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EC MICROBIOLOGY
Investigational Paper

Perspectives on Pathogenic Bacteria Infections in the Skin, Urine and Mucoid Surfaces of Humans

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Received: August 16, 2019; **Published:** September 17, 2019

Abstract

At the Parasitology Center, Inc. (PCI), Scottsdale, Arizona, we come across a number of patients with GI symptoms suggestive of parasitic infections that turn out to be free of parasites. Follow up tests for pathogenic bacteria using swab culture tests showed that practically all these patients were infected with pathogenic bacteria that produce symptoms similar to those known in classical parasitic infections. Our Neuro-cutaneous Syndrome (NCS) patients, among others with dermatological symptoms, often test positive for skin infecting bacteria such as *Staphylococcus* spp. Other organ systems and body fluids such as urine may also test positive for pathogenic bacteria. The presentation will focus on the common species of pathogenic bacteria that we find on the skin and in designated body tissues, surfaces, and fluids with particular reference to identity, transmission, symptoms and pathology, treatment, and prevention.

Keywords: *Pathogenic Bacteria Infections; Skin; Urine; Mucoid Surfaces*

Staphylococcus spp.

Staphylococcus is a genus of Gram-positive bacteria. It appears as round (cocci), and form in grape-like clusters. It includes at least 40 species. Most are harmless and reside on the skin and mucous membranes of humans and other organisms. Found worldwide, they are a small component of soil microbial flora. Assignment of a strain to the genus *Staphylococcus* requires it to be a Gram-positive coccus that forms clusters, produces catalase, has on appropriate cell wall. It divides along 2 axes, so forming clumps of bacteria. Streptococci other hand divide along one axis and form chains (strep. meaning twisted or pliant).

Figure 1

Symptoms: *Staphylococcus* can cause a wide variety of diseases in humans and other animals through either toxin production or penetration. Staphylococcal toxins are a common cause of food poisoning, e.g. sialadenitis, as they can be produced by bacteria growing in improperly-stored food items. *S. aureus* (= S. coagulase positive) causes skin infections (pimples, impetigo, boils, cellulitis as pimples, impetigo, boils furuncles, cellulitis folliculitis carbuncles, scalded skin syndrome, abscesses), pneumonia, meningitis, osteomyelitis, endocarditis, toxic shock syndrome (TSS), bacteremia, and sepsis. It is one of the 5 most common causes of nosocomial infections and is often the cause of postsurgical wound infections with 500,000 cases in US hospitals annually. *S. aureus* super-antigen activities induce toxic shock syndrome (TSS). This is characterized by fever, erythematous rash, hypotension, shock, multiple organ failure, and skin desquamation. Other strains of *S. aureus* can produce an enterotoxin that cause *S. aureus* gastroenteritis which is self-limiting, characterized by vomiting and diarrhea in 1-6 hours after ingestion and recovering in 8 - 24 hours. Symptoms include nausea, vomiting, diarrhea, and abdominal pain. Carriers are an important source of nosocomial infection and community-acquired methicillin-resistant *S. aureus* (MRSA). Most MRSA infections occur in people in hospitals or other health care settings, associated with invasive procedures or devices, such as surgeries, intravenous tubing or artificial joints. Another type of MRSA infection occurs in the wider community among healthy people. This form begins as a painful skin boil. It's spread by skin-to-skin contact. At-risk populations include groups who live or work in crowded conditions.

Coagulase production: *S. aureus* (=S. coagulase positive) produces coagulase, an enzyme that causes blood clot formation. *S. epidermidis*, a coagulase-negative species, is a commensal of the skin, but can cause severe infections in immune-suppressed patients and those with central venous catheters. *S. saprophyticus*, another coagulase-negative species, causes genitourinary tract infections in sexually-active young women. Other species of *Staphylococcus* can cause human infections, notably *S. lugdunensis, S. schleiferi,* and *S. caprae.*

Transmission: Infection is transmitted by direct or indirect skin to skin contact (surgical instruments, fomites, air, unwashed hands, skin lesions). Sexual contact is also a means of transmission.

