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STERILIZATION, DISINFECTION, ECOLOGY AND PREPARATION OF PEDAL SKIN

Sterilization is the destruction of all forms of microbial life, while dis-infection is the process by which pathologic microbes are destroyed. Since the AIDS epidemic began almost two decades ago, this definition has been engrained in the public psyche. It continues in 2005-2006 and beyond with the West Nile virus, continuing salmonella restaurant food poisonings, seasonal influenza epidemics, monkey-pox scares, etc.

Medically, these two concepts are important to understand when discussing the normal, pathologic, resident or transient ecology (flora) of the pedal skin. Once understood in this context, a logical approach to the gowning, gloving, prepping and draping process of the surgical patient and operator, can be appreciated. Finally, the fabrication of protective equipment and the appropriate use of prophylactic oral and parenteral antibiotics can likewise be formulated. These concepts will be reviewed according to this sequential approach.

The Sterilization Process

Sterilization is defined as the "destruction of all forms of microbial life including viruses, bacteria, and spores". There are a variety of sterilization methods available, including steam, autoclave, dry heat, gas (ethylene oxide), liquid, or cold sterilization. The Steam Autoclave is by far the most popular form of sterilization, since it is a simple, reliable and effective system. The effective steam system setting is one atmosphere above atmospheric pressure, at 121 degrees C (250 degrees F). This is equivalent to a pressure of 1 atmosphere (101 kPa, 15 lb/in2) above atmospheric pressure, for at least twenty minutes. The disadvantage of this method is it cannot be used on materials that are sensitive to moisture or moderate heat. Some newer steam autoclave systems replace the distilled water used with the traditional steam autoclave with methylethylketone, acetone, formaldehyde and three alcohols The time, pressure, and temperature settings are the same as the traditional autoclave.

Dry Heat Sterilization is a heat oven. The time pressure is two hours at a temperature of 170 degrees C (340 degrees F). Dry heat is advantageous for the sterilization of sharp instruments. The disadvantage is that it cannot be used for plastics, cloth, or paper. Also, special packing containers or foil must be used to cover the individual items.

Gas (ethylene oxide) Sterilization is a mutagenic agent that is a very effective sterilization method for materials that cannot tolerate steam or dry heat. The setting is 450-500 mg/liters at a temperature of 55- 60 degrees C. The problem with this method is that it is very toxic, flammable and requires a prolonged exposure time.

Cold (liquid) sterilization is considered a disinfectant unreliable as a sterilization method, except for glutaraldehyde. Several glutaraldehyde preparations on the market include: Cidex R and Cidex-7 R (Surgikos, Arlington, Tx), Acusol R, (Acuderm, Fort Lauderdale, Fl), Glutarex R (3M Company, St. Paul MN.) and Sporicidin R (Sporicidin Co., Washington, DC). Sporicidin R is the preparation that appears superior to other glutaraldehyde preparations by faster action on microorganisms.

Disenfection and Disenfectants

With the onset of AIDS, SARS (Sudden Acute Respiratory Syndrome) in 2003-05, and the hepatitis epidemic, the Centers for Disease Control and Prevention (CDC), along with the Occupational Safety and Health Administration (OSHA), devised stringent standards for the protection of the 5.6 million health care workers in the United States. The protocol includes the use of disinfectants that inactivate the HIV and hepatitis virus. Disinfection is defined "as any process, chemical or physical, by which pathogenic agents or disease producing microbes (but not necessarily all microbial forms) are destroyed". There are a number of chemical disinfectants that have been found to inactivate the HIV virus; however they are not always reliable because of their inactivation by blood or other organic matter. Consequently, the chemical disinfection of invasive instruments for surgery is not a recommended procedure. Instead disinfectants should be used to wipe up blood on inanimate objects (fomites) such as table tops and chairs.The World Health Organization (WHO) has determined the following disinfectants are effective against the AIDS virus: sodium hypochlorite solution (bleach), ethanol (ethyl alcohol), 2-propanol (isopropyl alcohol) 70%, polyvidone iodine (PVI) 2.5%, and formaldehyde (formol, formalin) 4%, glutaral (glutaraldehyde) 2% and hydrogen peroxide 6%.

