SCIENTIFIC ASSEMBLY
SEATTLE, WASHINGTON

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Backcountry 911: 1,001 Uses for Duct Tape and Safety Pins

During course you will learn how to use common supplies to treat emergencies in extreme environments. The speaker will teach you how to improvise in the construction of splints and transport aids. The minimum necessary supplies and how you can use them will be reviewed.

- Review common disorders that may occur in the extreme environment.
- Describe how to prepare for stabilization and transport.
- Identify the basic contents of a backcountry medical kit.
- Explain how to improvise first aid equipment from natural resources.

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BACKCOUNTRY 911:
1001 USES FOR DUCT TAPE AND SAFETY PINS:

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Due to its unpredictable and fluid environment, Emergency Medicine often requires health care providers to incorporate improvisation into their practice.

Defined as "to fabricate out of what is conveniently at hand," improvisation encompasses infinite variations, with few absolute rights and wrongs. Improvisation is an amazing amalgam of formal medical science integrated with an adventurous twist of creative and commonsense problem solving. It is limited more often by imagination than by personnel or equipment.

General Guidelines

A person working with complex improvised systems should always test his or her creation on a noninjured person ("work out the bugs") before applying it to a patient. This will greatly enhance the efficiency of any improvised system. Creativity is needed when searching for improvisational materials.

Improvised Airway Management

The most common cause of airway obstruction in the semiconscious or unconscious victim is relaxation of the oropharyngeal muscles, which allows the tongue to slide back and obstruct the airway. If only one rescuer is present, maintaining a patent airway with the jaw thrust or chin lift technique precludes further first aid management. A nasal trumpet type of airway can be improvised from a Foley catheter, a radiator hose, a solar shower hose, siphon tubing, or an inflation hose from a kayak flotation bag or sport pouch.

A temporary airway can be established by attaching the anterior aspect of the victim's tongue to the lower lip with two safety pins. An alternative to puncturing the lower lip is to pass a string through the safety pins and hold traction on the tongue by securing the other end to the victim's shirt button or jacket zipper.

Surgical Airway (cricothyrotomy)

Cricothyrotomy-the establishment of an opening in the cricothyroid membrane-is indicated for relief of life-threatening upper airway obstruction when a victim can not be ventilated effectively from the mouth or nose, and endotracheal intubation is for some reason not feasible. Such circumstances might arise, for example, in a victim with severe laryngeal edema, or with trauma to the face and upper larynx. cricothyrotomy may also be useful in a patient whose upper airway is obstructed by a foreign body that cannot be extracted by a Heimlich maneuver or by direct laryngoscopy.

In the wilderness, cricothyrotomy is done by cutting a hole in the thin cricothyroid membrane and then placing a hollow object into the trachea to allow for ventilation. The cricothyroid membrane can be located by palpating the victim's neck, starting at the top.

The first and largest prominence felt will be the thyroid cartilage ("Adam's Apple"), while the second is the cricoid cartilage. The small space between these two, noted by a small depression, is the cricothyroid membrane.

Improvised Cricothyrotomy Tubes

1) **I.V. Administration Set Drip Chamber**: Cut the plastic drip chamber of a macro drip (15 drops/ml) I.V. administration set at its halfway point with a knife or scissors. Remove the end protector from the piercing spike and insert the spike into the cricothyroid membrane. The plastic drip chamber is nearly the same size as a 15-mm endotracheal tube adapter and fits snugly in the valve fitting of a bag-valve device.)

2) **Syringe barrel**: The barrel of a 3 cc or 1 cc syringe with the plunger removed can be cut at a 45° angle at its midpoint to create an improvised cricothyroid airway device. The proximal phalange of the syringe barrel helps secure the device to the neck and prevents it from being aspirated.

3) **Any small hollow object**: examples include a small flashlight or penlight casing, pen casing, small pill bottle, and large bore needle or IV catheter. Several commercial devices are available which are small and lightweight enough to be included in most first aid kits.

Technique:
1) With the victim lying on his back, clean the neck around the cricothyroid membrane with an antiseptic if one is readily available. Put on protective gloves.
2) Make a vertical 1-inch incision through the skin with a knife over the membrane (go a little bit above and below the membrane) while using the fingers of your other hand to pry the skin edges apart. Anticipate bleeding from the wound. After the skin is cut apart, puncture the membrane by stabbing it with your knife or other pointy object.)
4) Stabilize the larynx between the fingers of one hand, and insert the improvised cricothyrotomy tube through the membrane with your other hand. Secure the object in place with tape.

Complications associated with this procedure include hemorrhage at the insertion site, subcutaneous or mediastinal emphysema due to faulty placement of the tube into the subcutaneous tissues rather than into the trachea, and perforation through the posterior wall of the trachea with placement of the tube in the esophagus.

