

# Necrotizing Fasciitis

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## INTRODUCTION

**N**ecrotizing fasciitis is the name of a dangerously fast spreading bacterial infection and is also commonly referred to as the *flesh eating bacteria*. The term necrosis is defined as tissue death. Necrotizing is to cause or undergo tissue death. The term fascia refers to the fibrous connective tissue that covers muscle. When the suffix -itis, which means inflammation, is added to the Latin plural form (fasci) to make the word fasciitis, the term means inflammation of the fascia.

## LEARNING OBJECTIVES

- Identify the causes of necrotizing fasciitis
- Describe the symptoms of necrotizing fasciitis
- Identify the methods to diagnose NF
- Compare the treatments for NF
- Explain the relationship of NF and MRSA

Some historians maintain that necrotizing fasciitis was first described in the time of Hippocrates, who noted problems with erysipelas, a superficial bacterial infection of the skin that was known to spread to the deeper tissues. Hippocrates described the infection in this manner, "...flesh, sinews, and bones fell away in quantities...fever was sometimes present and sometimes absent... there were many deaths"<sup>5</sup>

In 1952, the term "necrotizing fasciitis" was officially introduced by B Wilson, MD, although he never did find the specific bacteria that caused the disease.<sup>15</sup> Necrotizing fasciitis, although rare and incredibly fast-acting, has been seen throughout history. However, because it is more common in third world countries and was not officially identified until after the 1950s, little data is available on this uncommon bacterial infection. The bacterium that causes necrotizing fasciitis enters the body and reacts with other bacteria, causing subsequent chemical reactions. Toxins are released throughout the body

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and attack soft tissue layers under the skin. Tissue death then spreads to the nearby fascia that surrounds the muscle.

This article will help practitioners understand the symptoms and causes of necrotizing fasciitis, learn the relevant methods of treatment and identify methods of prevention.

#### CAUSES OF NECROTIZING FASCIITIS

The most common cause of necrotizing fasciitis is group A hemolytic streptococcus, which appears to be the relevant factor in up to 71% of all human cases. Also known as "GAS," this type of streptococcus is a common bacterium usually found on the skin and in the throat. It is interesting to note that some carriers where this bacte-

rium is present on their throat and skin show no evidence of an illness.

This bacterium may sound familiar, because it is the same bacterium that causes relatively mild illnesses, such as strep throat and the skin condition impetigo. The majority of GAS infections are not life threatening but occasionally this bacterium can produce severe and even fatal conditions when invading parts of the body where bacterium is not usually found, such as the blood, muscle or lungs.

Two of the most dangerous but infrequently occurring forms of GAS disease are necrotizing fasciitis (NF) and streptococcal toxic shock syndrome (STSS). Streptococcal toxic shock syndrome presents with a rapid drop in blood pressure and the kidney, liver and lungs begin to fail. Approximately, 10% to 15% of patients with invasive group A streptococcal disease will die from the infection, but more than 35% of individuals with STSS will succumb. Approximately 25% of patients with NF will die, and this disease is the focus of the article.

Group A hemolytic streptococcus is also known as *A streptococcus pyogenes*. *Streptococcus pyogenes* produces a wide variety of virulence factors which allow for its rapid multiplication and progression through the body. "*Streptococcus pyogenes* owes its major success as a pathogen to its ability to colonize and rapidly multiply and spread in its host while evading phagocytosis and confusing the immune system."<sup>17</sup> After *streptococcus pyogenes* attacks the body, it is in turn attacked by bacteriophages (viruses that attack bacteria). The bacteria then break down and release a gaseous toxin that flows in-between deep fascial planes and subcutaneous soft tissue. The gaseous toxin then starts to kill the soft tissue, fat, and fascia. After the toxin has festered and the tissue is dead, it then flows into the bloodstream. The toxic blood then moves through the organs in the body and causes systemic breakdown.<sup>15</sup>

There are plenty of other bacteria that can contribute to, and/or cause, necrotizing fasciitis. One example is a group of rod-shaped anaerobic bacteria called bacteroides, commonly found in the human intestine. When these bacteroides

venture outside the intestine, they can create an abscess filled with pus that usually spreads more bacteria throughout the body. The formation of pus in these wounds is extremely dangerous, because if a leak occurs from an abscess, it will cause infection to organs and muscular tissue, thus resulting in organ failure and muscular deterioration.<sup>18</sup>