Sodium Hypochlorite:

Sodium hypochlorite solution, or liquid bleach, is an excellent inexpensive disinfectant with bactericidal and virucidal activity. A major disadvantage is that bleach is corrosive to nickel, chromium steel, iron, and other oxidizable metals leading to deterioration of the equipment. The equipment should be soaked for no longer than 30 minutes in diluted bleach.

Ethanol (ethyl alcohol) and 2-Propanol (isopropyl alcohol):

Ethanol and 2-Propanol are germicidal for vegetative forms of bacteria: mycobacteria, fungi, and viruses after a few minutes of contact. They are not effective against bacterial spores.

Polyvidone Iodine:

Polyvidone Iodine (PVI) is an iodophor that can be used as a disinfectant and antiseptic. Its disinfectant activity is very similar to hypochlorite solution, but it is more stable and lesscorrosive to metal instruments. Equipment may be soaked in a 2.5% solution for 15 minutes.

Formaldehyde:

Formaldehyde (formol, formalin) destroys vegetative bacteria, fungi, and viruses in less than 30 minutes and bacterial spores after several hours. The major disadvantage of this solution is the vapor released. It is very toxic and irritating to mucous membranes.

Glutaraldehyde:

Glutaraldehyde (Glutarex R, 3M Co. St. Paul, MN, glutaral) destroys vegetative bacteria, fungi, and viruses in less than 30 minutes, while it takes about 10 hours to destroy spores. The problems with this solution are its release of toxic residues and expenses.

Hydrogen Peroxide:

Hydrogen peroxide (H2O2) is a potent disinfectant within 30 minutes due to the release of oxygen. The disadvantage is that it is corrosive to copper, aluminum, zinc and brass.

Ecology of the Pedal Integument

Hippocrates, in 400 BC, noted that wounds could be cleaned with boiling water. Joseph Lister, in 1865, was credited as the father of aseptic technique. "Based on Pasteur's discovery and on the germ theory", Lister found that simple hand washing and use of carbolic acid spray reduced the infection rate in his patients dramatically. Carbolic acid was found to be too toxic to the skin and less noxious agents were later developed.

Current practice requires surgeons to use appropriate degerming agents to reduce the bacterial count on their own skin, as well as the patient's skin. In contrast to surgical instruments that can be rendered absolutely sterile, living skin can never be completely sterilized of its bacterial colony. One can however, eliminate bacteria by cleaning in two ways. Initially, vigorous rubbing the hands together produces friction that removes dirt, transient flora and some resident bacteria. Then, additional cleansing occurs when soaps or detergents emulsify oil based bacteria and waste products from the skin.

Bacterial ecology of the feet can be divided into transient and resident flora affected in different ways when scrubbed for surgery. Generally, the specific floral type and quantity of organisms present on the pedal skin will depend upon factors such as: temperature, location (ie, interdigital web spaces), CO2 concentration, ketone bodies, glucose, pH, moisture, hair follicles, pilosebaceous glands, apocrine and eccrine (lactic acid) sweat glands (salt), and presence or absence of skin lipids.

Trauma, from ulcerations and frank lacerations, to superficial skin crevices and microscopic cuts, as well as the systemic or local (ie, diabetes mellitus or psoriasis) condition(s) of the host, all play a role in the microflora of the skin. Additionally, occlusive or porous footwear also play an important role in the presence or absence of specific bacteria on the skin of the human foot.

Resident (Ecology) Flora:

Resident Flora are colonizing microorganisms commonly isolated from the dermis and epidermis of the skin and isolated in numbers greater than 10-2 colony forming units (CFU's)/cm2 on dry acidic skin, and in numbers greater than 10-5 CFU's/cm2 on wet skin. The dorsal surface contains fewer organisms than the plantar surface, which in turn possess fewer organisms than the toe web spaces. They are permanent and indigenous to the skin and are not easily removed with washing.

