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Update on Wound Management: Evidence-Based Strategies for Optimizing Outcomes

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Collectively, wounds are the third most common problem seen in the emergency department (ED).[1] In 2000, more than 7 million wounds were treated in EDs in the United States.[2] Although the ultimate aims in wound treatment are to prevent infection and to obtain a functional and attractive scar, patient priorities also include, in descending order of importance, normal function, the least visible scar possible, and the least painful repair possible.[3,4] These goals may be achieved by decreasing tissue contamination, properly debriding devitalized tissue, and performing a well-approximated skin closure.[5]

A survey conducted of practicing emergency physicians and published in 1992 identified a variety of practices that are contrary to current literature and textbook recommendations.[6] These included soaking wounds and using either 10% povidone iodine or hydrogen peroxide to cleanse wounds. A large percentage also scrubbed the entire wound surface or irrigated wounds using techniques that have not been proven to deliver the recommended 5-8 psi necessary for adequate tissue cleansing. The majority of respondents infrequently or never practiced delayed primary closure, a treatment option for lacerations at increased risk for infection.

Although this study suggests that several inappropriate wound care practices occurred prior to 1992, there have been no further studies looking at this issue since then. This article aims to provide the emergency medicine practitioner evidence-based information on the evaluation and management of wounds and to help dispel some of the commonly encountered myths in the practice of wound care.

—The Editor

Epidemiology

Almost one-third of wounds occur in adult males between the ages of 19 and 35 years. Most of these wounds are located either on the head or neck (50%) or on an upper extremity (35%), and the fingers or hands usually are involved.[5] The most common method of injury is blunt trauma, such as bumping the head against a hard surface. Other common sources of injury include sharp instruments, glass, and wooden objects.[7] Mammalian bites are a relatively uncommon cause of significant lacerations.

The magnitude and direction of the injuring force and the volume of tissue on which the force is dissipated determine the type of wound sustained. Three types of mechanical forces produce soft-tissue injury: shear, tensile, and compression forces. Shear forces are those that occur as a result of direct cutting of tissue (e.g., knife wound). Tensile or tension forces are those that cause direct stretching of tissue. The resulting disruption or loss of tissue determines the configuration of the wound. Based on these mechanisms, wounds have been classified into six types:[8]

1. *Abrasions.* Wounds caused by forces applied in opposite directions, resulting in the loss of epidermis and possibly dermis (e.g., skin grinding against road surface, also known as "road rash").

2. *Lacerations.* Wounds caused by shear forces that produce a tear in tissues. Little energy is required to produce a wound by shear forces. Consequently, little tissue damage occurs at the wound edge, the margins are sharp, and the wound appears "tidy." Lacerations also may occur secondary to tensile or compression forces (e.g., forehead hitting a dashboard). The energy required to disrupt tissue in these cases is considerably greater than that required for tissue disruption by shear forces because the energy is distributed over a larger volume. These lacerations have jagged, contused, "untidy" edges.

3. *Crush wounds.* Wounds caused by the impact of an object against tissue, particularly over a bony surface, which compresses the tissue. These wounds usually contain contused or partially devitalized tissue.

4. *Puncture wounds.* Wounds with small openings in which depth cannot be visualized entirely. Puncture wounds are caused by a combination of forces.

5. *Avulsions.* Wounds in which a portion of tissue is separated completely from its base and either is lost or left with a narrow base of attachment (a flap). Shear and tensile forces cause avulsions.

6. *Combination wounds.* Wounds with a combination of configurations. For example, stellate lacerations caused by compression of soft tissue against underlying bone create wounds with elements of crush and tissue separation; missile wounds involve a combination of shear, tensile, and compressive forces that puncture, crush, and sometimes avulse tissue.

Evaluation

Wounds should be examined meticulously in all cases. Proper lighting and control of bleeding are required to identify foreign bodies and any injury to deeper vital structures, such as nerves and tendons. Wounds over joints and tendons should be examined through a full range of motion (both active and passive), since their position during the injury may differ from their position during the examination. Pain with active range of motion may be the only indication of a partial tendon laceration. When lacerations over-lie a joint, one must consider injecting the joint to determine continuity with the laceration, which would require operating room irrigation and repair.[9] A detailed neurovascular examination also should be performed and documented before the administration of local or regional anesthesia and wound closure.[3]

Universal precautions for physicians and health care workers are an essential part of wound management. They involve the use of protective barriers, such as gloves, gowns, masks, and eyewear, which reduce the risk for exposure to potentially infectious materials. During wound evaluation, the practitioner should avoid using his hands during wound exploration, especially when the presence of foreign bodies is suspected. Gloves help reduce the incidence of contamination of the hands but cannot prevent injuries caused by needles or other sharp instruments. Masks and protective eyewear or face shields should reduce the incidence of contamination of mucous membranes of the mouth, nose, and eyes. The Centers for Disease Control and Prevention (CDC) has published full guidelines on the use of universal precautions and protective barriers.[10]

Although few studies clearly have demonstrated the benefit of using sterile gloves in repairing routine lacerations in the ED, this