*Clostridium* is another bacterium that aids with the progression of necrotizing fasciitis. *Clostridium* can produce spores that will secrete powerful exotoxins that multiply the amount of toxins already present in the body. In an immune system that is already being overwhelmed by bacteria, these toxins help the necrotizing fasciitis to rapidly spread.<sup>2</sup>

*Peptostreptococcus* is the anaerobic partner to *streptococcus*. *Peptostreptococcus* also contributes to soft tissue infection. *Peptostreptococcus* and *Enterobacteriaceae* are bacteria that have become resistant to some antibiotics, such as penicillin G and clindamycin.<sup>14</sup>

#### TRANSMISSION

Hygiene can play a huge role in the transmission of necrotizing fasciitis although the spread of this disease is extremely preventable. Areas of infection where the skin has broken open carry the highest risk of transmission, especially if the infection has any leaking or oozing of pus. In rare cases, the bacteria are occasionally spread between people through close contact of bodily fluids, such as coughing, direct contact of open wounds and rarely, kissing. "People who live or sleep in the same household as an infected person or who have direct contact with the mouth, nose, or pus from a wound...have a greater risk of becoming infected."<sup>11</sup>

Necrotizing fasciitis has been known to begin in the bodies of those whose immune systems have been compromised. The infection has been discovered to affect those who have been diagnosed with comorbid conditions, such as diabetes, cancer, alcoholism, or who recently underwent an organ transplant. Surgical procedures may cause tissue injury, and while the immune system has been weakened, it is unable

to fight even a small bacterial invasion. In several other cases, the infection started when the bacteria entered the body through an opening in the skin, such as a cut on the hand or infected foot. "It can also enter through weakened skin, like a bruise, blister, or abrasion. It can also happen following a major trauma or surgery, and in some cases, there appears to be no identifiable point of entry."<sup>11</sup>



#### EARLY STAGES OF SYMPTOMS

The symptoms of necrotizing fasciitis can develop extremely quickly and, in some instances, symptoms have evolved from mild to life threatening in merely 24 hours. Due to the origin of the infection, which typically festers beneath the skin, most patients physically appear to be in good health. In many of the cases reported, the patients first appeared to have flu-like symptoms but later complained of severe pains on the body, which later became the area where the infection was growing. If the infection is closer to the surface of the skin, initially swelling, redness, and sometimes fluid-filled blisters are frequently evident.<sup>7</sup> Often, the appearance of these symptoms may lead physicians to believe that this is a small infection; meanwhile, the body is beginning to decompose from the inside.

### ADVANCED SYMPTOMS

After the third or fourth day, patients tend to notice that their symptoms are not decreasing. As the disease progresses, the redness or discoloration of the skin spreads. The blisters grow, not only by number but in size, and may begin to fill with a yellow fluid. The patient's blood pressure may drop causing them to appear delusional, confused or in a state of shock. In several reported cases, the site of infection was directly linked to a wound, such as a burn, cut, or even insect bite. "Scaling, peeling,



or discolored skin over the infected area, which are signs of tissue death..." often reveal the sight of infection, and then allow doctors to identify the disease and begin treatment.<sup>13</sup>

### CRITICAL SYMPTOMS

Once the disease is in its fourth to fifth day of activity, the body starts to shut down. The patient's blood pressure begins to drop dangerously and the body experiences "toxic shock." "Unconsciousness will occur as the body becomes too weak to fight off this infection..." At this point, treatment must be carried out to the fullest. Depending on how aggressive the particular strain of bacteria are that initiated the infection, the symptoms may progress much more rapidly.<sup>11</sup>

### DIAGNOSIS

While early diagnosis and treatment are key to fighting this disease, doctors and patients often fail to recognize necrotizing fasciitis, because it presents flu-like symptoms. In many cases, early diagnosis was not determined because of tests run due to symptoms but by the complications and confusion of symptoms presented. Due to these "red flags," doctors were able to diagnose and provide immediate treatment by administering antibiotics that would help fight several other bacteria as well. Unfortunately, most cases of necrotizing fasciitis have not been diagnosed early enough to fight the infection. However there are several ways to effectively diagnose the condition, including laboratory analysis, X-rays and surgical biopsies.

Gram stains show a poly-microbial flora with aerobic gram-negative rods and positive cocci. Gram staining may provide a clue as to whether a type I or type II infection is present, thereby providing physicians with an accurate indicator to determine which antibiotic therapy would be the most effective.<sup>15</sup>

Radiographs detect the presence of gas in subcutaneous fascial planes. However, many factors can cause these gases, so this method is not regarded as necessarily reliable or time efficient.

