Bacterial Infections
Protecting Yourself From Common Pathogens

The fight against bacterial infection represents one of the high points of modern medicine. The development of antibiotics in the 1940s offered physicians a powerful tool against bacterial infections that has saved the lives of millions of people. However, because of the widespread and sometimes inappropiate use of antibiotics, strains of bacteria have begun to emerge that are antibiotic-resistant. These new, stronger bacteria pose a significant threat to general welfare and health—and a challenge to researchers.

Bacterial infections can be caused by a wide range of bacteria, resulting in mild to life-threatening illnesses (such as bacterial meningitis) that require immediate intervention. In the United States, bacterial infections are a leading cause of death in children and the elderly (Howard BJ et al 1994). Hospitalized patients and those with chronic diseases are at especially high risk of bacterial infection (Murray et al 1998). Common bacterial infections include pneumonia, ear infections, diarrhea, urinary tract infections, and skin disorders.

Under normal circumstances, people are protected from bacterial infection by a healthy immune system. Thus, maintaining the healthiest immune profile possible will help reduce the risk of bacterial infection. For more comprehensive information on the immune system and general nutritional strategies to support healthy immune function, please see Maintaining a Healthy Immune System. The present chapter will focus more specifically on bacteria and approaches to staving off bacterial illness.

RISK FACTORS FOR BACTERIAL INFECTION

Although every human being is exposed to innumerable bacteria, some of us are at higher risk of infection than others. Besides a weakened immune system, there are other risk factors for bacterial infection and illness.

Age. Individuals at either end of the age spectrum (neonates and the elderly) are at increased risk of bacterial infections (Chandra RK 1989; Chandra RK 1992a). Neonates are most susceptible to infections by pathogens such as Escherichia coli (Chandra RK 2002; Chandra RK 2004). People older than age 60 years are susceptible to lower respiratory tract infections caused by Streptococcus pneumoniae.

Nutritional status. The human body requires a balanced diet that provides nutrients, minerals, and vitamins for a functional and effective immune response (Chandra RK 2004). Immune function is impacted by factors including hormonal status, age, and nutritional status (Hedlund J 1995). Malnutrition results in a depressed immune system that raises the risk of infection.

Genetic predisposition. Scientists have long known that some people have a genetic predisposition to bacterial infection (Hill AV 2000). The Human Genome Project, which recently completed a map of the entire human genome, increased our ability to locate specific genes related to infectious disease susceptibility (Bentley DR 2000). Ultimately, researchers hope to use genetic testing to identify people who are at increased risk of infectious diseases, then design drug therapies that target specific genetic defects that are expressed in conjunction with diseases (Cariou A et al 2002).

FORMS OF BACTERIAL INFECTION

Bacteria are associated with many illnesses and conditions. Some of the more common ones are listed below.

Respiratory Infections

Upper respiratory tract infections. Upper respiratory tract infections are a leading cause of time lost from work and school (Madoff LC et al 2004). Bacteria account for up to 25 percent of upper respiratory tract infections. Group A streptococci are responsible for 95 percent of the cases of strep throat in the United States (Goldmann O et al 2003; O'Brien KL et al 2002). Strep throat is most common in children and adolescents (aged 3 years to 18 years). Other pathogens include Haemophilus influenzae (Echave P et al 2003; Robinson KA et al 2001).

Otitis media. Middle ear infections are the most common bacterial infections in children in the United States. By the age of 3 years, two-thirds of American children have had at least one episode of otitis media, and the other third has had three or more episodes. S. pneumoniae is the most frequent cause (Leibovitz E et al 2004).

Lower respiratory tract infections. Common lower respiratory tract infections include acute, chronic, and health care–associated

pneumonia and bronchitis (Garcia Ordonez MA et al 1999; Hedlund J 1995). S. pneumoniae is the most frequent cause of community-acquired lung infections and pneumonia. Lower respiratory tract infections can occur in both healthy and immunocompromised individuals.

Tuberculosis (TB). An estimated 15 million people in the United States are infected with Mycobacterium tuberculosis (Dai G et al 1998; Skamene E 1991). Of these, however, far fewer will actually develop clinically evident disease. Whether TB infection will progress to disease depends on a person's nutritional status. TB occurs disproportionately in poorer populations. Infection is more likely to occur in people aged 15 to 25 years, those older than age 60 years, people with HIV, or people who have been incarcerated for longer than 6 months (Fleischmann RD et al 2002). In prisons in particular, overcrowding and the frequent movement of prisoners between cells is a factor in the spread of infection (Lobacheva T et al. 2005). It is important to note that the antibiotics used as first-line treatments in TB, such as Isoniazid, are known to cause deficiencies in vitamin B6 (NIH 2005).

