial infections in 1928. Such discoveries as Fleming's require an extraordinary eye to detail and scientific and chemical observation to conclude what he did by accident.

## **YOU CAN HELP PREVENT ANTIBIOTIC RESISTANCE BY:**

- understanding that most people don't need antibiotics for colds and flu because they are caused by viruses
- telling your doctor you only want an antibiotic if it is really necessary
- taking the right dose of your antibiotics at the right time, as prescribed by your doctor
- taking your antibiotics for as long as your doctor tells you to taking simple steps to avoid infections and prevent them from spreading
- Properly disposing of unused/unwanted antibiotics

Note: Some people use antibiotics to fight off an infection and it might be in fact the wrong antibiotic that they are using or using a drug to cure a wrong kind of infection and they think that the antibiotic helped, where in reality it was the body that fought off the infection rather than the antibiotic. This misleads the evaluation that people make about antibiotics. In turn this is very dangerous because when people use antibiotics when they don't need them, then their bodies become more antibiotic resistant and may lead them to die of an infection that they could have prevented by an antibiotic if their body was not resistant to it.

## **MICROORGANISMS GROUPED BY THREAT LEVEL RE: RESISTANCE**

**Urgent:** These bacteria are immediate public health threats that require urgent and aggressive action.

Ex: Clostridium difficile, Carbapenem - Resistant Enterobacteriaceae, and Neisseria Gonorrhoeae.

**Serious:** These bacteria are a serious concern and require prompt and sustained action to ensure the problem does not grow.

Ex: Mutidrug - Resistant Acinetobacter, Drug Resistant Campylobacter, and Fluconazole Resistant Candida.

**Concerning:** These bacteria are concerning and careful monitoring and prevention action are needed.

Ex: Vancomycin - Resistant Staphylococcus Aureus, Erythromycin - Resistant Group A Streptococcus, and Clindamycin - Resistant Group B Streptococcus.

## **NEW DRUGS AND APPROACHES**

Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa and Enterobacter species (**ESKAPE**): important pathogens of resistance.

As new antibiotics are being created some of the antibiotics might be affective, but even if they worked, they would not be commonly released to the public and would be held for special cases only.

**R&D Research and Development** are working on trying to accommodate for the resistant antibiotics with research and possible development of new affective treatment.

In the search for new developments, there is usually a need for volunteers to work in the field. Those volunteers are usually naive normal students that have not been exposed to many antibiotics and have a functional immune system. Safety is the key in the process.

**Generating Antibiotics Incentives Now (GAIN) Act 2012:** Created to maintain the antibiotic development, and to put other measurement in place such as by FDA to improve the productivity of new affective antibiotics.

**Antibacterial Drug Development Task Force:** Created by the FDA to support the development of new antibiotics.

**Defense Advanced Research Projects Agency (DARPA):** are trying to invent a different way of fighting infections without vaccine. DARPA is more focused on prevention rather than antibiotic treatment.