Improvised Barrier for Mouth-To-Mouth Rescue Breathing

A glove can be modified and used as a barrier shield for performing rescue breathing. Simply cut the middle finger of the glove at its halfway point and insert it into the victim's mouth. Stretch the glove across the victim's mouth and nose and blow into the glove as you would to inflate a balloon. After each breath remove the part of the glove covering the nose to allow the victim to exhale. The slit creates a one-way valve, preventing backflow of the victim's saliva

Ear, Nose, and Throat Emergencies

Epistaxis is a common problem in travelers. The reduced humidity in airplanes, cold climates, and high-altitude environments can produce drying and erosion of the nasal mucosa. Other etiologic factors include facial trauma, infections, and inflammatory rhinitis. Although most cases of epistaxis are minor, some present life-threatening emergencies.25

Anterior epistaxis from one side of the nasal cavity occurs in 90% of cases.5 If pinching the nostrils together for a full 10 minutes does not control the bleeding, nasal packing may be needed. A piece of cotton or gauze soaked with a vasoconstrictor such as Afrin or Neo-Synephrine Nasal Spray can be inserted into the nose and left in place for 5 to 10 minutes. Vaseline-impregnated gauze or strips of a nonadherent dressing can then be packed into the nose so that both ends of the gauze remain outside the nasal cavity. This prevents the patient from inadvertently aspirating the nasal packing.25

To completely pack the nasal cavity of an adult patient, a minimum of 3 feet of packing is required to fill the nasal cavity and tamponade the bleeding site.5 Expandable packing material such as Weimert Epistaxis Packing or the Rhino Rocket is available commercially. A tampon or balloon tip from a Foley catheter can also be used as improvised packing.25

Anterior nasal packing blocks sinus drainage and predisposes the patient to sinusitis. Prophylactic antibiotics are usually recommended until the pack is removed in 48 hours.25

If the bleeding site is located posteriorly, a 14 to 16 Fr Foley catheter with a 30 ml balloon can be used to tamponade the site.7 The catheter should be prelubricated with either Vaseline or a water-based lubricant. The catheter is inserted through the nasal cavity into the posterior pharynx. The balloon is then inflated with 10 to 15 ml of water and gently withdrawn back into the posterior nasopharynx until resistance is met. The catheter is secured firmly to the patient's forehead with several strips of tape. The anterior nose is then packed in front of the catheter balloon as described earlier.

Esophageal foreign bodies may cause significant morbidity. Respiratory compromise caused by tracheal compression or by aspiration of secretions can occur. Mediastinitis, pleural effusions, pneumothorax, and abscess may be seen with perforations of the esophagus from sharp objects or pressure necrosis caused by large objects.15

The use of a Foley balloon-tipped catheter has been reported to be a safe method for removing blunt esophageal foreign bodies.3,4,9 Success rates of 98% have been cited.4 Complications associated with this method include laryngospasm, epistaxis, pain, esophageal perforation, and tracheal aspiration of the dislodged foreign body.15 Sharp, ragged foreign bodies or an uncooperative patient precludes use of this technique.22

A 12 to 16 Fr Foley catheter is lubricated and placed orally into the esophagus with the patient in a sitting position. After the patient is placed in a Trendelenburg position, the catheter is passed beyond the foreign body and the balloon is inflated with water. The catheter is withdrawn with steady traction until the foreign body can be removed from the hypopharynx or expelled by coughing. Care must be taken to avoid lodging the foreign body in the nasopharynx. Any significant impedance to withdrawal should terminate the attempt.22 Use of this technique is recommended only in extreme wilderness settings or when endoscopy is not available.

Improvised Pleural Decompression of a Tension Pneumothorax

Signs and symptoms of a tension pneumothorax include: distended neck veins, tracheal deviation away from the side of the pneumothorax, unilateral absent breath sounds, hyperresonant hemithorax to percussion, subcutaneous emphysema, respiratory distress, cyanosis, and cardiovascular collapse. Tension pneumothorax mandates rapid pleural decompression if the victim appears to be dying. Possible complications of pleural decompression include infection, profound bleeding from puncture of the heart, lung, or a major blood vessel, or even laceration of the liver or spleen.

Improvised Pleural Decompression Devices

1) **Large-bore (12 or 14-gauge) intravenous catheter or needle**: To create a one-way flutter valve, cut a finger portion of a latex glove off at the proximal end of the finger and insert the needle or catheter into the open end of the glove finger and through the tip as shown.
The cut-out-finger portion of the glove creates a unidirectional flutter valve that allows egress of air from the pleural space during expiration, but collapses to prevent air entry on inspiration.
2) **Endotracheal tube**
3) **Foley catheter** with a rigid support like a close-hanger place into the lumen.
4) Section of a tent pole.
5) Hose from a hydration pouch (Camel Back™)

Technique
1. Swab the entire chest with povidone-iodine or other antiseptic
2. If sterile rubber gloves are available, they should be put on after the rescuer's hands have been washed.
3. If local anesthesia is available, infiltrate the puncture site down to the rib and over its upper border.
4. Insert a large bore intravenous catheter, needle, or any pointed, sharp object that is available into the chest just above the third rib in the midclavicular line (midway between the top of the shoulder and the nipple in a line with the nipple approximates this location). If you hit the rib, move the needle or knife upward slightly until it passes over the top of the rib, thus avoiding the intercostal blood vessels that course along the lower edge of every rib. The chest wall is 11/2 to 21/2 inches thick, depending upon the individual's muscularity and the amount of fat present. A gush of air signals that you have entered the pleural space; do not push the penetrating object in any further. Releasing the tension converts the tension pneumothorax into an open pneumothorax.
5. Leave the needle or catheter in place and place the cut-out finger portion of a rubber glove with a slit cut into the end over the external opening to create a unidirectional flutter valve that allows continuous egress of air from the pleural space.