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Figure 1. Langer's Lines

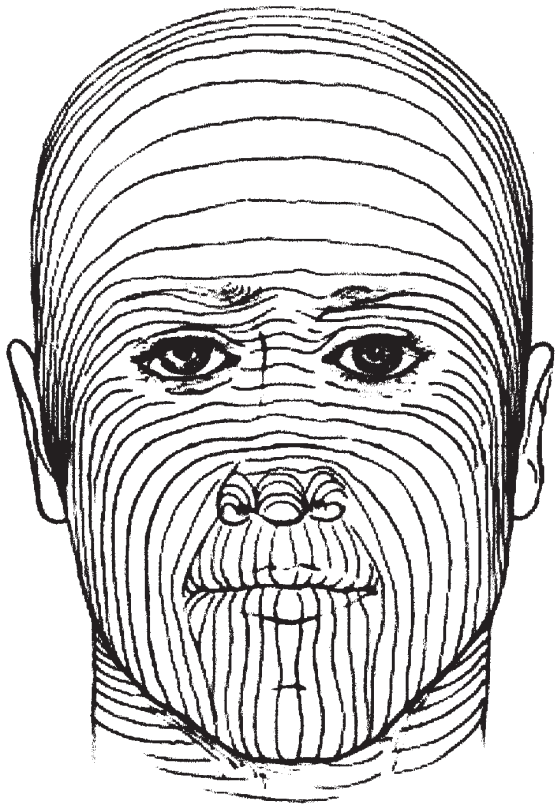

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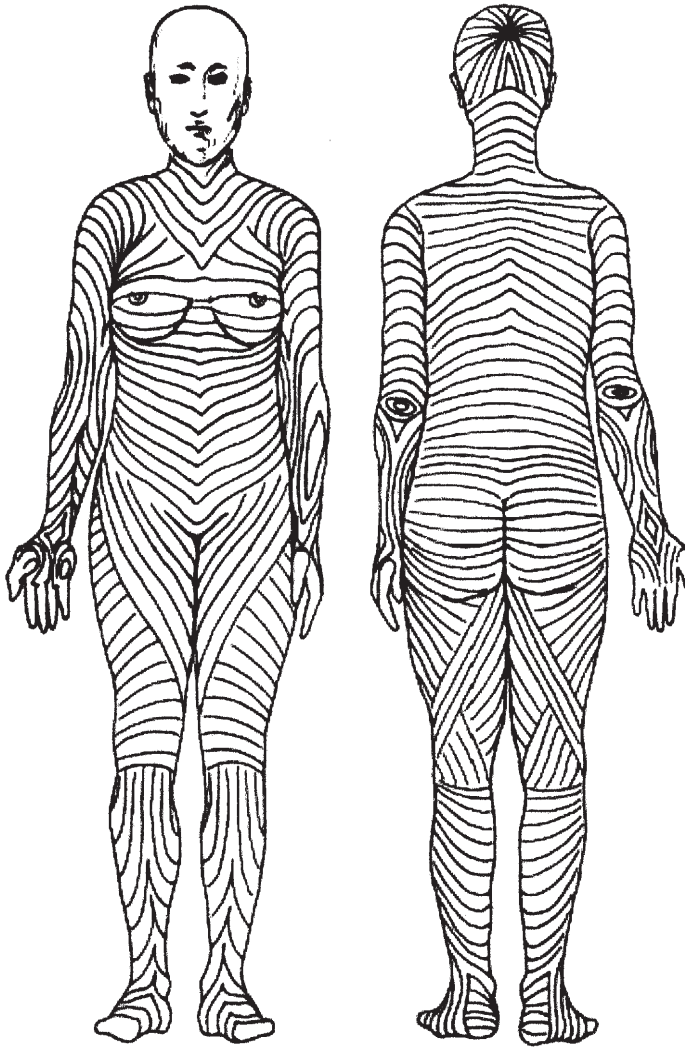
Figure 2. Langer's Lines



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practice still is recommended.[5,11,12] In a study comparing patients whose lacerations were repaired by a health care provider wearing a cap, mask, and gloves with patients whose wounds were repaired by a health care provider not using a cap, masks, or gloves, there were comparable wound infection rates in both patient groups.[13] In another study comparing wound healing and infection rates in patients randomly assigned to laceration repair either with full sterile technique or with a surgically clean technique, meaning without the use of a mask or sterile gloves, fewer infections were noted in the group whose wounds were repaired by the surgically clean technique.[14] Although using some type of gloves is required to comply with universal precautions, based on the above studies, the need for a completely sterile technique is debatable. Powder-free gloves further may reduce the risk of any foreign body reactions or infections that theoretically may result from the introduction of talc particles into the wound.[15]

Attention to host factors plays an important role in wound evaluation. Conditions such as extreme older and younger age, diabetes mellitus, chronic renal failure, obesity, malnutrition, and the use of immunosuppressive medications, such as corticosteroids and chemotherapeutic agents, all increase the risk of infection and can impair wound healing.[16] In a study conducted by Hollander et al, infected lacerations were likely to show the following features: they were longer, wider, deeper, and more likely to be jagged, have visible contamination, and have a foreign body identified.[1] Wounds located on the highly vascularized face or scalp are less likely to be infected than wounds in less vascularized areas.[17] The location of the wound also contributes to the cosmetic appearance of the scar by affecting static and dynamic skin tensions.[18] Thus, lacerations over joints, which are subject to large dynamic skin tensions, are prone to the development of wider scars, as are wounds that run perpendicular to the lines of minimal skin tension, the so-called Langer's lines.[3] (*See Figures 1 and 2.*) Compressive forces cause more devitalization of tissue, and therefore, crush wounds are more susceptible to infection and poor healing.[19] A critical aspect of ED evaluation of wounds is the ability of the practitioner to identify and recognize the need for surgical exploration in the operating room. Patients with suspected involvement of joints, nerves, or tendons may be better served by the ED physician who obtains the proper consultation for repair in the operating room.