Gastrointestinal Infection

Infectious diarrhea is a leading cause of morbidity and mortality worldwide (Marignani M et al 2004; Reinert P 1993). In the United States, 100 million people are affected by acute diarrhea every year. Most diarrhea is viral (not bacterial) in origin, but bacteria remain an important cause. Nearly half of patients with acute diarrhea must restrict activities, 10 percent consult physicians, 250,000 require hospitalization, and approximately 3000 die. Common bacterial pathogens that cause diarrhea include Campylobacter species, salmonella, shigella, and E. coli O157:H7.

Campylobacter jejuni. C. jejuni is the most common cause of bacterial diarrhea in the United States. The Centers for Disease Control and Prevention (CDC) estimates that more than 1 million Americans are affected yearly. Previously, most cases of bacterial diarrhea were caused by salmonella, but the increased use of antibiotics in poultry- and cattle-feed has been linked to the increasing incidence of drug-resistant C. jejuni (Butzler JP 2004; Moore JE et al 2005; Takkinen J et al 2003). Transmission is via exposure to contaminated food (especially chicken) and water, or contact with infected animals (especially cats and puppies) (Kasper DL et al 2004).

Salmonella. Salmonellosis is the second most frequent cause of bacterial disease in the United States. In 2002, more than 44,000 cases were reported to the CDC. Mild infections often are undiagnosed or unreported, so incidence may be 30 or more times greater than reported (Gold HS et al 2000). Infections with Salmonella species include diarrhea, fever, and abdominal cramps (Murray et al 1998). The elderly, infants, and people with impaired immune systems are at greater risk of severe disease. Transmission is via exposure to contaminated food (especially eggs) or water, or contact with infected animals (reptiles) (Conte JE Jr 2002; Howard BJ et al 1994).

Shigella. Shigella species infection causes a watery or bloody diarrhea with abdominal pain, fever, and malaise. An estimated 448,240 cases occur in the United States yearly. Groups at highest risk in the United States are children in child care centers, individuals in custodial institutions, and international travelers (Gold HS et al 2000; Madoff LC et al 2004).

Escherichia coli O157:H7. E. coli O157:H7 is associated with a severe diarrheal disease called hemolytic uremic syndrome. It has caused several nationally prominent outbreaks of food poisoning. An estimated 73,000 cases are reported in the United States annually (Conte JE Jr 2002). Transmission is through contaminated hamburger meat, apple cider, and fruits and vegetables (Madoff LC et al 2004).

Helicobacter pylori. H. pylori is the most common chronic infection in humans (Basso D et al 2004; Go MF 2002). Acute infection causes abdominal pain, weight loss, nausea, and vomiting. H. pylori is the major cause of gastritis and peptic ulcers in adults and children (Zambon CF et al 2002). H. pylori impairs absorption of nutrients, altering the balance of iron, vitamin B12, folic acid, alpha-tocopherol, vitamin C, and beta-carotene.

Skin Infection

Skin infections include impetigo, boils, carbuncles, cellulitis, and complications from burns (Gelfand JA 1984; Gold HS et al 2000). Common pathogens include Staphylococcus aureus, group A streptococci, and Pseudomonas aeruginosa (Baggett HC et al 2004; Toshkova K et al 2001; Wysocki AB 2002). Impetigo, a skin infection caused mostly by group A streptococci, can cause severe kidney inflammation, sometimes resulting in kidney failure.

Health Care–Associated Infection

Hospital-acquired and health care–related infections are an increasing threat to patient safety and health in the United States (Weinstein RA 1991; Weinstein RA 1998). In the United States, infections encountered in the hospital or a health care facility affect more than 2 million patients, cost $4.5 billion, and contribute to 88,000 deaths in hospitals annually (Malone DL et al 2002; Tasota FJ et al 1998).

Urinary tract infections are the most common, followed by pneumonias, skin and soft tissue infections, and invasive bloodstream infections. Surgical wound infections account for 20 percent to 30 percent of cases, but contribute to as many as 57 percent of extra hospital days and 42 percent of extra costs. Staphylococcus epidermidis, S. aureus, Enterococcus faecium, Enterococcus faecalis, E. coli, Enterobacter species, and P. aeruginosa are common pathogens in wound infections (Goldmann DA et al 1996; Weinstein RA 1991).