They are usually not involved with nosocomial infections, unless invasive procedures introduce them into deeper tissue or the patient is compromised. Resident cutaneous microflora of the wet (lipophilic diphtheroids) and dry pedal skin, include the following organisms, according to Marshall and colleagues, as well as Terleckyji and Abramson:

Coagulase negative staphylococci {CNS} (77-100%) such as S. S. capitis, S. cohnii, S. epidermidis, S, haemolyticus, S. hominis, S. saprophyticus and S. warneri. Aerobic micrococci (35-95%) include micrococcus luteus, variansand the aerobic diphtheroids (coryneforms). Anaerobic diphtheroids (92-100%) include both lipophilic and non-lipophilic organisms, such as Brevibacterium epidermidis (non-fluorescent diphtheroid) and Corynebacterium minutissimum (fluorescent diphtheroid), C. xerosis (non-fluorescent diphtheroid) and C. lipophilicus. The yeasts include Pityrosporum orbiculare and P. ovale.

Transient (Ecology) Flora:

Transient flora-are non-colonizing organisms found on the superficial epidermis and quantitatively represent less than 0.1% of the normal micro flora of the foot. They are isolated in numbers less than 10 colony forming units (CFU's)/cm2. Even though this type of flora remains for less than 24 hours and is easily removed by washing; it has been implicated in nosocomial (hospital acquired) infections. Transient cutaneous bacterial microflora of the human foot include the following organisms, according to Marshall and colleagues, as well as Terleckyji and Abramson:

Gram positive [0-16%] cocci (S. aureus, alpha-hemolytic streptococci, Group B streptococci and Group D streptococci {enterococci}). Gram positive [12-40%] rods (Clostridium sp., Bacillus sp., and Propionibacter, sp).Gram negative (11-25%) rods (Acinetobacter sp., Enterobacter sp., E. coli, K. pneumoniae, Moraxella sp., Proteus mirabilis, Pseudomonas maltophilia and P. aeruginosa). Transient cutaneous [6-32%] fungal microflora include Aspergillus sp., Candida albicans and C. parapsilosis, Penicillium sp., Rhodotorula sp., Scopulariopsis sp. and Trichophyton sp.

Opportunistic (Ecology) Flora:

The microbiological flora of the foot involved a constantly changing environment and may be modified, altered or become disease producing due to many factors. For example, in the hospitalized patient, opportunistic skin inhabitants may include S. aureus, S. epidermidis (S. albus) and S. haemolyticus, as well as Proteus sp., Pseudomonas sp., or Candida albicans. Fecal or urinary fallout, in the elderly or incontinent patient, may also contaminate the pedal skin, with microorganisms such as Group D streptococci enterococci), E. coli and Klebsiella pneumoniae.

Coagulable negative staphylococci (CNS), like the enterococci, are normal human commensals (60-90%) and usually represent contamination but not pathogenicity. However, it is now believed that some of these organisms (S. warneri, S. capitis, S. simulans, S. auricularis, S. xylosus) and especially S. epidermidis and S. saprophyticus, may play a more critical role in infected joint implant and fixation devices (<1%).

Reasons for this include glycocalyx "slime" biofilm production and antibiotic resistance but most of these infections are hospital acquired, rather than community acquired or postoperative infections. Many are methicillin resistant, gentamicin resistant, and also not sensitive to the cephalosporins commonly used in surgical prophylaxis ("heterotropic resistance"). Therefore, empiric vancomycin and rifampin is the drug of choice, if an abundance of CNS organisms are recovered from the site of a potential infection, prior to the sensitivity report. Again, this is especially true of hospitalized patients, since almost half of all S. epidermidis isolates are methicillin, as well as cephalosporin, resistant.

Protocols of Skin Preparation

An antiseptic is defined as any substance used on living tissue to destroy microorganisms, by binding to the stratum corneum; but it does not sterilize the skin. In fact, living, viable, epidermis can not be rendered truly sterile, only surgically clean or decontaminated. Anti-microbial antiseptic scrubs are used for the surgical hand scrub and as a preparative agent for the surgical skin site, to remove superficial flora and debris, and to reduce the risk of wound contamination.

Currently, there are several antimicrobial soaps on the market to reduce the resident and transient flora of the surgeon's hands and patient's foot. Which specific antimicrobial soap to use is clouded by many uncontrolled studies, and confusing testing procedures? The ideal hand scrub should reduce microbes on intact skin, contain nonirritating antimicrobial penetration, be broad spectrum in scope, fast acting, and be an effective detergent. If an antimicrobial soap cannot be used due to allergies, then a liquid non-medicated soap scrub followed by an application of alcohol based hand cleanser should be used.