Table 1. Properties of Commonly Used Local Anesthetics

AGENT (BRAND NAME)	CLASS	CONCENTRATION (%)	ONSET (MIN)	DURATION (HR)	MAXIMAL DOSE (MG/KG)
Procaine (Novocaine)	Ester	0.5-1.0	2-5	0.25-0.75	7
Procaine with epinephrine				0.5-1.5	9
Lidocaine (Xylocaine)	Amide	0.5-2.0	2-5	1-2	4.5
Lidocaine with epinephrine				2-4	7
Bupivacaine (Marcaine)	Amide	0.125-0.25	2-5	4-8	2
Bupivacaine with epinephrine				8-16	3

Adapted from: Hollander JE, Singer AJ. Laceration management. *Ann Emerg Med* 1999;34:356-367.

Foreign Bodies

The detection and management of foreign bodies in wounds pose significant challenges for emergency physicians. Although a small percentage of wounds contain foreign bodies, and not all foreign bodies require removal, failure to diagnose foreign bodies is one of the leading causes of litigation against emergency physicians.[20,21] Mechanism of injury can help determine which wounds are at risk for foreign bodies. If the suspicion for a foreign body is low and the entire depth and extent of the wound can be visualized, then additional imaging or exploration is not necessary. If an object is removed from a wound and does not appear to be intact, then further imaging and exploration are indicated. Objects that are very thin, small, breakable, or brittle may require further evaluation. Clinical findings such as localized pain, painful mass, foreign body sensation, or area of discoloration may suggest a retained foreign body. Plain radiography will demonstrate a majority of foreign bodies, as most objects are radiopaque (i.e., metal, glass, bone, teeth, gravel).[22] Glass is likely to be accurately visualized on 2-view radiographs if it is 2 mm or larger, and gravel if it is 1 mm or larger.[23,24] Factors that can limit detection of radiopaque foreign bodies include the object's density, configuration, size, and orientation.[22] Ultrasonography also has evolved as a potential tool in the evaluation of the presence of foreign bodies and has the ability to detect radiolucent foreign bodies as well. This modality of investigation is, of course, more operator-dependent and has been associated with false positive results with the presence of subcutaneous air, calcifications, and sesmoid bones.[25] Computed tomography (CT) can identify both radiolucent and radiopaque objects and provides additional information on the location of the object in relationship to nearby structures.[9] Because of the cost, lack of availability, and greater radiation, CT is recommended only for difficult-to-detect objects or when a wound is high risk, such as the presence of infection or potential involvement of joint space, and when other screening modalities have failed to detect a suspected foreign body.

In general, foreign bodies that are radiopaque also are less inflammatory than are radiolucent ones. The decision of when to remove a foreign body vs. carrying out further exploration is an individual one that must be made on a case-by-case basis. As exploration and removal of an object in soft tissue can cause further damage and contamination of the wound, small, inert objects not in close proximity to a joint, tendon, vessel, or nerve probably do not pose a significantly greater risk of infection, and consideration may be given to leaving them alone unless they can be removed easily or significant patient discomfort is present.[22] All patients should be informed of the increased risk of infection should the decision be made not to remove the foreign body.[26]

Anesthesia and Sedation

Appropriate wound anesthesia is critical to alleviate patient fears and concerns and to adequately explore wounds. There are several options available that decrease the discomfort of wound management. The selection of an appropriate option must be made on an individual basis and should take into account the age and underlying health status of the patient, the size of the laceration, the estimated amount of time required for closure, and the location of the wound.[26] Local anesthetic agents may be classified as amides or esters. (*See Table 1.*) The amide anesthetics include lidocaine and bupivacaine (remembered by the presence of an "i" in the first four letters of the generic name), and the ester anesthetics include procaine and tetracaine. Due to its longer duration of action, bupivacaine offers an advantage in busy EDs where the practitioner may not be able to focus on a laceration without interruption. Allergic reactions to anesthetic agents are rare and usually are due to preservatives (such as methylparaben). Patients with known allergies to a specific local anesthetic from one of the groups (for example, procaine) can be treated with an agent from the other group (for example, lidocaine). The use of pure agents without preservatives (for example, cardiac lidocaine) further reduces the risk of an allergic reaction.[3] Dilute diphenhydramine (0.5-1%) may be used for the rare patient who is allergic to an unknown local anesthetic agent.[27] Unfortunately, it is more painful to infiltrate, is less efficacious, and has a higher risk of significant complications (e.g., tissue necrosis).[28]

The use of methods to reduce the discomfort of infiltration of local anesthetics is an important skill that all ED physicians should practice and be familiar with. These include injecting through the wound margins in non-contaminated wounds, using the smallest-gauge needle (27 or less), and injecting slowly, no faster than 1 mL per 10 seconds.[29] The use of buffered lidocaine has been shown to be less painful than unbuffered lidocaine.[30,31] The change in the local pH of the wound due to buffering does not increase the likelihood of infection.[32] These solutions are prepared easily using a 9:1 or 10:1 ratio of 1% lidocaine to 0.9 mEq/L

Table 2. Wounds Managed with Secondary or Delayed Primary Closure

- Wounds that already are infected
- Wounds that are heavily contaminated and/or with visible debris
- Those with extensive tissue damage involving both the wound and surrounding skin
- Most bites on the trunk or extremities
- Those with a retained foreign body
- A major tissue defect that cannot be closed without excessive tension

Table 3. Indications for Use of Tissue Adhesives

LOCATION	INDICATION
Face	Most cutaneous closures
Lips and mucosa	Not recommended
Extremities and torso	Cutaneous closures, deep sutures recommended; not over the joint
Hands and feet	Minor lacerations only; generally not recommended

sodium bicarbonate.[26] Despite this, the practice of buffering lidocaine has not become routine practice in most EDs. A recent study has shown that buffered lidocaine has a longer shelf-life than originally thought.[33] This may allow for pre-buffering and short-term storage of the vials.

