Assessment and Management of SOFT TISSUE INJURIES

Part Two

By Frank Hubbell, DO

In the January/February issue of the Wilderness Medicine Newsletter we began a detailed discussion regarding soft tissue injuries. We looked at the anatomy of soft tissue, the importance of BSI in the treatment of these injuries, the circulatory system, controlling bleeding, and the specific types of soft tissue injuries. In this issue we will complete the process by reviewing the wild aspect of soft tissue injuries: long-term wound care, wound infections, and bandaging skills.
Wilderness & Long-term Wound Care

The principles of long-term wound care are to control bleeding, prevent infection, protect from further injury, promote healing, and monitor for signs of infection.

Control of bleeding was discussed in part 1 of this article, with techniques for controlling bleeding and the proper use of pressure dressings.

Prevention of infection is an understanding of proper wound cleaning techniques and the use of both sterile dressings and wet-to-dry iodine dressings.

Recognition and management of soft tissue infections, cellulitis, and abscess formation.

Protection of further injury and the promotion of healing are accomplished with proper dressing and bandaging skills.

Monitoring the wound site for signs of infection a minimum of two times a day with the dressing changes.

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The steps of proper wound management are to:

- Control bleeding—direct pressure, elevation, pressure dressings.
- Examine the wound—remove dressings and explore the wound.
- Evaluate function—circulation, sensation, and motion.
- Debride—properly scrub and clean the wound with soap and water.
- Irrigate—irrigate, irrigate, irrigate until clean.
- Dress and bandage—splint to protect and support if necessary.
- Monitor for signs of infection—red, swollen, tender, warm.

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Control of Bleeding

The first step is always to control bleeding. As mentioned in Part 1, this is accomplished by applying direct pressure. If that does not control the bleeding in several minutes, remove the dressings and evaluate the wound. Make sure pressure is being properly applied. If necessary, apply digital pressure to any bleeding arteries. Elevation of the wound above the level of the heart will help to lower the blood pressure at the bleeding site and thus help to stem the tide of blood loss. A pressure dressing may also be applied to maintain direct pressure for 20 – 30 minutes, freeing up hands to do other things.

Prevention of Infection—Wound Cleaning

To properly clean a wound you will need lots of clean, preferably sterile water, soap, and/or an iodine solution (Betadine/Povidone/Iodine), and possibly forceps or some sort of tool to aid in the removal of debris from the wound.

While the bleeding is being controlled and the wound is resting, blood clots are forming in the damaged blood vessels. Clot formation will maintain hemostasis (bleeding has stopped) while the wound is cleaned. During this 20 – 30 minute period, sterile water can be made by adding Betadine, Povidone, or iodine (any iodine solution) to the water and allowing it to stand for 30 minutes. For thorough wound cleaning you will need 3 – 4 liters (quarts) of sterile water solution for irrigation.

Wound irrigation is best accomplished if you can create a directed stream of the sterile water under force, such as can be produced by squirting water out of syringe. This can be done by using a syringe or it can be improvised by putting a small hole in the top of a flexible water bottle or cutting a pinhole in the corner of a Ziploc bag. If all else fails, simply pouring the sterile water into the wound will suffice.

Once bleeding has been controlled, for at least 20 minutes, blood clots will have formed in the vasculature, and the wound is ready to be closely examined and cleaned. Remove the dressings and take a close look at the wound. If possible, gently explore the wound, looking for anything that belongs outside of the body—grass, sticks, twigs, dirt, stones, or any debris. All foreign material must be removed, and most can be by gently lifting it out with forceps or by rinsing it out with the sterile water.

The Rinsing Process

Once the visible debris in the wound has been removed, begin the rinsing process. First rinse with a dilute soap solution or dilute iodine solution, 5 – 6 times, and then a final rinse with clear sterile water or with the dilute iodine solution. The iodine solution has to be less than 2% iodine; if the iodine concentration is too high, it can be toxic to the healthy tissues.
STOP—What are Iodine, Betadine, & Povidone?

**IODINE**

Iodine is a nonmetallic chemical element, atomic #53. It is an essential element used by the thyroid gland to produce the hormone, thyroxine (T4). Thyroxine establishes and maintains our basal metabolic rate. Caution, some people are very sensitive to iodine on the skin, and it will cause a chemical burn. Iodine in low concentrations is lethal to germs but harmless to human tissues, therefore making it an excellent wound disinfectant.

