General Considerations Concerning Antibiotics

1. Making new and effective antibiotics to deal with the challenge of resistant organisms is becoming very difficult. Bacterial evolution has out-paced the ability of researchers to produce effective antibiotics to deal with the new strains. Some strains of *Staphylococcus aureus* are resistant to all antibiotics. Medical procedures and surgeries that have been somewhat routine are now threatened with the possibility of infection with resistant organisms.
2. Testing *in vitro* may not always have the desired *in vivo* effects.
3. When using antibiotics it is important to take the medication for the appropriate time frame. Not doing so, may select for resistant strains.
4. Culture and sensitivity testing should be performed to identify the infecting organism and to appropriately select the correct antibiotic. Indiscriminate usage of broad spectrum antibiotics should be avoided as much as possible. Keep statistics and collected data and share information with local health facilities.
5. Some antibiotics are incompatible in solution with certain interfering agents. For example, tetracyclines, when mixed with the anti-coagulant heparin, will cause the antibiotic to precipitate out of solution. This destroys the medication that was intended to help the patient. Sometimes, drug/drug interactions can produce detrimental consequences. For example, the antibiotic group known as the aminoglycosides combined with certain muscle relaxants can potentiate the competitive neuromuscular blockade.
6. Route of administration and ultimate blood level concentration should be considered. There are three major routes; I.V(intravenous)., I.M(intramuscular)., or oral.

7. Consideration should be given as to how the antibiotic is cleared from the body. Clearance is through the kidneys(renal) or the liver(hepatic) or both. Major management problems can arise with regard to choice and dose of antibiotics. If the patient has a urinary tract infection use an antibiotic that is cleared through the kidneys. If the patient suffers from renal insufficiency there may be interference with the clearing of an antibiotic. If the patient has a bile tract infection, use an antibiotic that is cleared by the liver. If the patient has a condition which keeps the liver from functioning, this has to be considered.
8. Consideration should be given as to when to use a bactericidal agent vs. a bacteriostatic agent Since bacteriostatic agents require an intact immune system, they should not be used in patients with impaired host defense mechanisms such as those with leukemias, lymphomas or those that are receiving corticosteroids etc.
9. Why not consider the cost of therapy if an alternative and less expensive antibiotic works as well as a more expensive one.

Sources of Antibiotics

There are three major sources from which antibiotics are obtained:

1- **Microorganisms**. For example, bacitracin and polymyxin are obtained from some *Bacillus* species; streptomycin, tetracyclines, etc. from *Streptomyces* species; gentamicin from *Micromonospora purpurea;* griseofulvin and some penicillins and cephalosporins from certain genera *(Penicillium, Acremonium)* of the family Aspergillaceae; and monobactams from *Pseudomonas acidophila* and *Gluconobacter* species. Most antibiotics in current use have been produced from *Streptomyces* spp.

2- Synthesis. Chloramphenicol is now usually produced by a synthetic process.

3- Semi synthesis. This means that part of the molecule is produced by a fermentation process using the appropriate microorganism and the product is then further modified by a chemical process. Many penicillins and cephalosporins are produced in this way.

Physical Agents

A- Heat: application of heat is the simplest means of sterilizing materials, provided the material is itself resistant to heat damage. A temperature of 100℃ will kill all but spore forms of bacteria within 2-3 minutes in laboratory-scale cultures ; a temperature of 121℃ for 15 minutes is utilized to kill spores. Steam is generally used, both because bacteria are more quickly killed when moist and because steam provides a means for distributing heat to all parts of the sterilizing vessel. At sea level, steam must be kept at a pressure of 15 Ib/sq in. (psi) in excess of atmospheric pressure to obtain a temperature of 121˚C ; autoclaves or pressure cookers are used for this purpose. At higher altitudes, the pressure would need to be higher than 15 psi to reach 121˚C. for sterilizing materials that must remain dry, circulating hot air electric oven are available, since heat is less effective on dry materials, it is customary to apply a temperature of 160 – 170˚C for 1 hour or more.

B- Radiation: ultraviolet light and ionizing radiations have various applications as sterilizing agents.

Chemical Agents

A- **Alcohols:** ethyl alcohol, isopropyl, and *n*-propanol exhibit rapid, broad-spectrum antimicrobial activity against vegetative bacteria, viruses, and fungi but not sporicidal. Activity is optimal when they are diluted to a concentration of 60 – 90 % with water.

B- **Aldehydes:** gluteraldehyde is used for low-temperature disinfection and sterilization of endoscopes and surgical equipment. It is normally used as a 2% solution to achieve sporicidal, and virucidal.

C- **Biguanides:** chlorohexidine is widely used in hand washing and oral products and as a disinfectant and preservative. Mycobacteria are generally highly resistant.

D- **Bisphenols:** the bisphenols are widely used in antiseptic soaps and hand rinses. In general, they are broad-spectrum but have little activity against *Psudomonas aeruginosa* and molds. **Triclosan** and **hexachlorophene** are bactericidal and sporostatic.

E- **Halogen-Releasing Agents:** the most important types of chlorine-releasing agents are sodium hypochlorite, chlorine dioxide, and sodium dichloroisocyanurate, which are oxidizing agents that destroy the cellular activity of proteins. Hypochlorous acid is the active compound responsible for the bactericidal and virucidal effect of these compounds. At higher concentrations, these compounds are sporicidal. Iodine is rapidly bactericidal, fungicidal, tuberculocidal, virucidal, and sporicidal. Iodophors (eg, **povidone-iodine**) are complexes of iodine and a solubilizing agent or carrier, which acts as a reservoir of the active I_2.

F- **Heavy Metal Derivatives:** silver sulfadiazine, a combination of two antibacterial agents, Ag^+ and sulfadiazine, has a broad spectrum of

activity. Binding to cell components such as DNA may be responsible for its inhibitory properties.

G- **Organic Acids:** are used as preservatives in the pharmaceutical and food industries. Benzoic acid is fungistatic ; propionic acid is both bacteriostatic and fungistatic.

H- **Peroxygens:** hydrogen peroxide has broad-spectrum activity against viruses, bacteria, yeasts, and bacterial spores. Sporicidal activity requires higher concentrations (10 – 30%) of H_2O_2 and longer contact times.

I- **Phenols:** phenol and many phenolic compounds have antiseptic, disinfectant, or preservative properties.

J- **Quaternary Ammonium Compounds:** these compounds have two region in their molecular structures, one a water-repelling (hydrophobic) group and the other a water-attracting (hydrophilic) group. Cationic detergents, as exemplified by quaternary ammonium compounds (QACs), are useful antiseptics and disinfectants. QACs have been used for a variety of clinical purposes (e.g. preoperative disinfection of unbroken skin) as well as for cleaning hard surfaces. They are sporostatic ; they inhibit the outgrowth of spores but not actual germination process. QACs are also mycobacteriostatic and have an effect on lipid-enveloped but not lipid-nonenveloped viruses.

K- **Vapor-Phase Sterilants:** heat-sensitive medical devices and surgical supplies can be effectively sterilized by vapor-phase systems employing ethylene oxide, formaldehyde, hydrogen peroxide, or peracetic acid.