Treatment: MRSA strains are found associated with hospitals, but are becoming increasingly prevalent in community-acquired infections via meat and poultry from grocery stores showing 50% infection. For antibiotic recommendations see sensitivity results. For an herbal alternative use Freedom/Cleanse/Restore protocol.

Prevention: Hand washing techniques, use of disposable aprons and gloves, and use of ethanol as a topical sanitizer. Sexual contact is also a means of transmission.

Staphylococcus epidermidis

Staphylococcus epidermidis (=S. coagulase negative) is a gram positive bacterium. It is part of human skin flora (commensal). It is also found in the mucous membranes and in animals. Patients with compromised immune systems are often at risk of developing nosocomial or community acquired infection. It is also a major concern for people with catheters or other surgical implants because it causes biofilms that grow on these devices.

Transmission: *S. epidermidis* is part of the normal flora of human skin and mucous membranes. It is widely distributed in large numbers over body surface. Transmission is caused by implantation of contaminated medical devices such as shunts or prosthetic devices during hospitalization. Person to person spread in a hospital setting may cause patients to become colonized and potentially infected with antibiotic resistant strains.

Symptoms: Nosocomial bacteremia from Infected biofilms that grow on intravenous catheters and on medical prostheses placed within the body dialysis and endocarditis patients and those with implanted plastic devices.

Treatment: Antibiotics are largely ineffective in clearing biofilms. Remove or replace the infected implant. *S. epidermidis* forms biofilms on plastic devices. The organism's capsule is made up of sulfated polysaccharide which allows other bacteria to bind to the already existing biofilm making it difficult for antibiotics to effectively clear this infection. *S. epidermidis* strains are often resistant to antibiotics, including penicillin, amoxicillin and methicillin. Resistant organisms are most commonly found in the intestine or on the skin becoming resistant due to exposure to antibiotics secreted in sweat.

Prevention: Prevention is ideal. Use Vancomycin and Rifampin or Aminoglycoside. Hand washing is a must.

Streptococcus spp.

Streptococcus is a genus of spherical Gram-positive bacteria that divides along a single causing it to grow in chains. Species of *Streptococcus* are classified based on their hemolytic properties. In the medical setting, the most important groups are the alpha-hemolytic streptococci *S. pneumoniae* and S*treptococcus* Viridans-group, and the beta-hemolytic streptococci of Lancefield groups A and B (also known as "Group A strep" and "Group B strep").