**BETADINE**

Betadine is a commercially available 10% solution of iodine in water that is used as a skin and wound disinfectant. It is never used in its 10% concentrated form, as a solution of greater than 5% iodine can be harmful to human tissue. Iodine is very effective in dilute solutions. Betadine is usually diluted - 10 parts water and 1 part Betadine, which makes a 1% solution of iodine in water, a very effective disinfectant.

**POVIDONE IODINE**

Povidone iodine is a water-soluble complex of iodine and polyvinylpyrrolidone. As it is water-soluble, it can be applied directly to a wound as an antiseptic. Commercially available, it contains a 2% concentration of iodine, so it can be used directly on a wound or diluted with water to make an iodine solution. Once applied to the wound, it slowly releases iodine into the wound helping to keep the area sterile or to actively treat infected tissue.

Once debrided and irrigated clean, the wound site should be covered with clear, sterile dressings and a bandage. Dressings should be changed every 12 hours so the wound site can be evaluated for signs of infection.

Proper bandaging is essential to keep soft tissue injuries protected against infection.

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**The Yucky Reality of Multiplying Bacteria**

Bacteria divide and double about every 26 minutes at 98.6°F/37°C, the core temperature of the human body:

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<tr>
<td>5 thousands</td>
<td>1,024</td>
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<tr>
<td>6</td>
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<td>24</td>
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*256 trillion hungry mouths to feed in only 24 hours!
Recognition and Management of Soft Tissue Infections

Signs of Infections:

If there is bacteria in the wound site, they will begin to multiply rapidly causing a local infection, a skin cellulitis or an abscess. Bacteria in a wound are very happy— they like their environs dark, warm, moist, with minimal oxygen, and lots of nutrients. At 98.6°F/37°C bacteria multiply once every 26 minutes, so what starts out as 2 after ½ hour becomes 256 trillion hungry mouths to feed 24 hours later! (See the math in the side bar) This is why wound infection is a very big deal. Little, dirty wounds can become life-threatening sepsis in 24 – 48 hours.

Cellulitis

Cellulitis is a bacterial or viral infection of the dermal layers of the skin. As bacteria multiply, they produce waste products called pyrogens. These pyrogens are recognized by our immune system as coming from a foreign invading germ that is out to destroy us. Although bad, these pyrogens start the chain of events of this defensive mechanism that ends up causing localized vasodilation, increase circulation, and an increase in WBCs—called chemotaxis. If the process continues for too long, a fever develops as well.

The vasodilation at the wound site increases the circulation to that area. This brings in more nutrients, antibodies, and white blood cells (WBCs) all needed to help battle the invaders. When peripheral blood vessels dilate, small gaps between the endothelial cells that make up the vessels open up allowing WBCs to escape into the surrounding tissue and sera or fluid in the blood to also leak out. This process will cause an increase in the redness of the skin, warmth of the skin, mild swelling, and tenderness. Which explains the classic signs of a skin infection: rubor (redness), tumor (swelling), dolor (pain), and calor (warmth), all part of the immune system’s first line of defense.

In a process known as chemotaxis, the WBCs are attracted to the waste products produced by the bacteria. It is the collection of WBCs at the infection site that produces the pus or purulent material that can be seen draining from an infected wound.

As the pyrogens get into the systemic circulation, they are detected by the thermoregulatory center in the brain, causing the brain to increase the systemic body temperature, bringing on a good old-fashioned fever. Again, a very smart thing to do. Bacteria multiply every 26 minutes at 98.6°F/37°C, but, as the core temperature goes up, the rate of reproduction of the bacteria goes down, giving our WBCs a better opportunity to destroy the bacteria.

If the wound infection goes unattended and untreated, the bacteria may overwhelm the immune system and get into the lymphatic drainage from the wound site. The lymphatics then become infected signaled by a red streak, (lymphangina), moving centrally up the extremity. If it reaches the lymph nodes, the nodes will become warm, swollen, and tender, (lymphadenopathy). If the progress of the infection is not slowed or halted, it will eventually reach the central circulation and the heart. Once in the circulation it is quickly distributed throughout the body causing septic shock, high fevers, shaking chills (rigors), tachycardia, hypotension, and death. Thus, simple wound cleaning becomes very important.