Open ("Sucking") Chest wound

Penetrating trauma to the chest can produce a chest wound in which air is sucked into the pleura on inspiration.

Place a piece of plastic food wrap, aluminum foil or one side of plastic sandwich bag on top of the wound and tape it on three sides. The untaped fourth side serves as a relief valve to prevent formation of a tension pneumothorax.

Improvised Splinting and Traction*

CERVICAL SPINE INJURIES

Because of its mobility, the cervical spine is the region of the spinal column most commonly injured in trauma. Any obvious or suspected cervical spine injury demands full spinal immobilization with use of both a rigid or semirigid cervical collar and long board immobilization. Historically, dogma about cervical spine injuries has specified a "splint 'em as they lie" approach. Transporting a patient who is not in anatomic position is arduous in the backcountry. It is uncomfortable for the patient, is difficult for the rescuers, and most important, increases the risk of further injury. In general, gentle axial traction back to anatomic position is indicated unless (1) return to anatomic position causes a significant increase in pain or focal neurologic deficit or (2) movement of the head and neck results in any noticeable mechanical resistance.

All cervical spine injuries (or suspected injuries) deserve full long board immobilization. Movement of the pelvis and hips in a lateral direction is potentially more dangerous than anterior-posterior movement; therefore it is appropriate during extended transport to allow gentle flexion at the hip with immobilization in that position if it is more comfortable for the patient. Soft pads behind the knees and the small of the back also add to the patient's comfort during a long transport

Cervical Collars

Cervical collars should always be viewed as an adjunct to full spinal immobilization and never used alone. The improvised cervical collar should be used in conjunction with manual cervical spine stabilization followed by complete immobilization of the patient on a spine board. A properly applied and fitted collar is a primary defense against axial loading of the cervical spine, particularly in an evacuation that involves tilting of the patient's body uphill or downhill. Improvised cervical collars have in the past had a bad reputation, and textbooks continue to depict them made from a simple cravat wrapped around the neck. This type of system is of course no more effective than the soft cervical collars often used by urban plaintiffs trying to impress a jury.

An improvised cervical collar can work effectively *only* if it has the following features:

1. It is rigid or semirigid.
2. It fits properly (many improvised designs are too small).
3. It does not choke the patient.
4. It allows the patient's mouth to open if vomiting occurs.

The following are improvisational approaches to cervical collars.

Closed-Cell Foam System. The best closed-cell foam systems incorporate a full-size or three-quarter-length pad folded longitudinally into thirds and applied by being centered over the back of the patient's neck and wrapped forward. The pad is crossed under the chin, contoured underneath opposite axillae, and secured. If the pad is not long enough, extensions can be taped or tied on. This system also works well with blankets, beach towels, or even a rolled plastic tarp. Small flexible cervical collars that do not optimally extend the chin-to-chest distance should be avoided.

Padded Hip Belt. A padded hip belt removed from a large internal or external frame backpack can sometimes be modified to work perfectly. Wider is usually better. Excess circumference can be taken up by overlapping the belt and securing the excess material with duct tape.

Clothing. Bulky clothing, such as a fiberpile, or fleece jacket, can be rolled and then wrapped around the patient's neck to make a cervical collar. The extended sleeves can be used to secure the collar. Prewrapping a wide Ace wrap around the jacket compresses the material to make it more rigid and supportive.

Improvised Spinal Immobilization

As noted, the improvised cervical collar is only an adjunct to full spinal immobilization. Two immobilization systems are (1) short board immobilization, which is useful for short-duration transport (that is, getting the patient out of immediate danger) or when used in conjunction with a long board; and (2) long board immobilization, used for definitive immobilization during extensive transport.

All systems should be used in conjunction with a rigid or semirigid cervical collar, as described previously. Improvised lateral "towel rolls" are often added to these systems for additional head and neck support. These rolls can be improvised from small sections of Ensolite. Alternatively, a U-shaped head support or "horse collar" can be made from any rolled garment, blanket, tarp, or tent fly; this is placed over the patient's head in an inverted U and used in conjunction with the improvised cervical collar and spine board. Hiking socks or stuff bags filled with dirt, sand, or gravel also work well for this purpose. Stuff bags filled with snow for support should *never* be used because the snow can melt during transport and allow excessive head and neck motion. However, snow-filled stuff bags can act as temporary support while more definitive systems are being constructed.