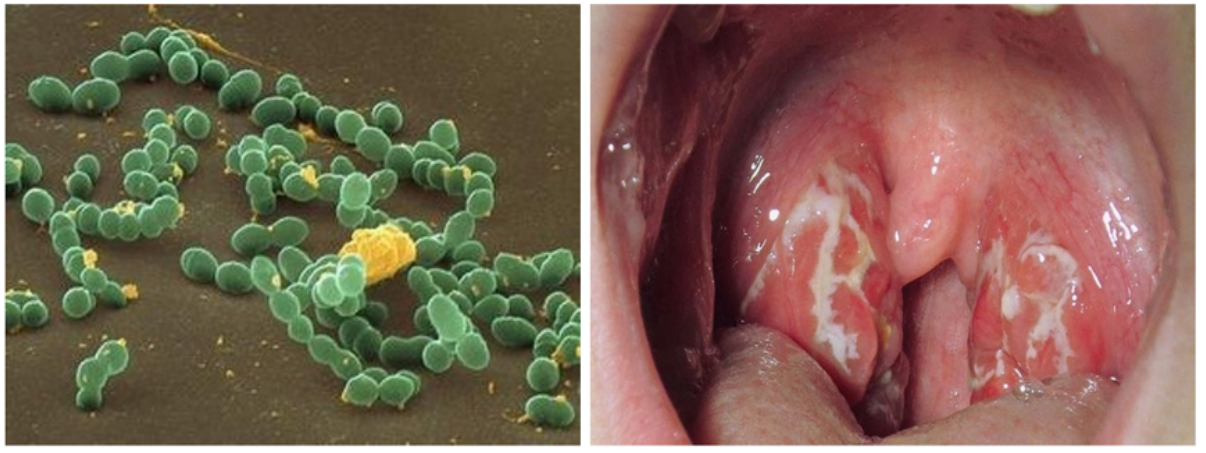

Figure 2

Transmission: Transmission depends on the species involved and the site of infection. For example, nasopharyngeal infections by *S. pneumoniae* are contracted from person to person via contaminated respiratory secretions. *S. pyogenes* infects the skin and upper respiratory tract via contaminated mucosa, secretions or coughs and sneezes. *S. agalactiae* of the female genital tract via mother to fetus in utero.

Symptoms: Streptococcal species cause pharyngitis (strep throat), pink eye, meningitis, bacterial pneumonia, endocarditis, erysipelas and necrotizing fasciitis (the 'flesh -eating' bacterial infections). However, many streptococcal species are nonpathogenic, and form part of the commensal human microbiome of the mouth, skin, intestine, and upper respiratory tract. *S. pneumoniae* causes bacterial pneumonia and occasionally otitis media, sinusitis, meningitis and peritonitis. *S. pharyngitis* (strep throat) causes impetigo, Scarlet fever, toxic shock syndrome, necrotizing fasciitis, pneumonia, and bacteremia with additional complications causing rheumatic fever and acute glomerulonephritis Rheumatic fever. *S. agalactiae* causes pneumonia and meningitis in neonates and the elderly, with occasional systemic bacteremia. They can also colonize the intestines and the female reproductive tract causing premature rupture of membranes during pregnancy, and transmission to the infant.

Treatment: These organisms are intrinsically resistant to a wide array of antimicrobial agents, and resistant to killing by any single agent such as ampicillin or vancomycin. Effective treatment can be achieved with the combination of a cell wall-active agent, such as ampicillin or vancomycin with an aminoglycoside, such as gentamicin or streptomycin. F/C/R is a good alternative.

Prevention: A single dose of 23-valent vaccine (Pneumovax) to prevent infection with most common serotypes of *S. pneumonia*. Vaccination is recommended for older patients with chronic pulmonary, cardiac, liver, or renal disease, asplenic (no spleen) patients, sickle cell, diabetes, and HIV infections or any other immune compromising condition.

Pseudomonas aeruginosa

Pseudomonas aeruginosa is a free-living Gram-negative, aerobic, coccobacillus bacterium commonly found in soil and water as well as on the surfaces of plants and animals. It is an emerging opportunistic and nosocomial pathogen infecting only compromised tissues and causing pathology in the gastrointestinal tract, heart, blood, respiratory system, central nervous system, ear, eye, bone and joint, UT, skin, and soft tissues. In the intestinal tract, it causes pathology from the oropharynx to the rectum including perirectal infections, pediatric diarrhea, typical gastroenteritis, and necrotizing enterocolitis. It uses a wide range of organic material for food; in animals, the versatility enables the organism to infect damaged tissues or those with reduced immunity.

Figure 3

Transmission of *Pseudomonas aeruginosa*: By ingestion of contaminated food or water, exposure to contaminated medical devices and solutions, introduction by penetrating wounds. Person to person transmission may occur. The organism survives well in soil, water and plants in domestic and hospital settings.

Symptoms: Symptoms are generalized inflammation and sepsis. If such colonizations occur in critical body organs, such as the lungs, the urinary tract, burns, wounds, kidneys, and causes other blood infections. The results can be fatal. Because it thrives on most surfaces, this bacterium is also found on and in medical equipment, including catheters, causing cross-infections in hospitals and clinics It is the

most frequent colonizer of medical devices (e.g., catheters). It can cause community-acquired and ventilator-associated pneumonias, "hot-tub rash" (dermatitis), burn infections, skin lesion ecthyma gangrenosum. One in ten hospital-acquired infections are from *Pseudomonas*.