What Are Bacteria?

Bacteria are microscopic, single-celled organisms found in air, water, soil, and food. They live on plants, insects, animals, pets, and even in the human digestive system and upper respiratory tract. There are thousands of kinds of bacteria, but only a few actually cause disease in humans.

Bacteria are frequently identified by their shape, the makeup of their cell walls, and their ability to grow in air. They can be round (such as staphylococci or streptococci), rod-shaped (such as bacillus or E. coli), or corkscrew-shaped (Borrelia species). In most cases, bacteria have cell walls that provide a target for many antibiotics (antibiotics easily identify bacteria) (Gold HS et al 2000).

They are also classified by their color after a Gram stain is applied. Gram-positive bacteria stain blue, while gram-negative bacteria stain pink.

Gram-negative bacterial cell walls contain a substance known as lipopolysaccharide (LPS), a highly inflammatory chemical that provokes an immune response in the human body. LPS is responsible for triggering the overreaction of the host immune system, which results in the release of oxygen and nitrogen species, cytokines, and other proinflammatory mediators.

Conventional Treatment of Bacterial Infection: Antibiotics and Resistant Bacteria

Antibiotics are the mainstay of bacterial treatment (Archer GL et al 2004). The goal of these drugs is to kill invading bacteria without harming the host. Antibiotic effectiveness depends on mechanism of action, drug distribution, site of infection, immune status of the host, and resistance factors of bacteria (Archer GL et al 2004; Roden DM 2004).

Antibiotics work through several mechanisms. Some (such as vancomycin and penicillin) inhibit formation of bacterial cell walls. Erythromycin, tetracycline, and chloramphenicol interrupt protein synthesis. Still others inhibit bacterial metabolism (sulfa drugs) or interfere with DNA synthesis (ciprofloxacin, rifampin) and/or cell membrane permeability (polymyxin b) (Conte JE Jr 2002).

When antibiotics were discovered in the 1940s, they were incredibly effective in bacterial infection treatment. Over time, however, many antibiotics have lost effectiveness against common bacterial infections because of increasing drug resistance (Barie PS 1998; Domin MA 1998). Bacteria may be naturally resistant to different classes of antibiotics or may acquire resistance from other bacteria through exchange of resistant genes. Indiscriminate, inappropriate, and prolonged use of antibiotics have selected out the most antibiotic-resistant bacteria (Petrosillo N et al 2002; van der Waaij D et al 2000). Antibiotic-resistant strains have emerged in hospitals, long-term care facilities, and communities worldwide (Flaherty JP et al 1996; Jacobs MR 1999; Levin AS et al 2003).

For example, S. aureus is a common bacterial pathogen that causes pneumonia, skin and urinary tract infections, and blood and surgical site infections. Some strains that are resistant to all current antibiotics, including vancomycin, have emerged in the United States and Japan. Antibiotic-resistant organisms lead to increased hospitalizations, health costs, and mortality (Amsden GW 2004; Apfalter P 2003; Austin DJ et al 1999; Baggett HC et al 2004; Barie PS 1998; Bonten MJ et al 2001; Borer A et al 2002; Tasota FJ et al 1998).

Besides increased drug resistance, high-dose and prolonged antimicrobial therapy can eliminate helpful bacterial flora and predispose people to infection (Carson CF et al 2003; Guarner F et al 2003). A common adverse effect of antibiotics is diarrhea, which can lead to loss of essential vitamins and minerals, especially vitamin K, magnesium, and zinc (Briend A 1988; Brunser O 1977; Fontaine O 1996; Guerrant RL et al 2000). Other adverse effects of antibiotic therapy include vitamin deficiencies, seizures, allergic shock (in people who are allergic to antibiotics), autoimmune disease, decreased platelets, kidney injury, drug/drug interaction, and death (Roden DM 2004).

What You Have Learned So Far...