TRACTION

Why are improvised traction systems so crucial? Traction can be lifesaving in certain situations. The importance of femoral traction in urban emergency medicine is generally accepted. In the backcountry environment, traction is essential for two fundamental reasons: (1) the general inability to provide intravenous volume expansion and (2) prolonged transport time to definitive care.

The primary purpose of backcountry femoral traction is to *limit blood loss into the thigh.* For a constant surface
area, the volume of a sphere is greater than the volume of a cylinder. Pulling (via traction) the thigh compartment back into its natural cylindrical shape limits blood loss into the soft tissue. Although the main objective is to control hem-
orrhage and prevent shock, enhanced patient comfort and decreased potential for

neurovascular damage are important secondary benefits. Properly applied, improvised femoral traction can save lives in the backcountry, particularly on extended transports where intravenous fluids are not available.

General Principles of Traction

The potential variety of traction designs is unlimited, but five key design principles should be considered when evaluating any femoral traction system:

1. Does the splint provide inline traction? Or, does the splint incorrectly pull the patient's leg off to the side or needlessly plantar flex the patient's ankle?
2. Is the splint comfortable? This one is easy: ask the patient.
3. Does the splint compromise neurologic or vascular function? Constantly check the patient's distal neurovascular function.
4. Is the splint durable, or will it break when subjected to backcountry stresses? As stated earlier, it might help to try the traction design on an uninjured patient and then knock the device around a bit to determine its strength.
5. Is the splint cumbersome? Many reasonable splint designs become so bulky and awkward that litter transport, technical rescue, or helicopter evacuation is impossible. For example, a full-length ski splint is not compatible with evacuation in a small helicopter.

Femoral Traction Systems

Every femoral traction system has six components:

1. Ankle hitch
2. Rigid support that is longer than the leg
3. Traction mechanism
4. Proximal anchor
5. Method for securing the splint to the leg
6. Additional padding

Ankle Hitch. A variety of techniques are used for anchoring the distal extremity to the splint. Many of these techniques work well, but some are impossible to recall in an emergency. The reader should choose an easy-to-remember technique and practice it. It is best to leave the shoe on the victim's foot and apply the hitch over it. Cut out the toe section of the shoe to periodically check the circulation.

Single runner system. A long piece of webbing, shoelace, belt, or rope can be looped over itself and one end brought through the middle to create a stirrup. After being rotated away from the person by 180 degrees, the hitch is slipped over the shoe and ankle.

Double runner system. This is a very straightforward technique. Two short webbing loops ("runners") are laid over and under the ankle as shown. The long loop sides are passed through the short loop on both sides and adjusted as needed. One advantage of this system is that it is infinitely adjustable, which enables the rescuer to center the pull from any direction. As always, proper padding is essential, especially for long transports. The patient's boot can distribute the pressure over the foot and ankle but will obscure visualization and palpation of the foot. A reasonable compromise is to leave the boot on and cut out the toe section for observation.

S-Configuration Hitch: This type of hitch is preferred if the victim also has an injury to his foot or ankle, because traction is pulled from the victim's calf instead of his ankle. Lay a long piece of webbing or other similar material over the upper part of the ankle (lower calf) in an S—shaped configuration. Wrap both ends of the webbing behind the ankle and up through the loop on the other side. Pull the ends down on either side of the arch of the foot to tighten the hitch and tie an overhand knot

Patient's boot system. Another efficient system uses the patient's own boot as the hitch. Two holes are cut into the side walls of the boot just above the midsole and in line with the ankle joint. A piece of nylon webbing or a cravat is threaded through and the ankle hitch is complete. Cutting away the toe may be necessary for neurovascular assessment.

Buck's traction. For extended transport, Buck's traction can be improvised using a closed-cell foam pad. The pad is wrapped around the lower leg as shown; a stirrup is then looped below the foot from medial calf to lateral calf. This assembly is then fastened with a second cravat wrapped circumferentially around the calf over the closed-cell foam (duct tape or nylon webbing can be used instead of cravats). This system greatly increases the surface area over which the stirrup is applied and decreases the potential for neurovascular complications and dermal ischemia. In addition, improvised Buck's traction can be used to manage backcountry hip fractures. However, recent literature indicates that this technique has little benefit.[1] If Buck's traction is used for a hip injury, smaller amounts of traction (roughly 5 pounds or less) should be used.

Rigid Support. The rigid support can be fabricated as a unilateral support (similar to the Sager traction splint or Kendrick traction device) or as a bilateral support, such as the Thomas half ring or Hare traction splint. Unilateral supports tend to be easier to apply than bilateral supports. The following are some ideas for rigid support.

Double ski pole or canoe paddle system. This is fashioned like a Thomas half ring, with the interlocked pole straps slipped under the proximal thigh to form the ischial support. Some mountain guides carry a prefabricated drilled ski pole section or aluminum bar that can be used to stabilize the distal end of this system.

Single ski pole or canoe-kayak paddle. In this system a single ski pole or paddle is used either between the legs, which is ideal for bilateral femur fractures, or lateral to the injured leg. The ultimate rigid support is an adjustable telescoping ski pole used laterally. The pole can be adjusted to the appropriate length for each patient, making the splint compact for litter work or helicopter evacuation.