RECOGNITION AND MANAGEMENT OF CELLULITIS

Monitor the wound site for the initial immune response to the multiplying bacteria.

- **Ruber**—The redness of the skin caused by the vasodilation.
- **Tumor**—Swelling of the soft tissue by the fluids that are escaping the dilated vasculature.
- **Dolor**—Pain caused by the swelling in the tissues.
- **Calor**—Warmth in the tissues from the vasodilation.

If the cellulitis goes untreated and the infection spreads into the lymphatics, then the bacteria will spread up the lymphatics.

- **Lymphangina**: red, tender streaks that progress up the extremity as the lymphatics become infected.
- **Lymphadenopathy**: swollen, tender lymph nodes that occur when the infection reaches the lymph nodes proximal to the area of cellulitis.
- **Sepsis**: If the infection reaches the central circulation, via the lymphatic drainage, then septic shock occurs with high fever, shaking rigors, tachycardia, and hypotension.

TREATMENT

As soon as cellulitis is suspected, examine the wound closely for any foreign material retained in the wound. Remove any that is found. Heats soak the area of cellulitis in non-scalding hot water with Epsom salts or table salt in the water. This is an old, tried and true technique for treating infections. Heating up the area will slow the rate of reproduction of the bacteria and increase circulation to the area by further vasodilation. The reason for salt in the water is that fluid flows to the areas of greatest salt concentration, this osmosis will help to draw the infectious material out. Epsom salt is used because it is harmless to the human tissues and lethal to bacteria. Which each treatment the area of cellulitis should by heat soaked every 4 hours for at least 30 minutes until the infection has resolved.
EVACUATE
As soon as possible, organize and evacuate the patient to advanced medical care for further evaluation and treatment, as they may need IV antibiotics or surgical management of the infected wound.

ABSCESS FORMATION
In a cellulitis, the war that is being waged by the multiplying bacteria and the WBC's occurs in the layers of the skin. As the WBCs begin to gather at the site of the infection (chemotaxis), forming in a space within the wound, this collection of WBCs and bacteria are referred to as an abscess.

An abscess is more dramatic then cellulitis. While cellulitis is red, warm to the touch, slightly swollen, but not normally tender, an abscess has a definite area of swelling with induration (a distinct palpable margin around the abscess), redness, warmth, and tenderness to the touch. In the case of abscess formation, cells called fibroblasts surround the infection site and build a wall of very tough, fibrous cells to prevent the bacteria from escaping into the body. If the bacteria do breech the wall of induration, just like with cellulitis, the infectious material will get into the lymphatics causing lymphangina, lymphadenopathy, and eventually septic shock.

As long as the abscess remains sealed and pressurized, it is very dangerous to one's health. The immune system will have a very hard time winning the battle. The abscess should be treated the same as a cellulitis with non-scalding hot water salt soaks. But, in addition, victory will be achieved by our aiding the healing process - the abscess needs to be incised and drained. This is actually as simple as creating a hole and allowing the infected, purulent material in the abscess to drain out, thus decompressing the abscess.

THE PRINCIPLES OF INCISION & DRAINING OF AN ABSCESS
- **Picture**—Assess and evaluate the abscess and surrounding anatomy.
- **Prep**—clean and prep the area of the skin to be incised.
- **Pain**—control—if possible numb the skin with ice or inject with lidocaine.
- **Puncture**—the abscess—with a scalpel or sharp knife pierce the abscess.
- **Purge**—gently compress and drain the abscess.
- **Purify**—rinse the abscess clean with iodine solution.
- **Protect**—cover with a sterile dressing and monitor during evacuation.

THE DETAILS OF HOW TO INCISE & DRAIN AN ABSCESS
**Picture**: Take the time to study the abscess, note the size, depth, location, and think about the surrounding anatomy. If you are going stick a hole in the skin to drain the abscess, you need to make sure that you avoid any obvious tendons, ligaments, nerves, or arteries.

**Prep**: Thoroughly clean the area with soap and water and paint with an iodine solution to minimize the bacteria count on the surface of the skin.