Treatment: By injecting gentamicin, amikacin, tobramycin, ciprofloxacin, levofloxacin, ceftazidime, cefepime, cefoperazone, cefpirome, ceftobiprole, carbenicillin and ticarcillin, (mezlocillin, azlocillin, piperacillin. *P. aeruginosa* is resistant to all other penicillins and many other antibiotics. F/C/R is a good alternative.

Prevention: Prevention is by avoiding all sources of transmission listed above.

Bacteroides SPP.

Bacteroides is a genus of Gram-negative, non-endospore-forming non-anaerobic bacillus bacteria that may be either motile or non-motile, depending on the species. *Bacteroides* are normally mutualistic, making up the most substantial portion of the mammalian gastrointestinal flora, where they play a fundamental role in processing complex molecules to simpler ones in the host intestine. There are over 1000 cells per gram of human feces. Long-term diet is strongly associated with the gut microbiome composition - those who eat plenty of protein and animal fats have predominantly *Bacteroides* bacteria, while for those who consume more carbohydrates, the species of *Prevotella* dominate. One of the most important clinically is *Bacteroides fragilis*.

Figure 4

Transmission: This is a fecal-oral infection, directly or indirectly by exposure to contaminated objects, equipment, and liquids. They are commonly found in the colon, oral cavity, bile, and urogenital tract.

Symptoms and pathology: *Bacteroides* species also benefit their host by excluding potential pathogens from colonizing the gut. Some species e.g., *B. fragilis*, are opportunistic human pathogens, causing infections of the peritoneal cavity, central nervous system, head, neck, chest, abdomen, pelvis, skin, soft tissues, gastrointestinal surgery, and appendicitis via abscess formation, inhibiting phagocytosis, and inactivating beta-lactam antibiotics. *Bacteroides* spp. can survive in the body cavity. *Bacteroides* has been proposed as an alternative fecal indicator because they make up a significant portion of the fecal bacterial population with high degree of host specificity.

Treatment: Surgical drainage of abscess(es) and removal of necrotic tissue(s), long-term course of antibiotics, prophylatic use of antibiotics prior to invasive surgical procedures and immediately following trauma that disrupts mucosal barriers. In general, *Bacteroides* are resistant to a wide variety of antibiotics, e.g. B-lactams, aminoglycosides. This high level of antibiotic resistance has prompted concerns that *Bacteroides* spp. may become a reservoir for resistance in other, more highly pathogenic bacterial strains. For antibiotic recommendations see sensitivity results. For an herbal alternative use Freedom, Cleanse, Restore protocol.

Prevention: Avoid any food or other exposures that may be potentially contaminated with fecal matter.

Candida spp.

Candida is a genus of fungi. Many species are harmless commensals or endosymbionts of animal hosts including humans, but other harmless species in the wrong location, can cause disease. *Candida albicans* in the gut flora can cause infections (candidiasis or thrush; see photos below) especially in immunocompromised patients. Systemic infections of the bloodstream and major organs affect over 90,000 people a year in the U.S., with a 40 - 50% mortality rate. Antibiotics promote gastrointestinal candida overgrowth, and penetration of the intestinal barrier and dissemination in systemic sites.

Figure 5

Transmission: *Candida* is a food-related infection prompted by high carb/sugar diet and heavy duty, long term antibiotic treatment.

Symptoms: One or more of the following categories and locations may be affected: mental, emotional, nervous, digestive, skin, eyes, hair, immune system, generalized (fatigue, etc.), women's and children's health issues. *Candida* are almost universal on normal adult skin and *C. albicans* is part of the normal flora of the mucous membranes of the respiratory, gastrointestinal, and female genital tracts which cause no disease. But overgrowth of several species including *C. albicans* can cause superficial infections such as oropharyngeal candidiasis (thrush) and vulvovaginal candidiasis (vaginal candidiasis) as well; as systemic infections.