Tent poles. This system employs conventional sectioned tent poles. The poles can be fitted together to create the ideal length rigid support. Because of their flexibility, tent poles must be well secured to the leg to prevent them from flexing out of position. A blanket pin or bent tent stake can be placed in the end of the pole to provide an anchor for the traction system. Alternately, a Prusik knot can be used to secure the system to the end of the tent pole

Miscellaneous. Any suitable object, such as a canoe or kayak paddle, two ice axes taped together at the handles, or a straight branch, can be used to make a rigid support. Although skis immediately come to mind as suitable rigid components, they are too cumbersome to work effectively. Because of their length, skis may extend far beyond the patient's feet or require placement into the axillae, which is unnecessary and inhibits the patient's mobility (for example, sitting up during transport). Premanufactured canvas pockets, available from the

National Ski Patrol System, provide a ski tip and tail attachment grommet for use with the ski system.

Traction Mechanism. The first modern popularized improvised traction mechanism was the Boy Scout–style Spanish windlass. Although these systems work and look good in the movies, they can be awkward to apply and are often not durable. The windlass can unspin if it is inadvertently jarred and can apply rotational forces to the leg.

The amount of traction required is primarily a function of patient comfort. A general rule is to use 10% of body weight or about 10 to 15 pounds for the average patient. After the traction is applied, rescuers should always recheck distal neurovascular function (circulation, sensation, movement).

Trucker's hitch. A windlass can be easily fashioned using small diameter line (parachute cord) and a standard trucker's hitch for additional mechanical advantage.

Prusik knot. Almost any system can be rigged with a Prusik knot. Prusiks are ideal for providing traction from rigid supports with few tie-on points (such as a canoe paddle shaft or a tent pole). The Prusik knot can be used to apply the traction (by sliding the knot distally) or simply as an attachment point for one of the traction mechanisms already mentioned.

Litter traction. If no rigid support is available and a rigid litter such as a Stokes is being used, traction can be applied from the rigid bar at the foot end of the litter. If this system is used, the patient must be immobilized on the litter with adequate countertraction, such as inguinal straps.

Proximal Anchor. The simplest proximal anchor uses a single proximal thigh strap, which can be made from a piece of climbing webbing or a prefabricated strap, belt, or cam lock). A cloth cravat can be used in a pinch. On the river a life jacket can be used. When climbing, a climbing harness is ideal.

Securing and Padding. All potential pressure points should be checked to ensure they are adequately padded. An excellent padding system can be made by first covering the upper and lower leg with a folded length of Ensolite. This is preferred over a circumferential wrap because the folded system allows for visualization of the extremity. The patient will be more comfortable if femoral traction is applied with the knee in slight flexion (padding placed beneath the knee during transport). The splint must be secured firmly to the leg. Almost any straplike object will work, but a 4- to 6-inch Ace bandage wrapped circumferentially will provide a comfortable and secure union. Finally, the ankles or feet should be strapped or tied together to give the system additional stability. Tying the ankles together also prevents the injured leg from excess external rotation and jarring during transport.

EXTREMITY SPLINTS

All fractures should be splinted before the patient is moved unless the patient's life is in immediate danger. In general, the splint should incorporate the joints above and below the fracture. If possible, the splint should be fashioned on the uninjured extremity and then transferred to the injured one.

On ski trips, skis and poles can be used as improvised splints. On white-water trips, canoe and kayak paddles can be used in a similar manner. Airbags used as flotation for kayaks and canoes can be converted into pneumatic splints for arm and ankle injuries. The minicell or ethafoam pillars found in most kayaks can be removed and carved into pieces to provide upper and lower extremity splints. A life jacket can be molded into a cylinder splint for knee immobilization or into a pillow splint for the ankle.

The flexible aluminum stays found in internal frame packs can be molded into upper extremity splints. Other improvised splinting material includes sticks or tree limbs, rolled-up magazines, books or newspapers, ice axes, tent poles, and dirt-filled garbage bags or fanny packs.

Ideally a splint should immobilize the fractured bone in a functional position. In general, "functional position" means that the legs should be straight or slightly bent at the knee, the ankle and elbow bent at 90 degrees, the wrists straight, and the fingers flexed in a curve as if the person were attempting to hold a can of soda or a baseball.

Splints can be secured in place with strips of clothing, belts, pieces of rope or webbing, pack straps, gauze bandages or elastic bandage wraps.

Padded aluminum can be molded into various configurations to splint extremity injures

TRIANGULAR BANDAGE MYTH

One of the most ubiquitous components of first aid kits and one of the easiest to replace through improvisation is the triangular bandage. The need to carry this bulky item, which is commonly used to construct a sling and swath bandage for shoulder and arm immobilization, can be eliminated by carrying two or three safety pins. Pinning the shirt sleeve of the injured arm to the chest portion of the shirt effectively immobilizes the extremity against the body.