In children, the appropriate attention to the relief and management of pain and anxiety during wound evaluation and repair frequently is inadequate. Most lacerations in children can be repaired with minimal or no anxiety and pain through the use of distraction techniques, careful infiltration of local anesthetics, or the use of topical anesthetics or tissue adhesive. In children who are anxious or have complicated or extensive wounds to repair, procedural sedation should be considered.[34] Restraints should be used to supplement, not replace, other techniques to obtain the degree of patient cooperation necessary to accomplish evaluation and management of the wound. In most instances, a papoose board or other similar form of restraint, with an explanation to the parents and child of the procedure and the need for restraint, is adequate.

Regional nerve blocks are a critical skill for all ED practitioners. They save time, decrease the possibility of systemic toxicity, and are less painful than local infiltration, particularly in areas such as the palm, plantar surface of the foot, and the digits.[35] Regional anesthesia should be used for large wounds that otherwise would require large, potentially toxic doses of local anesthetics; wounds in which undesirable tissue distortion would result from local infiltration; and wounds in which local infiltration would be particularly painful (for example, those on the plantar surface of the foot). The addition of a vasoconstricting agent such as epinephrine to the local anesthetic allows a higher dose to be administered, prolongs the duration of action, and helps control local bleeding. However, the use of vasoconstrictors should be avoided in areas with end arterioles.[3] Although the different methods of administering regional anesthesia are beyond the scope of this article, the reader is referred to standard ED or anesthesia procedural textbooks, such as Roberts JR: *Clinical Procedures in Emergency Medicine,* 3rd ed. St. Louis: W. B. Saunders Company, 1998.

Wound Preparation

Hair is a source of contamination and may complicate wound closure. It may be removed by clipping. Shaving damages hair follicles, allowing access to bacteria, and, therefore may increase infection rates.[34,36] Hair should not be removed from the eyebrows, however, because this removes a crucial landmark for appropriate approximation and the hair may not grow back in a cosmetically acceptable fashion.[3]

Nonviable tissue may impair the ability of the laceration to resist infection and is extremely pyogenic.[37] Therefore, surgical debridement of any crushed or devitalized tissue is one of the most fundamental aspects of wound preparation. One useful technique for debriding wound margins of crushed and devitalized tissue is to incise skin with a number 15 blade and remove subcutaneous tissue with a pair of iris scissors. Debridement should be performed very conservatively on the face due to its high vascularity and exceptional healing, so as to avoid distortion of the subtle facial symmetry and to ensure an optimal cosmetic result.[26] Simply soaking the wound in an antiseptic solution has not been shown to be of any benefit.[38] Scrubbing of the wound directly with a sterile surgical brush has benefit in that it helps remove both bacteria and foreign material that increases the risk of wound infection. However, scrubbing also causes tissue damage and decreases the ability of the wound to resist infection.[5] Detergents contained in scrub solutions cause tissue damage when they contact wound surfaces.[39,40] A glycoprotein matrix is secreted into wounded tissue 1-3 hours after injury. Based on this fact, gentle scrubbing may be effective in wounds older than three hours.[41] Delivering hydrogen peroxide into wounds kills fibroblasts and occludes local microvasculature and is not recommended.[42,43] During wound preparation, hydrogen peroxide should not contact wound margins. However, hydrogen peroxide does have the beneficial effect of hemolyzing red blood cells on tissue surfaces around the wound.[9]

Wound Irrigation

Proper irrigation reduces bacterial contamination and helps prevent infection, because any soil or small foreign bodies that remain reduce the inoculum of bacteria required to produce infection.[44-47] Although many types of fluids have been studied, saline remains the most readily available, economical, and effective irrigant.[48] Concentrated povidone-iodine, hydrogen peroxide, and detergents may cause substantial tissue toxicity and should be avoided.[49,50] The optimal volume of irrigant has not been determined; however, some clinicians use 60 mL per centimeter of wound length as a guideline.[26] Although the optimal irrigation pressure is unknown, most authors recommend high-pressure irrigation, with pressures on the wound in the range of 5-8 lbs per square inch.[51] This pressure may be

Table 4. Pearls and Pitfalls of Tissue Adhesive Use

PROBLEM	PREVENTION
Adhesive sticks to gloves	Use vinyl gloves instead of latex; adhesive easily is removed with gentle traction
Gauze sticks to skin	Dampen gauze with water or saline
Adhesive runs into eyes	Position sensitive areas uphill from area where adhesive is being applied and surround area with damp gauze
Adherence to plastic forceps	Use metal instruments; less adherent
Seepage into wound	Do not release wound edges until polymerization is complete; may remove with petrolatum-based ointment
Hematoma formation	Ensure complete hemostasis prior to wound closure
Adherence to skin sutures	Do not apply adhesive over or near skin sutures that already have been placed

Table 5. Contraindications to Tissue Adhesive Use

- Below skin surface
- Areas with dense natural hair
- Near or on eye
- Areas of tight skin tension, such as over a joint
- Patients with immune compromise, poor wound healing, collagen vascular disease, or coagulopathy
- Known allergy to cyanoacrylate or formaldehyde

achieved by using a 35- or 65-mL syringe and a 16- or 19-gauge needle.[45,52] Low-pressure irrigation with a bulb syringe is not effective. Irrigating from a plastic bottle, an intravenous (IV) bag, or an IV bag with a pressure cuff does not generate as much pressure as a 19-gauge needle and a syringe.[52] Pressures higher than the recommended 5-8 lbs per square inch may increase trauma to the tissue and should be reserved for highly contaminated wounds. A volume of irrigant greater than 100 mL per centimeter of wound length may be needed for significantly contaminated lacerations.[9]