Treatment: Best to include the probiotic *Saccharomyces boulardii* among other probiotics. Nystatin, Diflucan, Nizoral, or Sporonax are recommended for allopathic treatment. Freedom, Cleanse, Restore protocol is recommended for herbal treatment. Candida diet is more important than treatment. Patients with heavy metal toxicity should not be treated for intestinal *Candida* infections. *Candida* metabolizes heavy metals out of the system. Use F/C/R.

Prevention: Avoiding antibiotics, birth control pills, and foods high in sugar or yeast. Observe proper *Candida* diet.

Serratia spp.

Serratia marcescens is a species of opportunistic rod-shaped Gram-negative bacteria. It is a human pathogen associated with hospital acquired infections (HAIs), especially catheter-associated bacteremia, urinary tract infections and wound infections. It is responsible for 1.4% of HAI cases in the US. It is commonly found in the respiratory and urinary tracts of hospitalized adults and in the gastrointestinal system of children. It also thrives in moist conditions proliferating in the bathrooms on soap, tile, and shampoo residues, as well as on starchy/fatty foods, and dirt. It is also the most common organism found in both corneal scrapings and contact lenses. The chief risk factor for *S. marcescens* infection is long-drawn-out hospitalization. Those with weak immune mechanism are more susceptible.

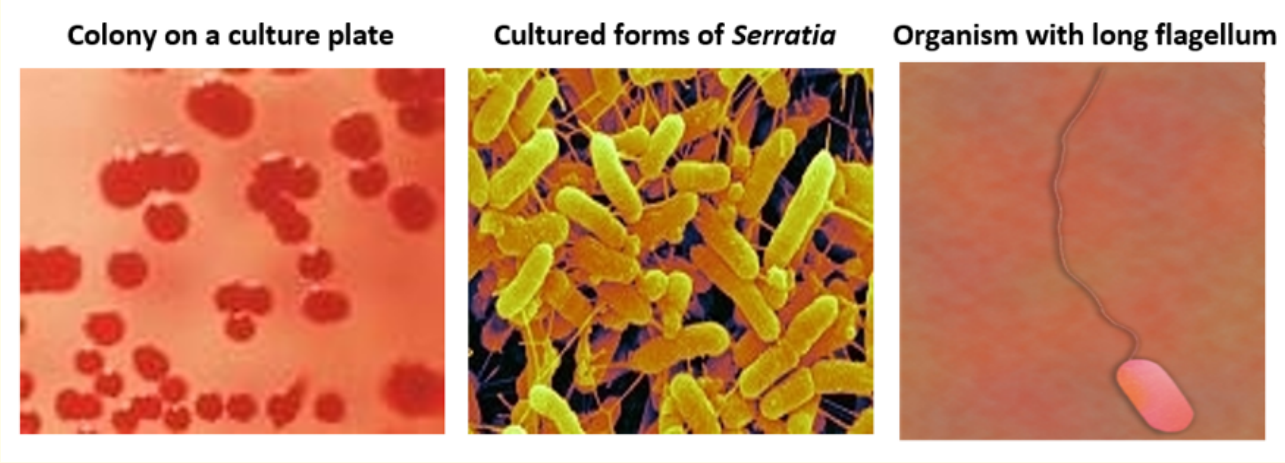

Figure 6

Symptoms and pathology: Many diseases are associated with *S. marcescens*: sepsis, bacteremia, meningitis and cerebral abscesses, urinary tract infections, osteomyelitis, ocular infections, and endocarditis. There is not one determining symptom or source of origin. The biofilms produced are generally pathogenic in the body. It is resistant to many antibiotics traditionally used to treat bacterial infections, such as penicillin and ampicillin. This is due to the *Serratia* unique membrane's (LPS) ability to survive in aerobic and anaerobic conditions. Most strains are resistant to several antibiotics. The LPS acts as an endotoxin. The release of LPS would over-stimulate the host defenses and cause them to undergo lethal endotoxic shock. The presence of LPS therefore makes it difficult to kill *Serratia marcescens* without causing the death of the host's cells. The prognosis for *S. marcescens* infections is moderately poor. Certain infections, such as UTIs, abdominal abscesses and arthritis show fairly good outcomes; whilst meningitis, cerebral abscesses, sepsis and endocarditis show moderate prognosis.