If the patient is wearing a short-sleeved shirt, the bottom of the shirt can be folded up and over the arm to create a pouch. This can be pinned to the sleeve and chest section of the shirt to secure the arm.

Triangular bandages are also used for securing splints and constructing pressure wraps. Common items such as socks, shirts, belts, pack straps, webbing, shoe laces, fanny packs, and underwear can easily be substituted.

Improvised Wound Management

The same principles that govern wound management in the emergency department also apply in the wilderness. The main problem faced in the wilderness is access to adequate supplies. The decision to close a wound primarily or pack it open should take into account the mechanism of injury, the age of the wound, the site of the wound, the degree of contamination, and the ability to effectively clean the wound.

WOUND IRRIGATION

The primary determinants of infection are bacterial counts and amount of devitalized tissue remaining in the wound.12 Ridding a wound of bacteria and other particulate matter requires more than soaking and gentle washing with a disinfectant.14 Irrigating the wound with a forceful stream is the most effective method of reducing bacterial counts and removing debris and contaminants.16,21 The cleansing capacity of the stream depends on the hydraulic pressure under which the fluid is delivered.11,20 Irrigation is best accomplished by attaching an 18- or 19-gauge catheter to a 35 cc syringe or a 22-gauge needle to a 12 cc syringe. This creates hydraulic pressure in the range of 7 to 8 lb/in2 and 13 lb/in2, respectively.11,18,20 The solution is directed into the wound from a distance of 1 to 2 inches at an angle perpendicular to the wound surface and as close to the wound as possible. The amount of irrigation fluid will vary with the size and contamination of the wound, but should average no less than 250 ml.11 Remember: "The solution to pollution is dilution."

There is a lack of consensus on which irrigation solution is the best for open wounds. Those who subscribe to the dogma that nothing should enter a wound that could not be instilled safely into the eye believe that normal saline is the best solution.6,13 In a study of 531 patients with traumatic wounds, there was no significant variation in infection rates among sutured wounds irrigated with normal saline, 1% povidone-iodine, or pluronic F-68 (Shur-Clens).8

Tap water was recently found to be as effective for irrigating wounds as sterile saline. In fact, the infection rate was significantly lower after irrigation with tap water, and no infections resulted from the bacteria cultured from the tap water.1

Improvised wound irrigation requires only a puncturable container to hold the water, such as a sandwich or garbage bag, and a safety pin or 18-gauge needle.

WOUND CLOSURE

Before a wound is closed, all foreign material and grossly devitalized tissue should be removed. Debridement can be done with scissors, a knife, or any other sharp object. Wounds can be closed with sutures, staples, tape, pins, or glue. Although suturing is still the most widely used technique, stapling and gluing are ideal methods for closing wounds in the wilderness.

Clinical studies of the use of staples to close traumatic lacerations have found various advantages of stapling over suturing: wound tensile strength is greater, there is less inflammation, the time required for closure is shorter, and fewer instruments are needed.19 Most important, the cosmetic outcome is not compromised.10 Staplers are lightweight, presterilized, and easy to use.

WOUND TAPING

Skin tapes are useful for shallow, nongaping wounds and have several advantages over suturing, including reduced need for anesthesia, ease of application, decreased incidence of wound infection, and availability. Any strong tape can be used to improvise skin tape strips, but duct tape works especially well. Puncturing holes in the tape before application helps to prevent exudate from building up under the tape.

Wipe the skin with a solvent like acetone first to remove oil and sweat. Benzoin should then be applied to the skin before the tape to augment adhesion. Wound taping does not work well over joints or on hairy skin surfaces unless the hair is first removed.

HAIR-TYING A SCALP LACERATION CLOSED

If you're faced with a bleeding scalp laceration and the injured person has a healthy head of hair, you can tie the wound closed using the victims own hair and a piece of suture (0-silk works best), dental floss, sewing thread or thin string. Take the material and lay it on top of and parallel to the wound. Twirl a few strands of hair on each side of the wound and then cross them over the wound in opposite directions so that the force pulls the wound edges together. Have an assistant tie the strands of hair together with the material while you hold the wound closed with the strands of hair. A square know works best. Repeat this technique as many times as necessary, along the length of the wound, to close the laceration.

GLUING

The FDA has recently approved a topical skin adhesive to repair skin lacerations. Dermabond™ (2 Octyl Cyanoacrylate) is packaged in a small single use applicator and cost about $30 per tube. Tissue glue is ideal for backcountry use because it precludes the need for topical anesthesia, is easy to use, reduces the risk of needle stick injury, and takes up lot less room in a backpack than a conventional suture kit. When applied to the skin surface, tissue glue provides strong tissue support and peels off in 4 to 5 days without leaving evidence of its presence.23 It provides a faster and less painful method for closing lacerations than does suturing and has yielded similar cosmetic results in children with facial lacerations.17 Tissue glue evokes a mild acute inflammatory reaction with no tissue necrosis.23

The concept of gluing wounds is not new; the U.S. Army used a quick-sealing glue to treat battlefield wounds in Vietnam, and Histoacryl (butyl-2-cyanoacrylate) tissue adhesive has been used in Europe and Canada for sutureless skin closure for more than a decade.24

Dermabond has four time the 3-dimensional breaking strength of histoacryl, and also forms a more flexible bond. It thus provides a stronger and longer bond than its european counterpart. Petrolium based ointments and salves, including antibiotic ointments, should not be used on the wound after gluing, as these substances can weaken the polymerized film and cause wound dehiscence.