MRI and computerized tomography (CT) have been effectively used for diagnosing NF. In combination with the clinical assessment MRI, in particular, aids in confirming the presence of NF and whether the patient should undergo surgical debridement.<sup>7</sup>

### TREATMENT

The treatments for necrotizing fasciitis must be as aggressive as the symptoms, and immediate hospitalization is recommended. Symptoms will typically start as flu-like, causing no specific alarm. Once the infection grows enough to rise to the surface of the skin, it will appear as gangrene. Immediately, antibiotics must be flushed throughout the patient's body to prevent the spread of the disease to any non-infected areas. The death rate of necrotizing fasciitis reaches nearly 40% in some populations. A quick

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response is necessary and several cases reported required prompt amputation of the areas most infected. “Supportive care for shock, kidney failure, and breathing problems is often needed...” as the body begins to shut down after the fourth to fifth day.<sup>11</sup>

## Necrotizing fasciitis and community-associated MRSA<sup>8,9</sup>

Previously healthy individuals who have recently taken antibiotics may be at a greater risk of contracting methicillin-resistant *S. aureus*. This bacterium is resistant to antibiotics and some individuals may acquire skin problems and even necrotizing fasciitis. *Staphylococcus aureus* was previously overshadowed by the more common *Streptococcal pyogenes* when investigating necrotizing fasciitis.

The resistance of some bacterium to treatment by antibiotics is a growing concern, because such resistance indicates that more aggressive drug therapies must be utilized. Antibiotics, which target specific bacterium, are not appropriate for all bacterial infections. When antibiotics are prescribed inappropriately, such as for the treatment of viral or fungal infections, then the individual does not receive the best medical assistance and also increases the possibility that therapy with antibiotics in the future may not be effective, thereby increasing the risk of contracting MRSA.

MRSA is no longer a challenge faced in the hospital environment by the elderly and chronically ill. Apparently healthy people are contacting it, and some deaths have resulted.

If the MRSA is acquired during a hospital stay, it is considered a hospital-associated MRSA. However, if a healthy individual contracts MRSA outside the hospital, the condition is referred to as a community-associated MRSA.

In Los Angeles recently, a greater number of infections has been noted involving community-associated methicillin-resistant *S. aureus* (MRSA).

When examining the records of 843 patients whose wound cultures grew MRSA over a 15-month period, 14 patients showed both clinical and intraoperative symptoms of necrotizing fasciitis, necrotizing myositis, or both.

Causative factors in the patient population include current or past injection drug use, previous MRSA infection, diabetes, chronic hepatitis C, cancer, HIV or AIDs.

The median age of the patients was 46 years and 71% were male.

Medical and surgical therapies were provided as needed to all the patients. There were no fatalities but several patients experienced severe complications. Reconstructive surgery was required for some cases, and prolonged hospital stays in the intensive care unit were mandated for others. In 86%, wound cultures were monomicrobial for MRSA. When blood cultures were obtained, 40% of these patients showed positive results.

In a Minneapolis study, two groups of patients were compared; one group was comprised of individuals who contracted community-associated MRSA infections, and the other was composed of individuals who experienced community-associated methicillin-sensitive

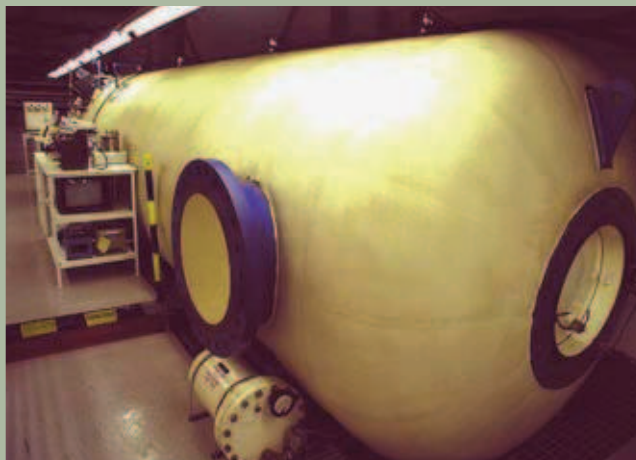
*S. aureus* (MSSA) infections. The latter population is characterized by a receptivity to antibiotics, and their condition is more readily addressed. The study noted that the MRSA group was seven times more likely to have taken antibiotics in the last six months. “We found that the use of any antibiotic puts people at risk for MRSA,” reported Kathryn Como-Sabetti, MPH, senior epidemiologist, Minnesota Department of Health and Children’s Hospitals and Clinics of Minnesota.