Popular antimicrobial hand scrubs include: alcohol, 4% chlorhexidine, povidone-iodine and 3% hexachlorophene. The less commonly used scrubs include 5% Para-chloro-meta-xylenol and Triclosen.

The Alcohols:

The alcohol(s) mode of action is by denaturation of proteins. They have excellent bactericidal activity against Gram-positive organisms, Gram-negative organisms, the tubercle bacillus, and fungus. However, they have no anti-sporocidal activity. Alcohols' major disadvantage is its drying effects and volatility. There are no data on how alcohol is affected by organic material.

4% Chlorhexidine:

Chlorhexidine 4% (Hibiscrub/Hibitane R, Stewart Pharmaceuticals, Wilmington, DE) is a cationic bisbiguanide, in which the mode of action is to disrupt the microbial cell membrane. This antimicrobial has good activity against Gram-positive organisms and viruses, with less activity against Gram-negative

organisms and fungus. Adverse reactions include allergic dermatitis and photosensitivity, although these are rare. Studies show chlorhexidine provides immediate and persistent microbial reduction when compared to Betadine / Phisohex-R (Winthrop Pharmaceutics).

Providone-Iodine:

Providone-iodine (Betadine-R, Iodophor-R, 1-2% iodine in alcohol) is the most commonly used hand scrub. The mode of action for providone-iodine is "cell wall penetration, oxidation and substitution of cell wall contents with free iodine". Providone-iodine has good activity against Gram positive and Gram-negative organisms, tubercle bacillus, fungus and viruses. It has some activity against spores. Allergic reaction is uncommon.

3% Hexachlorophene:

3% hexachlorophene (Phisohex-R) is a chlorinated biphenyl in which the mode of action involves disruption of the microbial cell wall. It is bacteriostatic against Gram-positive organisms but is less active against Gram-negative bacteria, tubercle bacillus, fungi and viruses. The adverse effects are similar to 4% chlorhexidine. Hexachlorophene is contraindicated in pregnant women and infants because of its absorption levels, from the GI tract and across the mucous membrane, which can lead to CNS irritability and convulsions. It is also not advisable to use Phisohex R for routine bathing since acute dermatitis of the skin may occur. A Povidone-iodine scrub will decrease the bacterial count fasterthan chlorhexidine or hexachlorophene for immediate effect. However, hexachlorophene and chlorhexidine are more effective over a longer period of time in reducing the bacterial count during scrubbing.

5% Para-Chloro-Meta-Xylenol:

5% Para-chloro-meta-xylenol (PCMX) is a halogen substituted xylenol, in which the mode of action involves cell wall disruption along with enzyme inactivation. It has good activity against Gram positive organisms, but less activity against Gram negative, tubercle bacillus, fungi, and viruses. PCMX is less effective than chlorhexidine, povidone-iodine, and hexachlorophene in reducing skin microorganisms.

Triclosan:

Triclosan (Irgansan DP-300) is a diphenyl ether compound in which the mode of action is to disruption of the microbial cell wall. It has good activity against Gram-positive organisms and Gram negatives, except for Pseudomonas, while it has little activity against fungus. Additional studies are still needed to determine the efficacy of triclosan as a hand scrub. Thus overall, chlorhexidine reduces the greatest number of microbial flora, compared to hexachlorophene and povidone-iodine.

Surgical Prepping

In the late 19th century, Lister first began preoperatively preparing the surgical site with Carbolic acid spray. This proved to be a rather toxic method, and over the years different chemical compounds have been used to prepare the skin for surgery. Today a popular skin preparation is the Betadine R scrub

and paint method. The American College of Surgeons advised that the operative site be scrubbed; however the methods vary considerably.