Tissue glue has also been used successfully to treat superficial painful fissures of the fingertips ("polar hands"), which commonly occur in cold climates and at high elevations.2

Technique

1) Irrigate to wound with copious amounts of disinfected water.

2) Control any bleeding with direct pressure. A gauze pad moistened with Afrin or Neosynephrine spray can be place into the wound to help control bleeding.

3) Once hemostasis is obtained, wound edges are manually approximated using fingers or forceps.

4) Paint the tissue glue over the manually apposed wound edges using a very light brushing motion of the applicator tip. Excessive pressure of the applicator to the tissue should be avoided as this might separate the skin edges, forcing glue into the wound. Apply multiple thin layers (at least 3), allowing the glue to dry between each application (about 2 minutes).

5) Glue can be removed from unwanted surfaces with acetone, or loosened from skin with petrolatum jelly.

Improvised Eyeglasses

Exposure of unprotected eyes to ultraviolet radiation at high altitudes may result in photokeratitis (snow blindness). Symptoms are delayed, and the victim is often unaware that an eye injury is developing. When sunglasses are lost at 14,000 feet in the snow, photokeratitis can develop in a mere 20 minutes. Improvised sunglasses can be fashioned from duct tape, cardboard, or other light-impermeable material that can be cut. Cardboard glasses with narrow eye slits can be taped over the eyes for protection.

Slits can also be cut into a piece of duct tape that has been folded over on itself with the sticky sides opposing. After a triangular wedge is removed for the nose, another piece of tape can be applied to secure the glasses to the head.

Pinhole tape glasses can improve vision in a myopic person whose corrective lenses have been lost. With myopia, parallel light rays from distant objects focus in front of the retina. The pinhole directs entering light to the center of the cornea, where refraction (bending of the light) is unnecessary. Light remains in focus regardless of the refractive error of the eye. Pinhole glasses decrease both illumination and the field of vision. Therefore a piece of duct tape or cardboard should be punctured repeatedly with a safety pin, needle, fork, or other sharp object until enough light can enter to focus on distant objects, and the device should be secured to the face.

A Final Note

Under certain conditions, improvised systems are entirely *suboptimal* and may not meet standard of care criteria. It would, for example, be ill advised to fabricate a litter for transporting a patient with a suspected spine injury when professional rescue is only a few miles away. An improvised litter system might be entirely appropriate, however, if the injured person is 40 miles out in Alaska's Brooks Range and needs transport to a sheltered camp or potential helicopter landing zone. The context of the situation should be considered. At times, persons are obligated to do whatever they can, and a resourceful approach to problem solving combined with a little ingenuity could save a victim's life.

REFERENCES

1. Anderson GH et al: Preoperative skin traction for fractures of the proximal femur, *J Bone Joint Surg* 75B(5):794, 1993.

1a. Angeras MH, Brandberg A: Comparison between sterile saline and tap water for the cleansing of acute traumatic soft tissue wounds, *Eur J Surg* 158:347, 1992.

2. Ayton JM: Polar hands: spontaneous skin fissures closed with histoacryl blue tissue adhesive in Antarctica, *Arctic Med Res* 52:127, 1993.

3. Bancewicz J: Oesophageal bolus extraction by balloon catheter, *Br Med J* 1:1142, 1978.

4. Bigler FC: The use of a Foley catheter for removal of blunt foreign objects from the esophagus, *J Thorac Cardiovasc Surg* 51:759, 1966.

5. Bratton JR: Epistaxis management: conservative& surgical, *J S Carolina Med Assoc* 80:395, 1984.

6. Bryant CA et al: Search for a non-toxic surgical scrub solution for periorbital lacerations, *Ann Emerg Med* 5:317, 1984.

6a. Chan D et al: The effect of spinal immobilization on healthy volunteers, *Ann Emerg Med* 23(1):48, 1994.

7. Cook PR, Renner G, Williams F: A comparison of nasal balloons and posterior gauze packs for posterior epistaxis, *Ear Nose Throat J* 64:446, 1985.

8. Dire D: A comparison of wound irrigation solutions used in the emergency department, *Ann Emerg Med* 19:704, 1990.

9. Dunlap LB: Removal of an esophageal foreign body using a Foley catheter, *Ann Emerg Med* 10:101, 1981.

10. Dunmire SM et al: Staples versus sutures for wounds closure in the pediatric population, *Ann Emerg Med* 18:448, 1989.