Timing of Wound Closure

Not all wounds that are seen in the ED should be closed immediately. There are three basic types of wound closure: primary, secondary, and delayed primary. Primary closure refers to closing a wound within hours after the injury. Most wounds that can be cleaned easily and completely may be closed primarily. There is some conflicting information in the literature as to how old a wound may be to preclude primary closure. Although there is a direct relation between the time interval from injury to laceration closure and the risk of subsequent infection, the length of this interval is highly variable.[5]

A study of 300 forearm and hand lacerations demonstrated that lacerations closed within four hours had a lower infection rate than those closed greater than four hours after injury.[53] Conversely, a much larger study of 2834 patients did not demonstrate a difference in infection rate in lacerations closed more or less than six hours after injury.[54] Another study demonstrated that the location of the laceration dictates when it can be closed. In a study of 204 lacerations, facial lacerations healed well regardless of time to closure. However, trunk and extremity lacerations had lower rates of healing if they were closed more than 19 hours after injury than if they were closed earlier. This study is limited by sample size, but it seems to suggest that areas with greater vascularity do well regardless of time to closure.[55] Each wound should be considered individually with regard to primary closure.

Secondary closure, or closure by secondary intention, refers to allowing a wound to close on its own, without sutures, staples, or other active intervention. This is reserved for wounds that are heavily contaminated or those wounds that cannot be irrigated adequately, such as puncture wounds. Many animal and human bites fall into this category. The benefits of this method stem from the fact that closure of a contaminated wound increases the risk of wound infection. Sutures are detrimental to wound healing and also increase the risk of wound infection, as they act as a foreign body, and the puncture from the suture needle induces inflammation.[8,57,58] There are some significant drawbacks, however, to closure by secondary intention. The defect may not be able to be closed completely in areas in which the surrounding skin is immobile, such as the pretibial area or scalp. Exposed tendons, nerves, or blood vessels may become dry in an open wound. The patient must be able to care for the wound and not further contaminate it.[8]

Delayed primary closure refers to closure of a wound at a time remote from the time of the injury, usually in a cosmetically important area. This technique is used for a wound that is contaminated or unable to be cleaned completely, but needs closure for cosmetic or functional reasons. If there is a substantial risk that closing a particular wound could result in an infection, the final management decision can be postponed for 3-5 days.[8] The basis for delayed primary closure is that the natural healing of an open wound gradually gives enough resistance to infection to allow an uncomplicated closure.[9,58] Wounds that are to be managed by delayed primary closure initially are managed in a similar manner to wounds closed by secondary intention.

The wound should be cleaned, debrided where necessary, packed with sterile saline-moistened gauze, and covered with absorbent sterile dressing. Patient home care is variable—the patient may be instructed not to disturb the dressing for a few days or to change it once or twice daily. Instructions should be individualized. Antibiotics are not beneficial and are not indicated in uncomplicated cases. The wound should be re-evaluated on post-injury day four. If the wound is not infected at that time, the wound edges can be approximated with suture. There is no delay in final healing when using either delayed primary or secondary closure.[8]

Methods of Wound Closure

Tissue Adhesives. Tissue adhesives are being used with increasing frequency in the United States since the introduction of octylcyanoacrylate (Dermabond, Ethicon) after FDA approval in 1998. A tissue adhesive offers many potential advantages over standard wound closure, including ease of use, decrease in pain and time to apply, as well as not requiring a follow-up visit for suture removal.[59]

When applied to tissues, cyanoacrylate adhesives polymerize rapidly through an exothermic reaction catalyzed by a small amount of moisture. This produces heat, which is more pronounced the more heavily the adhesive is applied. Adhesives can cause an intense inflammatory reaction in the subcutaneous tissues and never should be applied within wounds.[60]

A study in 1998 compared the one-year cosmetic outcome of wounds treated with octylcyanoacrylate tissue adhesive vs. monofilament sutures and correlated the early, three-month and one-year cosmetic outcomes.[61] Seventy-seven lacerations were evaluated at one year and no difference was found in the optimal wound scores or visual analog scale cosmesis scores. This study led the authors to recommend the following indications for the use of tissue adhesives shown in Table 3.[61]

If wound edges are separated more than 5 mm by underlying skin tension, the wound is unlikely to stay closed with tissue adhesives alone.[60] Relatively short wounds also are preferred candidates for tissue adhesive closure.

A recent Cochrane review of tissue adhesives was done to summarize the best available evidence for the effect of tissue adhesives in the management of lacerations in children and adults.[59] Included in the review were eight studies that compared a tissue adhesive with standard wound care. No significant difference was found for cosmesis at any of the time points examined. Pain scores and procedure time significantly favored tissue adhesives. A small but statistically significant increase in wound dehiscence was found in the tissue adhesives group. Only one study compared two different tissue adhesives directly, butylcyanoacrylate (not currently approved for use in the United States) and octylcyanoacrylate, and no significant differences were found in any parameters.

The largest trial to date of laceration closure with a tissue adhesive was the FDA study done for the approval of Dermabond in 1997. In a prospective, randomized study with 814 patients, time to wound closure was 50% less than with sutures, and there was a slight increase in infection rate (3.6% vs 1.2 % of controls).[62] In vivo studies have shown that Dermabond possesses antimicrobial properties against gram-positive organisms,[63] so it is surmised that the increased infection rate possibly was due to the less vigorous cleaning of the wound in the tissue adhesive group prior to closure. Other published studies using octylcyanoacrylate have reported a low rate of wound infection. However, these wounds may be at risk for infection because local anesthesia often is not needed for wound closure, so irrigation and debridement may be less aggressive and inadequate, and the adhesive may seep into the wound if the edges are not held together tightly, resulting in a foreign body reaction and forming a nidus for infection.[64] Wounds closed with tissue adhesives initially have less tensile strength, but this disappears after seven days.[60]