Transmission: This is primarily through hand-to-hand contact by medical personnel. Solutions used for medical purposes, catheterizations, and needle punctures can be contaminated and infect patients. The bacterium grow well on disinfectants, antiseptics, distilled water, and de-ionized water isolated from blood bags.

Treatment: For antibiotic recommendations, see sensitivity results. See F/C/R.

Prevention: Once established, complete eradication of the organism is often difficult, but can be accomplished by application of a bleach-based disinfectant. Rinsing and drying surfaces after use can also prevent the establishment of the bacterium by removing its food source and making the environment less hospitable.

Enterococcus

Enterococcus often occurs in pairs (diplococci) or short chains that are part of the normal intestinal flora of humans and animals but are also important pathogens. The genus includes more than 17 species, but only a few cause clinical infections. With increasing antibiotic resistance, enterococci include nosocomial pathogens. *Enterococcus faecalis* and *E. faecium* make up about 90% of clinical isolates from humans with *E. faecium* representing the most common vancomycin-resistant enterococci (VRE).

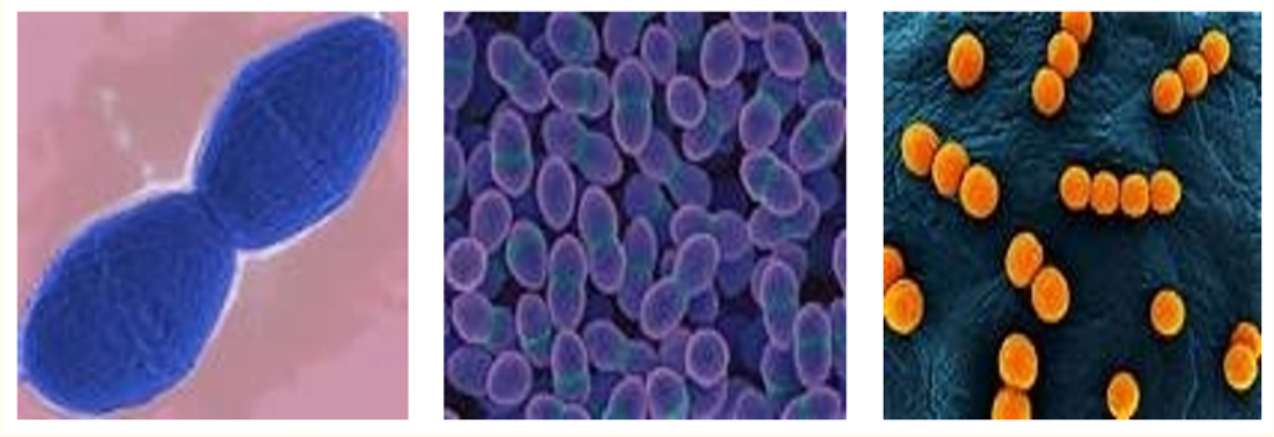

Figure 7

Symptoms and pathology: Clinical infections caused by *Enterococcus* include urinary tract infections, bacteremia, bacterial endocarditis, diverticulitis, and meningitis. Enterococcal meningitis is a rare complication of neurosurgery. It often requires treatment with intravenous or intrathecal vancomycin, yet it is debatable as to whether its use has any impact on outcome: the removal of any neurological devices is a crucial part of the management of these infections. Enterococci are major infectious agent in chronic bacterial prostatitis and are able to form biofilm in the prostate gland making their eradication difficult. Individuals at risk for colonization include critically ill patients who have received lengthy courses of antibiotics (particularly those in long-term care facilities), solid-organ transplant recipients and patients with hematologic malignancies, and health care workers. Unfortunately, spontaneous decolonization is uncommon, and antimicrobials are unlikely to eradicate VRE colonization. In 2004, *Enterococcus* spp. Took the place of fecal coliform as the new USA federal standard for water quality at public salt water beaches and *E. coli* at fresh water beaches.