In Denver, reports from a study have noted an increasing number of necrotizing fasciitis cases caused by MRSA. Of the five patients in the study, one was an alcoholic, one was a diabetic and the other three had been considered healthy. To remove infected tissue, these patients experienced two to seven surgeries. “Necrotizing fasciitis is still a rare disease, but MRSA no longer is,” said Lisa Young, MD, University of Colorado at Denver, and Health Sciences Center.

It appears that community-associated MRSA is a growing cause of necrotizing fasciitis. In locations where community-associated MRSA infection is endemic, individuals with suspected necrotizing fasciitis should be given empirical treatment including antibiotics that have proven effective combating this infection, such as vancomycin.

## DEBRIDEMENT

Debridement is a process used to remove the dead tissue of a wound, in order to allow the underlying living tissue to heal. Many different types of debridement are available, but the two most commonly used in treating necrotizing fasciitis are surgical and mechanical debridement. During surgical debridement, dead tissue is simply removed with a scalpel or scissors. This option is considered to be the quickest and most effective. Mechanical debridement is the oldest and most painful method. The infected area is covered with gauze or some other type of dressing and allowed to dry overnight. Once the dressing is completely



dry, the covering is forcibly removed from the wound, taking away not only the dead tissue, but also possibly pulling away healthy, living tissue. Mechanical debridement is not always recommended because of the inevitable loss of healthy living tissue when uncovering the wound.<sup>3</sup>

In Iowa, a 52-year old farmer inadvertently hit his shin bone while climbing into a tractor. After a few hours, he experienced a severe headache, fever and uncontrollable pain. His leg was swollen and huge blisters appeared.

He went to the emergency room and was subsequently referred to the University of Iowa Burn Treatment Center. He was underwent two surgi-

cal procedures and recovered. Another patient at the same facility had 40 pounds of diseased tissue removed during surgery.

The staff at the facility is well trained, and they are able to recognize the symptoms of NF quickly and act immediately, because they regularly treat patients with complex conditions. However, they have noticed an increase in the number of NF cases and speculate that obesity and diabetes may be linked to the higher incidences. A study is currently underway.

## MAGGOT DEBRIDEMENT THERAPY (MDT)☒

In one reported case of necrotizing fasciitis, debridement was used to remove the infection located on the right side of the abdomen and scrotum of a 46 year-old man who had a history of smoking and alcoholism. First, the patient underwent a series of 10 surgical debridements as well as intense antibiotic therapy. When these were not successful, maggot debridement therapy was initiated. In this particular case, a total of nearly 1,200 *Lucilia sericata* maggots were used in Biobags over a span of 19 days. The process of the maggot debridement therapy, although in this case very productive, is a meticulous and complicated procedure.

“Throughout this study, all maggot applications were performed using the contained technique (Biobags). In the Biobag technique, larvae are enclosed between two layers of 0.5-mm polyvinyl alcohol hydro sponge, which have been heat sealed. Next, a small cube of spacer material is inserted to prevent bag collapse. The bag containing the maggots is placed inside the wound. A net is placed over the bag and taped to an adhesive on the wound edges. Wet gauze and a light bandage are wrapped over the net. Catheters are placed inside the bandages in order to wet the gauze three times daily with normal saline solution (0.9%) in order to prevent maggots dying from dehydration. Every three to four days, new contained maggots were placed on the wound until thorough debridement was reached.”

After the treatment was over, "...a mesh graft was used to close the rest of the wound... and the patient was discharged from the hospital, returned to work, and has remained in good condition for more than three years..."<sup>16</sup>

#### ALTERNATIVE TREATMENTS

A few alternative treatments for necrotizing fasciitis are available, although none have seemed to be as commonly preferred as those described previously. Hyperbaric oxygen therapy is used when anaerobic bacteria are involved and also to increase a patient's oxygen level in the blood, which can help prevent tissue death.

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With necrotizing fasciitis, the soft tissues under the skin and around the muscles are being attacked; therefore, a greater amount of oxygen pumped into the body and blood stream will promote healing of damaged tissues and help fight infection.