Table 6. Suture Size and Timing of Removal[71,72]

LOCATION OF WOUND	SUTURE SIZE	TIMING OF REMOVAL
Scalp	4-0, 5-0	5-8 days
Face	5-0, 6-0	3-5 days
Chest/abdomen	3-0, 4-0	7-10 days
Back	3-0, 4-0	12-14 days
Upper extremity	4-0, 5-0	8-10 days
Lower extremity	3-0, 4-0	8-12 days
Foot	3-0, 4-0	10-12 days
Joint–extensor surface	3-0, 4-0	10-14 days
Joint–flexor surface	4-0, 5-0	8-10 days

Wounds that are to be closed with a tissue adhesive should be cleaned and irrigated in a similar manner as for lacerations that would be closed with sutures or staples. The wound edges should be approximated with fingers or forceps, and the skin surface must be dry.

Dermabond comes in a cylindrical, clear plastic container with a cotton-like tipped applicator at the end. A glass vial 3.4 cm long containing the violet-colored Dermabond liquid is in the plastic inner cylinder. To use Dermabond, the inner glass vial must be cracked by squeezing the outer plastic cylinder and forcing the liquid through the applicator tip onto the wound surface.[64] Three to four thin layers of Dermabond should be painted over the opposed wound edges, extending at least 5 mm beyond the edges of the wound, in the direction of the long axis of the wound. The wound edges should be held together manually for at least 30 seconds after Dermabond application to complete polymerization.[61,64]

Aftercare instructions should include prohibiting the use of antibacterial or other petroleum-based products on the wound as these hasten the breakdown of the adhesive. The wound should not be soaked in water and should not be scrubbed. It may be washed gently after 24 hours. No dressing is required, as tissue adhesives provide their own dressing. The adhesive typically sloughs off in 7-10 days.[38,61,65]

Until recently, Dermabond was the only FDA-approved tissue adhesive being used in the United States. In September 2002, n-butyl-2-cyanoacrylate (Indermil) was approved for use.

Staples. Closing lacerations with skin staples has several advantages over suturing: speed of repair, lower cost, and low level of tissue reactivity. In prospective, randomized studies of stapling vs. suturing, stapling was shown to be less costly than suturing (with that advantage increasing as the laceration length increases), overall time for wound care was shorter, and there were no additional complications.[66,67] Overall, staples have been shown to produce cosmesis identical to that from sutures when used on the scalp, neck, trunk, and extremities.[66-68] Wounds that can be considered for staple closure include linear lacerations with sharp, straight edges on the extremities, scalp, or trunk. Prior to stapling a wound, the wound edges should be approximated, but this often is difficult to do adequately. Staples should not be used for deep scalp lacerations with active bleeding or on

Table 7. Characteristics of Suture Material[71,72]

SUTURE MATERIAL	KNOT SECURITY	TENSILE STRENGTH	TISSUE REACTIVITY	SECURITY*
ABSORBABLE—VARIABLE RETENTION OF TENSILE STRENGTH				
Chromic gut	fair	fair	most	10-14 d
Polyglactin (Vicryl)	good	good	minimal	30 d
Polyglycolic acid (Dexon)	best	good	minimal	30 d
NONABSORBABLE—HOLD MOST OF TENSILE STRENGTH FOR MORE THAN 60 DAYS				
Nylon (Ethilon)	good	good	minimal	n/a
Polypropylene (Prolene)	least	best	least	n/a
Silk	best	least	most	n/a

* Retention of 50% of tensile strength

the face, neck, hands, or feet. Deep sutures should be placed when necessary to reduce skin tension. Avoid placing staples too tightly, as this can lead to tissue ischemia and necrosis. The timing of staple removal is the same as the timing of suture removal and is specific for the body part involved.

Sutures. A complete discussion of suturing techniques is outside the scope of this article. A few caveats, however, will be mentioned. The goal of suturing is to reduce skin tension while approximating opposing wound edges. Excessive tension leads to unnecessary scarring, wound necrosis, and possible dehiscence. Placement of deep sutures helps reduce skin tension and decrease dead space and hematoma formation. All of these factors likely will improve cosmetic outcome, although well-designed trials to prove this are lacking.[5]

The use of subcuticular or subcutaneous sutures had both advantages and disadvantages. The use of buried, absorbable subcuticular sutures decreases the tension on wound edges, maintains eversion for a prolonged period of time, and provides tensile support. This allows for early removal of transdermal sutures, which decreases the likelihood of suture track marks and minimizes scarring overall.[69,100] This technique often is not used because of the concern of increased infection risk. Experimental rat models have shown that subcuticular sutures do not increase inflammation in uncontaminated wounds.[69] However, when the wound was contaminated with *Staphylococcus aureus*, then thoroughly irrigated and closed with subcuticular sutures, the wounds had increased rates of inflammation and infection despite the irrigation.[100] It probably is best to avoid subcuticular sutures for acute wounds, except for the cleanest wounds in cosmetically important areas.

Deep sutures do not increase infection rate in low-risk wounds.[75] Sutures should not be placed through adipose tissue, as they will not hold tension and will increase the infection rate.[5,70] Using the smallest diameter suture that adequately will close the wound can minimize scarring. Characteristics of the various suture types as well as size choices and time to removal are summarized in Table 6.