- Bacteria can be found colonizing every surface of our environments, and some even live inside our digestive, respiratory, and genitourinary tracts. Bacteria can be either beneficial or harmful.
- A compromised immune system raises the risk of infection from harmful bacteria. Also, advanced age, a genetic predisposition, or compromised nutritional status can raise the risk of bacterial infection.
- Bacteria can cause a wide range of illnesses, from gastrointestinal upset to skin disorders to life-threatening illnesses that require immediate attention. Dangerous bacteria that cause illness include Streptococcus species, E. coli, and salmonella. Bacterial illnesses include diarrhea, respiratory illness, and pneumonia.

- The mainstay of bacterial infection treatment is antibiotics. While antibiotics work in the majority of cases, indiscriminate use of antibiotics has resulted in the emergence of drug-resistant bacteria.
- A healthy immune system and proper nutritional status can help stave off bacterial infection or improve the immune response to infection. An inflammatory immune response to bacterial infection can result in further injury to cells and tissues.

NUTRITIONAL APPROACHES TO BACTERIAL INFECTION: A HEALTHY IMMUNE SYSTEM

Nutritional deficiencies can affect immune response and increase susceptibility to infection. In turn, infection further aggravates nutritional deficiencies by increasing metabolic demands, decreasing nutrient intake, or blocking absorption from the gut (Calder PC et al 2002; Scrimshaw NS et al 1997; Scrimshaw NS 2003). Nutritional and dietary supplements stimulate immune response and may result in fewer infections, particularly in the elderly and in malnourished, critically ill individuals (Chandra RK 1999).

Some dietary supplements have been shown to enhance immune function.

Phytonutrients. Phytonutrients are plant-derived, naturally occurring compounds thought to have curative, preventative, and nutritive value (Balentine DA et al 1999; Craig W et al 1999). The major immune-boosting components in fruits, vegetables, and herbs are flavonoids and carotenoids, which are antioxidants that protect cells from oxidative damage (Craig WJ 1999; Craig W et al 1999). Flavonoids have a number of powerful complementary and overlapping effects, including modulation of detoxification enzymes, stimulation of the immune system, reduction of platelet aggregation, modulation of cholesterol synthesis, reduction of blood pressure, and antioxidant and antibacterial effects (Craig W et al 1999; Lampe JW 1999). Carotenoids may boost the immune system to fight bacteria by increasing the number of white blood cells (Balentine DA et al 1999; Craig W et al 1999).

Alkylglycerols. Alkylglycerols are found in shark liver oil as well as cow, sheep, and human breast milk. They are thought to act as immune boosters against infectious diseases. They have no known adverse effects at relatively high dosages of 100 milligrams (mg) three times daily (Pugliese PT et al 1998). For more safety information on shark liver oil, especially for people with atherosclerosis, see the Safety Caveats section.

Fighting Bacteria

In addition to immune-boosting supplements, a number of nutrients have shown antibacterial activity, especially when it comes to inhibiting bacterial infection. While large-scale human studies have yet to be conducted on many antibacterial nutrients, the existing animal studies show considerable promise with these agents.

Bee propolis and honey. Before antibiotics, honey was used to treat bacterial wound infections (Lusby PE et al 2002; Miorin PL et al 2003; Molan PC 2002). Bee propolis has antibacterial and anti-inflammatory properties. In vitro laboratory studies have shown activity against TB, H. pylori, skin ulcers, and colitis (Boyanova L et al 2003; Dobrowolski JW et al 1991; Grange JM et al 1990).

Bromelain. Bromelain (a digestive enzyme derived from the pineapple plant) has been used for centuries as a folk remedy for digestive problems and to promote wound healing. It has been proposed as a digestive aid and also has shown immunomodulatory properties (Engwerda CR et al 2001). In animal studies, bromelain has been effective against E. coli by disrupting the bacteria's ability to adhere to the mucosal lining in the digestive wall (Mynott TL et al 1996, 1997).

Cranberry juice. Cranberry juice can be an effective therapy for bacterial urinary tract infections, both to manage infection and to reduce recurrence (Fleet JC 1994; Kontiokari T et al 2001). Cranberry supplements are also available.

Oil of oregano. Oregano oil has been used for centuries in Far Eastern and Middle Eastern cultures to treat respiratory infections, chronic inflammation, urinary tract infections, dysentery, and jaundice. Laboratory studies in which the oil was applied directly to food-borne pathogens showed that oregano oil has strong antibacterial properties (Dadalioglu I et al 2004). Medicinal oregano grows wild in the mountainous areas of Greece and Turkey. It has a high mineral content that enhances its therapeutic benefits, including calcium, magnesium, zinc, iron, potassium, copper, boron, and manganese. This oil is considered safe for humans and may be used in conjunction with antibiotics to fight bacterial infection (Preuss HG et al 2005).