This method involves a patient entering an enclosed chamber where pure oxygen is pumped inside under high pressure. Hyperbaric oxygen therapy is utilized to treat severe burns, carbon monoxide poisoning, certain infections, symptoms of decompression, extreme bloodloss, and muscles and soft tissues which have lost their supply of oxygen.<sup>6</sup>

Very similar to debridement therapy, a fasciotomy is a procedure that removes dead tissue. Debridement therapy removes tissue mostly from the exterior of a wound to enable the living tissue underneath to heal properly. A fasciotomy removes dead and damaged fascia, which is the "...thin connective tissue covering, or separating, the muscles and internal organs of the body."<sup>4</sup>

#### NON-SURGICAL TREATMENTS

When treating necrotizing fasciitis, the first line of defense is to flush the body full with antibiotics. Because necrotizing fasciitis is caused by so many bacteria working together, a wide panel of antibiotics is needed to counteract all of them. "It is common to see misdirected treatment that is aimed at coexisting flora instead of the causative organism."<sup>7</sup> Due to the abundance and use of modern day antibiotics, some bacteria have become resistant if not immune to antibiotics. This resistance is another reason why the body must be treated with so many antibiotics.<sup>7</sup>

The most common antibiotics used for treatment are<sup>15</sup>:

- Penicillin G—Stops multiplication and kills susceptible microorganisms.
- Ampicillin—Alternative to penicillin and amoxicillin.
- Clindamycin—Attacks staphylococcal infection. Stops aerobic and anaerobic streptococci. Stops bacterial growth. Alternative to penicillin G.
- Metronidazole—Used against anaerobic bacteria and protozoa. Causes cell death.
- Ceftriaxone—Effective against gram negative activity. Used in combination with penicillin.
- Gentamicin—Used in combination with a gram positive agent for gram negative effectiveness. Only used in contradiction to other antibiotics.
- Chloramphenicol—Effective against gram negative and positive bacteria

#### MORTALITY AND MORBILITY

It is difficult to provide a specific mortality rate for necrotizing fasciitis. Death attributed to this disease is directly correlated to how early diagnosis is made and how soon treatment is initiated. Necrotizing fasciitis caused by group A *streptococci pyogenes* is the most rapidly progressive and devastating form of the disease. If it is not diagnosed and treated immediately, the condition results in a large percentage of morbidity and mortality. Nearly 50% of adult cases reported signs of toxic shock and multi-organ shut down. At this point, the mortality rate varies from 30%



to 70%, depending on the severity of other factors in addition to the disease. The mortality rate in cases that were treated immediately ranges from 25% to 40%. Since 1883, more than 500 cases have been reported in the literature.<sup>7</sup> The average age of survivors is 35 years old, and the average age of non-survivors is 49 years old.

### CONCLUSION

The onset of necrotizing fasciitis is frightening because it can begin from a common strain of Group A *Streptococcus pyogenes* bacteria but leave a patient fighting for life within a matter of days. Whether diagnosis is immediate or not,



this disease will change the patient's life forever. Treatment can be an intense flush of antibiotics through the entire system or an extreme procedure of surgical debridement of soft tissues and skin, both leaving the body powerless and feeble. Although cases of this disease are far and few, the condition does not discriminate. It attacks anyone, from the young to the old, the healthy to the chronically ill, diabetics or addicts. When dealing with this infection, medical attention must be sought immediately.

About 9,000 to 11,500 cases of invasive GAS disease occur in the US annually and approximately 1,000 to 1,800 deaths result. Of these

cases, necrotizing fasciitis constitutes about 6% to 7%, as compared to strep throat and impetigo, which are reported to occur in the millions annually. Only a few people who have been in contact with GAS will develop an invasive GAS disease

Practicing good hand washing is the best method of prevention, especially after coughing and sneezing or preparing foods or eating. Individuals with sore throats should visit a doctor who can perform diagnostic tests to determine if strep throat is evident.

Keep all wounds clean, including scrapes, burns, cuts and sores caused by shingles and chickenpox, insect or animal bites. In addition to the previously mentioned symptoms, watch for redness or swelling near the wound. If a muscle has been recently strained or a fever develops, chills or severe pain are experienced, immediate medical care should be sought, because these could be signs of deep tissue injury. Treatment with anti-inflammatory drugs is to be avoided since these medications may reduce the symptoms without treating the actual cause

Health care professionals must be vigilant when observing their patients and themselves. This disease is treatable and damage is much less severe if diagnosed early.

### ABOUT THE AUTHOR

Valentin Rodriguez lives in Fresno, California and is a student at San Joaquin Valley College, in Fresno. He is currently enrolled in the surgical technology program and anticipates graduating in 2009. Valentin is 26 years old and loves the fact that surgical technologists are the practitioners in the operating room who are relied on to remain calm and help the surgeon with every step. He is very interested in ophthalmology and finds eyes fascinating.

Before enrolling, he never knew such a career existed and as soon as Valentin discovered surgical technology, he was unable to consider anything else.

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