Skin-Closure Tapes. Skin closure tapes can be used to close a wound primarily or to provide additional support after suture or staple removal. Skin tapes work best for a superficial straight laceration that is under little tension. They also can be used to close lacerations that are under a splint or cast to preclude the need for suture or staple removal. Skin tapes can be used to repair skin tears in the elderly, as their skin often is too friable to hold suture. Tapes alone cannot maintain wound integrity in areas subject to tension.[5]

The wound and surrounding skin must be clean and dry. Adherence of the tape to the skin is improved by the use of benzoin painted on the skin 2-3 cm beyond the wound edges. Care should be taken not to allow any benzoin to enter the wound, as this can cause induration and wound infection.[73] If properly applied, the tapes will fall off in a few days when the skin exfoliates.[60]

Topical Antibiotics

Topical antimicrobial agents frequently are applied as part of wound aftercare. There was very little evidence to support this practice until a recent prospective study. Patients with lacerations fewer than 12 hours old were randomized into four groups, listed as follows with the associated infection rate: Bacitracin zinc, 5.5%; neomycin sulfate, bacitracin zinc, polymyxin B sulfate, 4.5%; silver sulfadiazine, 12.1%; and petrolatum, 17.6% (P=0.0034).[74]

In addition to infection prevention, topical agents can be used to reduce the formation of a crust that covers and separates the edges of the wound. They also can prevent the dressing from adhering to the wound.[8] There is no data regarding the length of use of topical agents, but it seems reasonable to use them until epithelization occurs at three days post-injury.[74]

Dressing and Post-Repair Wound Care

The ideal wound dressing is one that does not deter healing, helps prevent infection, is safe around mucous membranes and eyes, is not toxic to tissue, and is well tolerated by patients.[75] Such a dressing does not exist, but most of the current options are adequate. As long as the outer surface of the dressing is dry, it is an effective barrier to bacteria.[38]

A basic wound dressing consists of four layers: a nonadherent layer adjacent to the wound, gauze sponges to absorb any exudates, wrapping to hold the first two layers in place, and tape or an elastic bandage to complete the entire package.[60] The simplest, most useful nonadherent dressing is a layer of topical antimicrobial ointment. This is covered with a layer of gauze and tapped into place. This is an adequate dressing for a clean wound with minimal exudate.[60] Wounds covered with permeable dressings, such as plain gauze, tend to become dry. This damages the shallow layer of exposed der-

Table 8. Available Forms of Tetanus Toxoid[9]	
DTP	Diphtheria and tetanus toxoids and pertussis vaccine; use for those younger than 7 years old
DT	Diphtheria and tetanus toxoids; use for those younger than 7 years old when pertussis is contraindicated
DTaP	Diphtheria and tetanus toxoids and acellular pertussis vaccine; use for those younger than 7 years old
Td	Tetanus and diphtheria toxoids; use for those older than 7 years old

Table 9. Tetanus-Prone Wounds[78]
Wounds that are: • 6 hours old • > 1 cm deep • contaminated • stellate • denervated, ischemic • infected

mis, which impedes epidermal resurfacing. If a wound is kept moist for 48 hours, the epidermis will migrate over the surface up to 100% faster than when a dry scab is allowed to form.[76,77] Tape or elastic bandages that serve as the outer wrapping should not be wrapped circumferentially around an extremity or digit.[60]

The patient should be instructed to keep the dressing in place at least 24 hours before it is removed and inspected for signs of infection. The wound should not be allowed to get wet for 48 hours and should not be immersed in water until it is healed, as this predisposes to wound maceration. The frequency of dressing changes depends on the rate of healing, the presence of exudates, and patient's ability to care for the wound.[60]

Tetanus

Tetanus is a devastating but totally preventable disease marked by muscle spasm and autonomic instability with a mortality of about 11% in the United States.[78,79] Acute injury accounts for 77% of all cases of tetanus, including punctures (49%), lacerations (22%), and abrasions (12%).[79] Tetanus spores are ubiquitous in the soil and are carried into the wound with the soil. The spores may germinate after the wound has healed, thus accounting for cases that have no readily apparent source.[8]

Lack of proper immunization is the greatest risk factor for contracting tetanus.[78] The lowest rates of immunizations in the United States are found in older adults, Hispanics, African-Americans, those with a poverty-level income, and those without military service.[80,81]

Prevention of tetanus involves administration of one of the four available forms of tetanus toxoid. Tetanus toxoid variably is combined with diphtheria and pertussis, as concurrent vaccination usually is appropriate. The available forms are listed in Table 8. Serious adverse reactions are uncommon. Most often, any side effects seen are due to the pertussis component and include malaise, fever, erythema, and swelling at the injection site. The only true contraindications to tetanus toxoid administration are anaphylaxis, neuropathies, and encephalopathies with previous doses.[78] The standard dose is 0.5 mL intramuscularly.

Recommendations by the Centers for Disease Control.[79] Tetanus toxoid is all that most patients who are to receive tetanus prophylaxis will need. However, certain subsets of patients need human tetanus immunoglobulin (HTIG) also. HTIG is indicated in general for anyone who has not completed a primary immunization series. The dose is 250 IU IM.[78]

The dilemma for the physician becomes who needs tetanus toxoid, HTIG, or both. Conventionally, tetanus-prone wounds, as defined below, require at least tetanus toxoid. This is only a guideline, however, and all wounds should be considered tetanus-prone. The use of HTIG should be considered in certain patient groups, as tetanus toxoid may not provide adequate protection from tetanus. This includes patients who typically have poor antibody response such as the elderly and immunocompromised individuals. More liberal use of HTIG and more frequent dosing (fewer than five years) is recommended in these patients.[78]

Tetanus toxoid is accepted widely as being safe in pregnancy. The safety of HTIG is not well documented, but it should not be expected to have an adverse effect on the fetus. Do not withhold HTIG if it is indicated.[78]