Thyme. Thyme, another essential herbal oil, has shown antibacterial properties. For example, thyme has been demonstrated to inhibit many strains of E. coli, including E. coli 0157:H7 (Marino M et al 1999). It has also been very effective in preventing the growth of listeria (Faleiro L et al 2005).

Ginger. The characteristic odor and flavor of ginger root come from a volatile oil composed of shogaol and gingerols. Gingerols have been investigated for analgesic, sedative, antipyretic, antibacterial, and gastrointestinal tract motility effects. They have been found to inhibit gram-positive and gram-negative bacteria (Chrubasik S et al 2005; Mascolo N et al 1989; Thongson C et al 2004).

Enhancing Your Immune System While Fighting Bacteria

The nutrients vitamin A, beta-carotene, folic acid, vitamin B12, vitamin C, vitamin D, riboflavin, iron, copper, zinc, and selenium have both antioxidant activity and immunomodulating functions that affect the course and outcome of bacterial infections (Bhaskaram P 2001; Meydani SN et al 2001; Murray et al 1997). In general, people taking multivitamin and multimineral supplements report significantly fewer infectious illnesses. In one small study, efficacy was highest in individuals with type 2 diabetes (Barringer TA et al 2003).

Glutamine. Glutamine helps build and maintain muscles and modulate pH and contributes to a healthy digestive system (MacKay D et al 2003). It is also an important precursor to glutathione, a natural antioxidant. Glutamine has been shown to help boost immune function through white blood cell respiration and production of messenger chemicals used by the immune system (Bistrian BR 2004).

Vitamin A. Low levels of vitamin A have been associated with increased susceptibility to bacterial infection, and vitamin A supplementation has been suggested to decrease days of work lost to infection (Aukrust P et al 2000; Barringer TA et al 2003; Bhaskaram P 2001). Vitamin A appears to be important in mucosal immune responses in the respiratory and gastrointestinal tracts (Cui D et al 2000). The effect may be primarily from stabilizing the membranes of mucosal cells and enhancing white blood cell function (Molina EL et al 1996). Vitamin A has been studied in dosages up to 75,000 international units (IU) per day for up to 12 months in the context of skin cancer with no appreciable toxicity (Alberts D et al 2004).

Vitamin E. Vitamin E improves immune function in the elderly. Supplementation with vitamin E (alpha-tocopherol) has been documented to increase levels of anti-inflammatory chemicals and decrease levels of proinflammatory proteins (Meydani SN et al 2001). Vitamin E enhances the immune system through its ability to protect immune cells from free-radical attack, which preserves membrane integrity and fluidity (Tengerdy RP 1990).

Zinc. Many studies have shown that zinc deficiency is associated with impaired immune function (Bogden JD 2004; Cuevas LE et al 2005; Cunningham-Rundles S et al 2000; Stefanidou M et al 2005). A combination of zinc and selenium may enhance immunity and protect against infections, especially in the elderly. A review article of published studies showed that elderly individuals taking modest doses of a multivitamin and multimineral dietary supplement containing zinc and selenium had fewer days on antibiotics and fewer infections than counterparts who did not take zinc-containing multivitamins or supplements (Chandra RK 1992).

Garlic. Crushed garlic has potent antibacterial effects (Ankri S et al 1999; Cutler RR et al 2004; Jonkers D et al 1999; Sovova M et al 2002). It fights infection by enhancing immune cell activity and inhibiting bacteria and other microorganisms (Craig WJ 1997; Harris JC et al 2001). The compound in garlic that produces antibacterial activity is known as allicin (Ankri S et al 1999; Sovova M et al 2002). Allicin is released when intact cells of a garlic clove are cut or crushed. There is evidence that garlic is effective against antibiotic-resistant strains of Staphylococcus species, pneumonia-causing bacteria, and antibiotic-resistant strains of H. pylori (Dikasso D et al 2002; Sivam GP 2001; Tsao SM et al 2003).

Goldenseal. Goldenseal (a member of the buttercup family) has been used topically to treat eye and skin irritations and orally to treat infections (O'Hara M et al 1998). Berberine, the main active ingredient in goldenseal, prevents bacteria from adhering to epithelial cells (Sun D et al 1988), inhibits the intestinal secretory response of cholera and E. coli toxins, and normalizes intestinal mucous membranes after damage from cholera (Sack RB et al 1982).