11. Edlich RF: Current concepts of emergency wound management, *Emerg Med Rep* 5:22, 1984.

12. Edlich RF et al: Principles of emergency wound management, *Ann Emerg Med* 17:1284, 1988.

13. Edlich RF, Sinkinson CA: Current concepts of emergency wound management. Part II, *Emerg Med Rep* 5:173, 1984.

13a. Isaac J, Goth P: *The Outward Bound wilderness first aid handbook,* New York, 1991, Lyons & Burford.

14. Lammers RL et al: Effect of povidone-iodine and saline soaking on bacterial counts in acute, traumatic, contaminated wounds, *Ann Emerg Med* 19:709, 1990.

14a. Lyons S, Wilderness Professional Training, Crested Butte, Colo: Personal correspondence, 1994.

15. Nandi P, Ong GB: Foreign body in the esophagus: review of 2394 cases, *Br J Surg* 65:5, 1978.

16. Peterson L: Prophylaxis of wound infections, *Arch Surg* 50:177, 1945.

17. Quinn JV et al: A randomized, controlled trial comparing a tissue adhesive with suturing in the repair of pediatric facial lacerations, *Ann Emerg Med* 22:1130, 1993.

18. Rodeheaver GT et al: Wound cleansing by high pressure irrigation, *Surg Gynecol Obstet* 141:357, 1975.

19. Roth JH, Windle BH: Staple versus suture closure of skin incisions in a pig model, *Can J Surg* 31:19, 1988.

19a. Schimelpfenig T, Lindsey L: *NOLSwilderness first aid,* Wyoming, 1991, NOLS Publications.

20. Sinkinson CA: Maximizing a wound's potential for healing, *Emerg Med Rep* 10:11, 1989.
21. Stevenson T et al: Cleansing the traumatic wound by high-pressure syringe irrigation, *J Am Coll Emerg Phys* 5:17, 1976.
22. Taylor RB: Esophageal foreign bodies, *Emerg Med Clin North Am* 5:2, 1987.
22a. Tilton B: *The basic essentials of rescue from the backcountry,* Indiana, 1990, ICSBooks.
23. Toriumi DM et al: Histotoxicity of histoacryl when used in a subcutaneous site, *Laryngoscope,* April 1991.
24. Watson DP: Use of cyanoacrylate tissue adhesive for closing facial lacerations in children, *Br Med J* 299:1014, 1989.
25. Yonkers AJ et al: Etiology and management of epistaxis, *Ear Nose Throat J* 60:453, 1981.

Appendix A

The Versatile Foley Catheter

Urinary retention is not an uncommon problem during high altitude sojourns. The combination of cold weather, long hours in the sleeping bag and anticholinergic medicines such as antihistamines can all predispose one to a distended, atonic bladder. A foley catheter is crucial for relieving this malady.

There are many other uses for the foley as well. It can act as a tourniquet to draw blood, start IV's, or stop bleeding. Once lubricated, it can be inserted into the nose for use as a tamponade for posterior epistaxis. When endoscopy is unavailable, it can be used to remove esophageal foreign bodies by inserting the catheter past the foreign body and then inflating the cuff to catch the obstruction and pull it out.

When cut to a smaller length, the foley can be used as a nasal airway. A foley with a stint inserted to keep it from collapsing can be used as a chest tube to relieve a tension pneumothorax.

The foley catheter can even act as a makeshift stethoscope. Simply place the diaphragm from an old stethoscope or a piece of paper rolled into a funnel with a piece of x-ray film attached into one end and an ear piece into the other for wilderness auscultation.

This simple stethoscope can also act as a primitive x-ray machine. Since sound transmission is weaker through a broken bone, one can suspect the presence of a fracture by listening for a dampened sound while holding a tuning fork against the injured limb.

And, finally when you return to the car after your outing and need some gasoline, don't forget that the foley can be used to siphon gas from your neighbor's tank.

Appendix B

Improvised Use of a Safety Pin

- Two safety pins can be used to pin the anterior aspect of the tongue to the lower lip to establish an airway in an unconscious patent with an obstruction of their airway due to relaxation of the tongue and posterior pharynx.
- Replacing the lost screw in your glasses to prevent the lens from falling out.
- Improvised glasses - Draw two circles in a piece of duct tape where your eyes would fit. Use the pin to make holes in the circles and then tape this to your face. The pin holes will partially correct myopic vision.
- Neurosensory skin testing.
- Irrigation of wounds with a safety pin punctured sandwich bag.
- Removing embedded foreign bodies from the skin.
- Draining an abscess or blister.
- Relieving a subungal hematoma.
- Fish hook.
- Improvised sunglasses.
- Finger splint (mallet finger).
- Sewing needle using dental floss as thread
- Holding gaping wounds together
- Replacing a broken zipper on clothing.
- Holding gloves or mittens on your coat sleeve.
- Unclogging jets in camping stoves.
- Pin triage note to multiple victims.
- Removing corneal foreign body (with opthaine).
- Sling and swath for shoulder or arm injuries
- Fix ski binding.
- Removing thrombosed hemorrhoid.
- Pin strap on shirt tightly around chest for rib fracture support.