The most that can be hoped for is to reduce the bacterial contamination at the surgical site". The function of the antiseptic surgical preparation is to dilute the inoculum present on skin and defat (emulsify) the skin surface of perspiration and oils. Preoperative measures involving the patient include bathing with antiseptics and preoperative shaving. Bathing the night before surgery, with antimicrobial soap, has been suggested to reduce S. aureus contamination. However, clinical studies have not substantiated this as an effective means to reduce infection. Preoperative shaving appears to have been instigated by Gustav Neuber, in Germany, and has remained a ritual through this century; however several authors began to question the effectiveness of shaving the surgical site. Seropian "challenged this dogma of hair removal preoperatively by showing the infection rate of hair removal was 10 times higher than depilatory cream". If preoperative shaving must be done, it should be performed immediately before the surgical procedure. Some suggested alternatives to razor shaving are depilatory creams and electric clippers. Depilatory creams, for hair removal, have given favorable results for several authors who have confirmed the safety of this technique.

Surgical Wound Infections

Measures to reduce postoperative surgical infections include prophylactic antibiosis, the patient's underlying health status, length of operation and stay in the hospital. Additional factors include preoperative shaving and bathing of the patient. For example, patients who are over 65 years old are six times more likely to develop a postoperative infection. The patient's nutritional status as well as underlying diseases such as sickle cell anemia, diabetes mellitus and steroid therapy, seem to make the patient more prone to infection. Interestingly, formalities as "double gloving" to reduce skin bacterial colony counts, or the use of superficial "skin" or dissecting "deep" scalpels have not been experimentally proven to reduce the rates of postoperative infections.

Early admission, as well as prolonged stay in the hospital, for uncomplicated foot and ankle surgical cases, is now discouraged since there is a causal relation between the occurrence of nosocomial infection and extra hospital stays. Hughes estimated that "5.5% of hospitalized patients develop a nosocomial foot infection", while Miller found in-house postoperative infections to range from 2.2% to 5.4%. Martin surveyed 151 patients undergoing outpatient foot surgery and found the infection rate to be 1.3% and Hugar found an infection rate of 1.35% in his foot surgical center. His study indicated that all types of foot surgery may increase the risk of infection.

A postoperative infection is defined as a clinical condition caused by the action of a pathogenic microorganism in the surgical site. It is usually manifested by drainage or abscess formation. When an infection occurs, it usually demonstrates the cardinal signs of inflammation, such as redness, edema and pain. The incubation period lasts from 48-72 hours and produces a sharp increase in temperature. The most common causative agents include S. aureus and Streptococci hemolytic A. enteric gram-negative bacteria are not commonly involved.

Surgical Wound Classification Scheme

With the advent of modern aseptic surgical technique, antibiotic prophylaxis, and advances in clinical nutrition, the overall rate of surgical wound infection has decreased to 4.5%. However, they still account for over 40% of all hospital acquired infections.

Perioperative attention should be directed towards reducing the number of potential pathogens, addressing the patient's underlying health status, determining the condition of the wound, and decreasing the duration of the operation; all of which can facilitate the growth of opportunistic pathogens. The American College of Surgeons (ACS) and the National Research Council Study, have classified surgical wounds into four categories, according to their potential risk for postoperative infections.

1. Clean Wounds:

Surgical wounds are considered clean if they are uninfected, no inflammation is encountered, no break in aseptic technique occurs and no hollow organs opened. In addition, if they are elective and primarily closed, a closed drainage system may be employed. Clean wounds have an infection risk of 1-5%. Antibioticprophylaxis is rarely given unless there is a higher risk of infection, such as joint implant. Staphylococcus or Streptococcus species are usually the pathogens involved.

2. Clean-Contaminated Wounds:

These are surgical wounds in which a hollow organ is entered with little or no spillage. They are considered potentially contaminated. These generally include operations involving the respiratory, alimentary and genitourinary tracts. They have an infection risk of 8-11%. Prophylaxis is used only for high-risk patients or procedures.

3. Contaminated Wounds:

Surgical wounds are considered contaminated if there is a preexisting infection, a major break in aseptic technique, if there is gross spillage from the gastrointestinal tract, or an acute inflammation without pus formation is encountered. Traumatic wounds of less than four hours old are included in this group.
They have an infection risk of 16-25%. Most patients require antibiotic prophylaxis, and delayed wound closure is common, unless the wound is believed converted to a clean one prior to closure.

4. Dirty and Infected Wounds:

Surgical wounds are considered dirty or infected if pus is encountered at the time of the surgery.