Licorice. Licorice is derived from the root of the Glycyrrhiza species. Glycyrrhizin is converted by intestinal flora to glycyrrhetinic acid, which has immunomodulating activity. In laboratory studies, glycyrrhetinic acid has demonstrated powerful effects against H. pylori gastritis and ulcers (Chung JG 1998; Krausse R et al 2004). Studies have shown that, in humans, adverse effects begin at daily dosages of 100 mg (Stormer FC et al 1993).

Lactoferrin. Lactoferrin, a component of whey, increases good microflora (such as Bifidobacterium bifidum) and decreases bad bacteria, resulting in a desirable intestinal flora environment that is essential for optimal health, immunity, and disease resistance.

Other organisms inhibited by lactoferrin include gram-positive and gram-negative bacteria, yeasts, and some intestinal parasites such as Vibrio cholerae, E. coli (Haversen LA et al 2000), Shigella flexneri, S. epidermidis, P. aeruginosa, and Candida albicans (Baldi A et al 2005; Griffiths EA et al 2003; Kuwata H et al 1998; Nikolaev AA et al 2004).

Lactoferrin may be especially useful as an adjuvant therapy for antibiotics. One study looked at the synergistic effect between lactoferrin and vancomycin. Researchers found that lactoferrin lowered vancomycin-resistance in some bacteria (Leitch EC et al 2001).

Probiotics. Probiotics are bacterial cultures contained in yogurt, buttermilk, cheese, kefir, and sauerkraut, or in dietary supplements that contain friendly bacteria (such as Lactobacillus, Bifidobacterium, Eubacterium, and Propionibacterium species)

normally present on skin and in vaginal, urinary, and intestinal tracts. These bacteria are essential to the proper function of the vaginal, urinary, and digestive tracts (Bengmark S 1998; Cunningham-Rundles S et al 2000; Dani C et al 2002).

Probiotics assist immune function by inhibiting harmful bacterial growth, promoting good digestion, maintaining proper pH, and enhancing immune function (Perdigon G et al 1995). Probiotics produce bacteria-inhibiting substances (natural antibiotics) and prevent harmful bacteria from attaching to vaginal, urinary, and intestinal tract mucosal linings (Ochmanski W et al 1999; Vaughan EE et al 1999). Probiotics have demonstrated In vitro ability to suppress H. pylori (Cremonini F et al 2001; Drouin E 1999; Felley C et al 2003; Johnson-Henry KC et al 2004; Wang KY et al 2004). They may be useful in preventing acute infectious diarrhea (Marignani M et al 2004), urinary tract infections (Kontiokari T et al 2003; Reid G 2002), and restoring vaginal flora (Andreeva P et al 2002).

Antibiotics often destroy friendly bacteria on skin and in urinary, vaginal, and intestinal tracts. Probiotics can be used to recolonize and restore natural floral balance in organ and body systems after antibiotic treatment (Fooks LJ et al 2002; Guarner F et al 2003; Shi HN et al 2004).

Tea catechins. Tea (black, green, or oolong) is a good source of free radical-scavenging antioxidants (Trevisanato SI et al 2000). Other infection-fighting chemicals were heightened in cells of tea drinkers, leading researchers to conclude that drinking tea primed the immune system to fight infection (Bukowski JF et al 1999; Kamath AB et al 2003).

These results have been borne out in many clinical studies. Elements of tea, called catechins, have been widely studied for their ability to prevent bacterial infection. One such study examined catechins' ability to prevent infection in the prostate gland in rats. This condition, known as chronic bacterial prostatitis, is extremely common in men. Researchers found that tea catechins were able to reduce both bacterial growth and inflammation in the rats' prostate glands. Morever, the catechins worked well as an adjuvant therapy for ciprofloxacin, the standard antibiotic treatment for this condition. Researchers suggested that tea catechins, which have shown additional antibacterial effects and synergistic properties with antibiotics, be considered to help manage chronic bacterial prostatitis (Lee YS et al 2005).

In another interesting study, researchers infused plastic film with tea catechins, then tested this surface for antibacterial properties. They found that the catechin-infused film was significantly resistant to bacteria such as E. coli and suggested that implants and catheters made from catechin-infused plastic might be able to help reduce infection during invasive procedures (Maeyama R et al 2005).