Transmission: VRE is transmitted from person to person most commonly by healthcare workers whose hands have inadvertently become contaminated, either from feces, urine, or blood of a person carrying the organism. It can also be spread indirectly via hand contact with open wounds or by touching contaminated environmental surfaces, where the bacterium can survive for weeks.

Treatment: For antibiotic recommendations, see sensitivity results. For an herbal alternative use Freedom, Cleanse, Restore protocol.

Prevention: Each hospital -- through collaboration of its quality-improvement and infection-control programs; pharmacy and therapeutics committee; microbiology laboratory; clinical departments; and nursing, administrative, and housekeeping services -- should develop a comprehensive, institution-specific, strategic plan to detect, prevent and control infection and colonization with VRE. The following elements should be addressed in the plan.

Enterobacter spp.

Enterobacter is a genus of common rod-shaped, non-spore-forming bacteria. Several strains are pathogenic causing opportunistic infections in immunocompromised (usually hospitalized) hosts and those on mechanical ventilation. The urinary and respiratory tracts are the most common sites of infection. Two clinically important species from this genus are *E. aerogenes* and *E. cloacae.*

Figure 8

Transmission: Transmission is through direct or indirect contact of mucosal surfaces with infectious agent (e.g. bacteria can transfer from contaminated hands in neonatal units or contaminated urinals) or, in the case of endogenous flora, through transfer to adjacent, susceptible, sterile body sites. Enterobacteriaceae can also be spread through the fecal-oral route.

Symptoms and pathology: Enterobacter infections can include bacteremia, lower respiratory tract infections, skin and soft-tissue infections, urinary tract infections (UTIs), endocarditis, intra-abdominal infections, septic arthritis, osteomyelitis, CNS infections, and ophthalmic infections. Enterobacter infections can necessitate prolonged hospitalization, multiple and varied imaging studies and laboratory tests, various surgical and nonsurgical procedures, and powerful and expensive antimicrobial agents. The presence of *Enterobacter cloacae* B29 in the gut of a morbidly obese individual may contribute to the patient's obesity. Reduction of the bacterial load within the patient's gut to non-detectable levels, was associated with a parallel reduction in endotoxin load corresponding to significant reduction in

weight. Symptoms include systemic inflammatory response syndrome (SIRS) including heart rate that exceeds 90 bpm, a respiratory rate greater than 20, and a temperature above 38°C or below 36°C. Other symptoms: fever especially in children, hypotension and shock in about one third of cases, Septic shock (as disseminated intravascular coagulation, jaundice, acute respiratory distress syndrome, and other complications of organ failure), purpura fulminans and hemorrhagic bullae, ecthyma gangrenosum and cyanosis and mottling: mostly in children. Lower respiratory tract infections can manifest identically to those caused by Streptococcus pneumoniae or other organisms.

Treatment: For antibiotic recommendations, see sensitivity results. For an herbal alternative use Freedom, Cleanse, Restore protocol.

Prevention and susceptibility to disinfectants: most Enterobacteriaceae and vegetative bacteria are susceptible to 70 - 80% ethanol and to 1% sodium hypochlorite, glutaraldehyde, formaldehyde, iodine's, hydrogen peroxide, peracetic acid, and quaternary ammonium compounds. Use Lab coat, gloves, and eye protection upon direct skin contact with infected materials or animals or with risk of splashes.

Other precautions: All procedures that may produce aerosols or involve high concentrations or large volumes should be conducted in a biological safety cabinet (BSC). The use of needles, syringes, and other sharp objects should be strictly limited.

Volume 15 Issue 10 October 2019