Prophylactic Antibiotics

Clean surgery in the USA accounts for approximately 70% of all surgical cases, with a 1-5% infection rate. Obviously, the most effective means to treat an infection is to prevent contamination in the first place. Interestingly, antibiotics have been used since 1932 and their role is still controversial. This is

because early studies showed that the use of prophylactic antibiotics lead to an increase in resistant organisms. The problem was lack of controlled studies that lead to "overdosage and faulty timing of the administration of the IV antibiotic, ranging from several hours to several days postoperatively". These conflicting reports were not resolved until Burke's definitive 1961 study, in which he inoculated experimental lesions, in guinea pigs, with S. aureus.

He found the antibiotics suppressed Staphylococcus growth, when administered "from the moment the bacteria gains access to the tissue, and is over in three hours". This is called the "effective" or "definitive period". He defined this period, as the time when the developing staphylococcal lesions may be suppressed by the addition of antibiotics". A delay in the administration of the antibiotics, after the crucial three-hour time period, failed to reduce the size of the control lesion.

Additionally, it must be recalled that prophylactic antibiotics are not totally benign and side effects can, and do, occur. Usually these entail hypersensitive cutaneous reactions such as flush, flare, wheel, rash or hive formation. A super-infection from organisms not sensitive to the specific drug may also occur, and life threatening anaphylactic shock may be the ultimate complication to consider. Prophylactic antibiotics are generally not used in AIDS patients for fear of sterilizing normal gut flora allowing overgrowth potential of more resistant organisms.

Since Burke's study, several other studies have substantiated the importance of administering the IV antibiotic at the appropriate time to be effective. For example, Polk and Griffiths, and Chodak, established that giving IV antibiotics 30-60 minutes before the surgical incision, "results in the drug reaching therapeutic levels in the tissues", in adequate time to permit coverage of 100 minutes, from S. aureus infection.

Prophylactic Antibiotic Agents of Choice:

Since their introduction in the early 1960's, cephalosporins have been the most widely used prophylactic IV antibiotic in the hospital setting. This is due to the drugs effectiveness against S. aureus and S. epidermis, the most common pathogens in postoperative wound infections. However, the indiscriminate use of these antibiotics has lead to the development of resistant organisms.

The most commonly used cephalosporin are cefazolin, cephalothin and cephapirin. There is no conclusive evidence that any one of these antibiotics is the best choice for prophylaxis, nevertheless cefazolin (Ancef R, Smith, Kline & French Laboratories, Philadelphia, Pa) is usually preferred. It is often the agent of choice because it is able to achieve the longest bone level penetration, has good antistaphylococcal activity, rarely causes adverse reaction, and is cost effective. Cefazolin is usually administered as a one-gram intravenous bolus, 15-30minutes prior to surgery. This will provide 100 minutes of protection to the tissue. If the procedure is more than 100 minutes long, the initial bolus may be doubled from one to two grams, or an additional intraoperative dose may be given. This will provide a longer duration of coverage. Cefamandole (Mandol R, Parke-Davis, Morris Plains, NJ), is a second generation cephalosporin, which may also be used for prophylaxis. It has slightly better coverage over Gram-negative microorganisms, but it has no added advantage over first generation cephalosporins.

If the patient is allergic to cephalosporins, the two alternatives are erythromycin and vancomycin. Erythromycin is probably the safest and most effective agent, however an adverse effect is phlebitis at the IV site. Therefore, the lactobionate form is usually recommended. The usual prophylactic dosage is 500 mg to 1 gram IVPB given 60 minutes prior to surgery.

Vancomycin does offer some promise as a prophylactic antibiotic because of its excellent coverage for methicillin resistant S. aureus (MRSA) infections, which are also resistant to cephalosporins. It is actually less toxic than previously thought yet ototoxicityand nephrotoxicity are rare adverse effects. Peak and trough levels, formally mandatory, are now less rigorously monitored. The recommended prophylactic dosage is 500 mg IVPB over a 30minute period prior to surgery. Rifampin may also be a helpful adjunct.

Vancomycin is also the likely the drug of choice in most formularies, for patients with penicillin or beta-lactam sensitivities. However, over utilization and possible drug resistance is a current concern.