**Pain Control**: If you are using a scalpel or other surgically sharp instrument, pain control is probably not necessary. However, pain control can be achieved by either cooling the area down with snow or ice to numb the skin (do not cause frostbite), or infiltrating the area with 1% or 2% lidocaine injection.

**Puncture**: To avoid important underlying structures, keep incisions to about 1 cm and do the incision parallel to the long axis of the limb or body. Since arteries, nerves, tendons and other important structures run lengthwise this helps avoid cutting across one and severing it. The puncture wound has to go deep enough to penetrate the abscess. This will be evident with the bloody, purulent material that will exude from the abscess. The purulent material can be, and most often is, very foul-smelling due to the anaerobic bacteria in it.

**Purge**: Gently compress the sides of the abscess, along the margins of the induration to force the purulent material out. Do not be overzealous, as you do not want to breech the wall of induration and push the infectious material deeper into the surrounding tissues. With a pair of forceps of other small instrument, you can also gently explore the cavity of the abscess to break up any adhesions (loculations) and help evacuate the gunk.

**Purify**: Last but not least, try to rinse the abscess out with some dilute iodine solution. This will help to remove all unwanted material and destroy the bacteria in the abscess.

**Protect**: Cover the surgical wound with a sterile dressing. Change the dressing at least every 12 hours, and monitor for signs of cellulitis or further abscess formation. Continue to treat with non-scalding hot water salt soaks every 4 hours during the preparation for evacuation. As soon as possible, evacuate to advanced medical care, as they may need to administer IV antibiotics or perform a surgical exploration of the abscess.
MONITOR THE WOUND SITE

Stitches & Wound Closure:

Wound repair is rarely functional; it is almost always cosmetic. “Functional” means that it is necessary to make the repair to restore proper body function, as would be the case of a lacerated tendon that needs to be sewn back together. When a wound is closed, unless it was thoroughly cleaned and sterilized, the chance that the wound will become infected is increased. And a wound infection is much more dangerous than a scar.

Bite wounds, for example, are very “dirty” wounds that are full of bacteria from the animal’s mouth. They are almost impossible to thoroughly clean. Because of this, even after a good scrubbing with soap and water and many rinsing, bite wounds are usually left open to heal. This way if they do get infected, the infection can drain out onto the skin, avoiding abscess formation. A tetanus booster should be given and rabies’ prophylaxis should be considered as well. Once the wound has healed, a cosmetic repair can later be performed to remove any unwanted scars.

Wet-to-Dry Dressings:

Wet-to-dry dressings are dressings that have been soaked with a dilute Betadine or iodine solution and then placed onto the wound and allowed to dry over a period of several hours. As the iodine dressing dries, it sterilizes the surface that it is in contact with. This dressing is very useful in an environment where it is going to be difficult to keep a wound clean and dry. As the dressing dries out, the wound is inspected, and a new iodine-soaked dressing is applied. This process keeps the wound as free of infectious bacteria as is possible in that environment. Betadine is a brand name for a solution that contains a concentration of 10% iodine. Betadine is always used in a diluted form since iodine in a greater than 5% solution is harmful to human tissue.

Summary—In the Wilderness Setting:

- Control bleeding
- Properly and thoroughly scrub and clean the wound
- Do not close the wound
- Dress and bandage the wound to protect and promote healing
- With loss of function, splint to support the extremity
- Change dressings 2 times per day
- Monitor for signs of infection
- If the wound continues to get wet, use Betadine/iodine wet-to-dry dressings

Oh, and by the way....

Tetanus Prophylaxis

Tetanus is a rare problem today because of the availability of tetanus vaccines. The disease used to be referred to as lockjaw because one of the symptoms of a tetanus infection was spasm of the jaw muscles, making it impossible to open their mouth.

Since a tetanus vaccine provides immunity for about 10 years, tetanus boosters should be given every 10 years.

Tetanus is caused by the bacteria Clostridium tetani, bacteria that commonly exist in dirt and in animal manure. It is an anaerobic bacteria, in that it does not like oxygen, and grows very well in dark, moist, warm areas with little or no oxygen, such as deep in a puncture wound. As the bacteria grow in the wound, it elaborates a toxin that causes the symptoms of lockjaw and can be deadly.