Catechins are thought to boost immunity by enhancing resistance to infection and selectively modulating the formation of cytokines, which are associated with inflammation, among other things. Researchers have also hypothesized that hydrogen peroxide generated by the catechins may also be responsible for its antibacterial properties (Arakawa H et al 2004). In a laboratory study of immune cells taken from heavy smokers, tea catechins were shown to help the immune cells recover their function (Yamamoto Y et al 2004).

LIFE EXTENSION FOUNDATION RECOMMENDATIONS

Bacterial infections are occasionally life-threatening health concerns. Older and newly emerging antibiotic-resistant infections are an increasing danger for children, the elderly, and people who have chronic diseases. Bacterial infections can disrupt normal intestinal flora, reduce nutrient and mineral supplies, and compromise immune responses. A healthy immune system can prevent or neutralize bacterial infections.

When dealing with a possible bacterial infection, it is impossible to tell, short of laboratory tests, which pathogen is causing the problem. Therefore, it is important to visit a physician for proper testing and, if necessary, to obtain prescription antibiotics. In addition, many nutrients have been shown to help strengthen the immune system and inhibit bacterial infection. Nutrients that have been demonstrated to inhibit bacterial activity or enhance the immune system include:

- **Life Extension Mix**—Follow directions on label.
- **Life Extension Superbooster**—1 softgel daily
- **Lactoferrin**—300 milligrams (mg) daily
- **Oregano oil**—400 to 1000 mg of essential oils daily
- **Garlic extract**—600 to 1200 mg of Kyolic garlic daily
- **Norwegian shark liver oil**—200 mg of active alkylglycerols
- **Bromelain**—500 mg before each meal
- **L-arginine**—900 mg daily
- **L-glutamine**—1 to 2 grams (g) daily
- **Cranberry extract**—500 mg daily
- **Probiotics**—Follow directions on label.

- **Whey protein**—1 to 2 scoops daily
- **Green tea extract**—725 mg daily
- **Garlic bulb powder**—1800 to 9000 mg of Pure Gar daily (if you already have an infection)

BACTERIAL INFECTION SAFETY CAVEATS

An aggressive program of dietary supplementation should not be launched without the supervision of a qualified physician. Several of the nutrients suggested in this protocol may have adverse effects. These include:

Bromelain

- Consult your doctor before taking bromelain if you are taking anticoagulants or antithrombotic agents. Bromelain can thin the blood.
- Bromelain can cause gastrointestinal symptoms such as nausea and diarrhea.
- Bromelain can cause bleeding from the uterus between menstrual periods (metrorrhagia) and excessive uterine bleeding during menstruation (menorrhagia).

Garlic

- Garlic has blood-thinning, anticlotting properties.
- Discontinue using garlic before any surgical procedure.
- Garlic can cause headache, muscle pain, fatigue, vertigo, watery eyes, asthma, and gastrointestinal symptoms such as nausea and diarrhea.
- Ingesting large amounts of garlic can cause bad breath and body odor.

Green Tea

- Consult your doctor before taking green tea extract if you take aspirin or warfarin (Coumadin). Taking green tea extract and aspirin or warfarin can increase the risk of bleeding.
- Discontinue using green tea extract 2 weeks before any surgical procedure. Green tea extract may decrease platelet aggregation.
- Green tea extract contains caffeine, which may produce a variety of symptoms including restlessness, nausea, headache, muscle tension, sleep disturbances, and rapid heartbeat.

L-Arginine

- Do not take L-arginine if you have the rare genetic disorder argininemia.
- Consult your doctor before taking L-arginine if you have cancer. L-arginine can stimulate growth hormone.
- Consult your doctor before taking L-arginine if you have kidney failure or liver failure.
- Consult your doctor before taking L-arginine if you have herpes simplex. L-arginine may increase the possibility of recurrence.

L-Glutamine

- Consult your doctor before taking L-glutamine if you have kidney failure or liver failure.
- L-glutamine can cause gastrointestinal symptoms such as nausea and diarrhea.

Shark Liver Oil

- Do not exceed the maximum recommended dose.
- Prolonged use (more than 30 days in a row) causes a rare side effect known as thrombocythemia (excess platelets), which can cause the blood to clot.
- Shark liver oil can cause rash, breath that smells like garlic, fatigue, irritability, and gastrointestinal symptoms such as nausea and diarrhea.

For more information see the Safety Appendix