The semisynthetic penicillins (oxacillin, methicillin, andnafcillin) are not commonly used for surgical prophylaxis, because of increased penicillinase resistant organisms. The aminoglycosides, lincomycin, and clindamycin are generally too toxic and narrow in spectrum for prophylactic use. In order for any prophylactic antibiotic to be effective, it should have low toxicity to the patient, be administered one hour before surgery, and continued only for a short period of time after the surgery.

Indications for use of Prophylactic Antibiotics:

There are a number of pedal indications for the use of prophylactic antibiosis. Antibiotic prophylaxis in limb amputations is still disputed. Very little has been written on this topic. Some previous studies have indicated that the use of prophylactic antibiotic may be useful for lower extremity amputations. Claforan R (Aventis Pharmaceuticals, Sommerville, NJ) or cefotaxime, a third generation cephalosporin, may be beneficial for diabetic amputations since these are usually polymicrobial related infections. The suggested dosage is 1-2 grams, IV, Q 8-12 hours.

Indications For Podiatric Antibiotic Prophylaxis

I. Implantation of foreign Material
- a. Prostheses (implants)
- b. Extensive external fixation devices (Ilizarov frame)
- c. Internal fixation devices.

II. Systemic Diseases interfering with the natural mechanism of host defense
- a. Diabetes Mellitus
  - i. lower extremity amputations
- b. Rheumatic Heart Disease
- c. Peripheral Vascular Disease
- d. Poor Nutritional Status
  - i. cirrhosis of the liver
- 5. Mal-absorption syndromes

6. Corti-costeroid therapy
7. Miscellaneous: leukemia, aplastic anemia, hemolytic anemia, sickle cell anemia, and a-gammaglobulinemia

III. Acute Trauma

IV. Other indications
a. Over 70 years old
b. Previous surgery at surgical site
c. Prolonged surgical time.

Prophylactic Oral, Topical and Antibiotic Wound Lavage

Oral antibiotic administration has been documented to be ineffective for prophylaxis in foot surgical procedures. Oral agents are poorly absorbed and several doses are required to attain sufficient bone level concentrations. Studies have shown the oral antibiotics fail to reduce postoperative infection rates, and actually lead to an increased incidence of resistant organisms.

The first topical antibiotics to be used in surgical wounds were gramicidin and tyrocidin. These were developed by Rene' J. DuBois at the Rockefeller Institute. Unfortunately, surgeons soon found these antibiotics to be too toxic and they were discontinued. Many clinical and experimental studies have been done to determine whether irrigation of the surgical wounds with antibiotics is effective in reducing postoperative wound infections. The data from these studies are inconclusive. Local wound irrigation has been found to be beneficial in "washing out fat, detritus, and blood clots which may act as a foreign body nidus and encourage bacterial growth". Some other benefits include: low systemic toxicity and lack of hypersensitivity or inflammation. Finally, the commonly used antibiotic flushes are Betadine R and Kantrex R (Squibb-Navo, Inc., Princeton, NJ). Betadine prepared as a 50:50 mixture with saline solution is recommended because it is broad spectrum and has low systemic toxicity.

Betadine irrigation should not be used with implant surgery, since he foreign body reactions may result around the implant due to the iodine ions reacting with the surface implant charges. Kanamycin (Kantrex-R) also has low systemic toxicity. It is bacteriocidal against gram positive and Gram-negative organisms, except streptococcus and Pseudomonas. Kanamycin flush solution is mixed by the addition of one Gram Kanamycin to 500 ml. of saline solution.

The indiscriminate use of prophylactic antibiotics is discouraged due to the development of resistant organisms, as well as the high medical costs to the patient. Yet, if used in selective cases, prophylactic antibiotics have an important role in foot and ankle surgery.

Concluding Remarks

The definitions and processes of sterilization and dis-infection, for both medical instruments and the human integument, were reviewed in this section. The perspective of the material was within the context of the normal resident, transient and modified pathologic microbiological (ecology) flora of the pedal skin. The use of oral and parenteral, prophylactic antibiotics were also reviewed.

It is hoped that this knowledge will be useful to the podiatrist in the practical aspects of foot surgery. It also may be important to be aware of this material for board certification examinations.

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