What about antibiotics?

Antibiotics are prescription medications that are used to treat bacterial infections. Based on their mechanism or action, they are sorted into families such as penicillins, macrolides, quinolones, tetracyclines, and sulfa drugs, to name a few. When a bacterial infection is suspected, the choice of which antibiotic to use is initially an educated guess. The decision depends upon which bacteria we suspect is causing the problem, the tissues that the antibiotic needs to penetrate or get into, the patient’s medical history including allergies, potential drug interactions, and age. So, it is not necessarily an easy decision and not without risk. The key to prevention of wound infection is proper wound care and cleaning to prevent infection. There will be a more in depth discussion and recommendation on the use of antibiotics in the next issue of the Newsletter.
Bandaging Techniques:

Fundamental first aid skills, bandaging techniques are used to stabilize injuries, supports splints, and to hold dressing over wounds in place. An article on soft tissue injuries would not be complete without illustrations to explain the purpose of each bandaging technique.

Dressings refer to soft items that are placed directly onto a wound to help protect the wounded tissue from further injury or insult.

Dressings & Bandages Commonly Used

**Gauze Pads**
Come in a variety of shapes, sizes, and materials.
Vary from large 12” x 9” trauma or abdominal dressings to smaller 4” x 4” or 2” x 2” square pads.

**Roller Gauze**
Comes in a variety of widths and materials.
1” to 6” roller gauze is commonly used to hold gauze dressings in place.

**Elastic Wraps**
Available in a variety of widths, usually 2”-6”.
Very helpful to create pressure dressings, stabilize sprains (RICE), and as the final wrap over splinting material to contain the entire splint.

**Triangular Bandages**
Tried and true, these are large triangular pieces of cotton fabric that are used to tie dressings and splints in place.

**Cravats**
Cravats are simply triangular bandages that have been folded into 3”-4” wide straps.

Specific Bandages and Their Techniques & Uses:

**Scalp**
Used as an improvised hat to protect the head or to hold a dressing on the forehead or scalp.

**Toothache**
Used to hold a fractured jaw in place or to hold a dressing on to the side of the head or face over the temporal areas.
Shoulder:
Used to support and hold dressings onto the shoulder or upper arm. Two variations are shown.

Arm Sling & Swathe:
Used to support and splint any injury to the upper extremity. By far one of the most useful and commonly utilized bandages.
**Hip:**

Used to support and hold dressings on the hip, buttocks, or upper leg.

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**Knee:**

Used to support and hold dressings onto the knee.

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**Sprained Ankle:**

Used to support and stabilize a sprained ankle; can also be used as the ankle hitch for an improvised traction splint.

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**Other specific soft tissue injuries that were discussed in previous issues of the newsletter**

- **Burns**—Nov/Dec 2005
- **Eyes**—Sept/Oct 2005
- **Teeth**—Sept/Oct 2004
- **Frostbite**—Jan/Feb 2004
- **Non-Freezing Cold Injuries**—Jan/Feb 2005
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“But a certain Samaritan, who was on a journey, came upon him; and when he saw him, he had compassion, and came to him, and bandaged up his wounds, pouring oil and wine on them; and he put him on his own beast, and brought him to an inn, and took care of him.”

Luke 10:43 (NAS)

The Wilderness Medicine Newsletter is dedicated to all the good Samaritans who do not hesitate to help those in need.

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The Wilderness Medicine Newsletter is intended as an informational resource only. Neither the WMN nor its staff can be held liable for the practical application of any of the ideas found herein. The staff encourages all readers to acquire as much certified training as possible and to consult their physicians for medical advice on personal health matters.

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**SOLO WILDERNESS FIRST AID & MEDICAL TRAINING OPTIONS**

**KEY:** WFA: Wilderness First Aid • AWFA: Advanced Wilderness First Aid • WEMT: Wilderness Emergency Medical Technician • EMT/RTP: WEMT Refresher Training Program

*WEMT Module: certifies street EMTs to the WEMT level • WFR: Wilderness First Responder • WFR Intensive: fewer days, more hours/day • WFR O-T-T: WFR while hiking On the Trail • WFR Review: two-day WFR review • Mission Med: medicine for missionaries • Wild Day: 1-day wilderness recert for WEMTs

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