Prophylactic Antibiotics

Prophylactic antibiotics have been used for years in aftercare of simple lacerations. This practice has no support in the literature. Unnecessary use of antibiotics is associated with increased bacterial resistance, side effects, and cost. Most traumatic soft-tissue injuries sustain a low level of bacterial contamination.[80] Much of the current knowledge of laceration characteristics associated with increased infection rates is based on skin incisions made under sterile conditions in the operating room and with animal models inoculated with bacteria. This does not necessarily extrapolate to human wounds, which typically are in highly vascular areas and have lower bacterial counts.[8] A prospective, cross-sectional study of 5521 patients revealed an overall wound infection rate of 3.5%. Factors associated with increased risk of infection included advanced age, history of diabetes, presence of a foreign body in the wound, jagged wound edges, stellate shape of the wound, a wide laceration, and an injury deeper than the subcutaneous tissue.[1]

In experimental models of contaminated incisions, antibiotics have no therapeutic value greater than three hours after the injury.[83] When the wound is contaminated with greater than 109 bacteria per gram of tissue, such as with fecal contamination, infection will develop despite antibiotic treatment.[84]

A meta-analysis was conducted to determine whether prophylactic systemic antibiotics prevent infection in patients with simple non-bite wounds managed in the ED. Seven studies were included in the analysis with a total of 1734 patients.[82] Patients treated with antibiotics had a slightly greater incidence of infection, which was not statistically significant. There is no evidence in published trials that prophylactic antibiotics offer protection against infection in

Table 10. Simplified Tetanus Prophylaxis in the Acute Wound[78]

PRIMARY IMMUNIZATION	TD	TIG
Not complete	Yes	Yes
Completed, < 5 yrs	No	No
Last booster > 5 yrs	Yes	No

Table 11. Indications for Prophylactic Antibiotics[8]

- Extremity bite wounds
- Punctures
- Intraoral lacerations that are sutured
- Orocutaneous lip wounds
- Highly contaminated wounds
- Involvement of tendons, bones, or joints
- Delayed closure greater than 12-24 hours
- Patients with immune compromise

non-bite wounds treated in the ED. There are no clear indications as to when to give antibiotics. However, prophylactic antibiotics may be considered in the circumstances listed in Table 11.

If antibiotics are to be given, they should be given parenterally in the ED as early as possible. Ceftriaxone is an excellent option in this setting. Oral antibiotics should be continued only for two or three days in the absence of a developing infection.[8]

Human Bites

Human bites typically present on the upper extremities, often as the result of fighting.[60] Human saliva can contain up to 108 organisms per milliliter. Mouth flora typically are polymicrobial, but there is an organism, *Eikenella corrodens*, that often is isolated from human bite infections. It is a slow-growing, facultative anaerobe gram-negative rod that is found in dental plaque. It acts synergistically with aerobic organisms to worsen infection.[38,85] Eikenella typically is sensitive to ampicillin, penicillin, some cephalosporins, and the quinolones, but resistant to penicillinase-resistant penicillin, clindamycin, and metronidazole.[60]

Human bites to locations other than the hand appear to have infection rates similar to nonbite lacerations if proper wound care is administered.[38,60] Bites to the hand are particularly concerning, as many complications can result, including cellulitis, abscess, tenosynovitis, septic arthritis, and osteomyelitis. The patient may not volunteer a history of a bite, particularly if the wound occurred as the result of a punch to the opponent's face and the patient was under the influence of drugs and/or alcohol. The "clenched-fist" injury or "fight bite" occurs on the dorsum of the metacarpophalangeal region of the fist as it strikes the mouth and teeth of another individual.[86] The teeth easily may penetrate the joint space or tendon sheath with only a small, innocent-appearing entrance wound. Suspect a bite wound of the hand of any patient who reports being in an altercation. The hand should be examined thoroughly throughout the full range of motion, with emphasis on identifying a foreign body or tendon or joint involvement. Obtain radiographs when a fracture or unidentified foreign body is suspected. The wound then should be irrigated thoroughly. Bites on the hand should not be sutured. Consultation with a hand specialist in the ED is indicated if: the wound already is infected; there is evidence of neurovascular compromise; joint or tendon involvement is suspected; or there is radiographic evidence of fracture, foreign body, or joint space air.[60] If there is no indication for emergent consultation, the wound should be covered with a dry, sterile dressing and splinted in the position of function. The patient should be discharged on an appropriate antibiotic, such as amoxicillin/clavulunate or a second generation cephalosporin for five days with wound re-evaluation in 1-2 days. Be sure to administer tetanus prophylaxis if indicated. Non-hand bites should be managed like any other laceration, with proper wound care and antibiotics for patients with immune compromise. A recent Cochrane review of antibiotic use for infection prophylaxis in mammalian bites in which eight studies were included demonstrated a significant reduction in infection resulting from human bites, but not from bites by dogs or cats. There is evidence that they reduce infection of bites to the hand.[87]

HIV and hepatitis B and C transmission via human bite rarely has been documented, usually in cases with significant blood exposure such as with an intraoral laceration.[88,89] Other diseases, such as actinomycosis, syphilis, tuberculosis, and herpes, have been transmitted via human bites.[90]

Animal Bites

Animal bites are quite common, with dog bites being the most often reported (90% of all reported bites).[91] Other animals implicated include cats, rodents, and miscellaneous wild animals. The most commonly bitten areas include the hands (48-59%), arms (16-26%), legs (15%), and face (8-30%).[60] The wounds inflicted by animals include punctures, lacerations, abrasions, and avulsions. Dog bites often produce significant tissue damage, in addition to a wound that is at risk for infection. Infected dog bites typically are polymicrobial, including *Pasturella multocida*, Eikenela, and Enterobacteria. An unusual organism, *Capnocytophaga canimorsus*, has been isolated from infected dog bites. This is a gram-negative aerobic rod that is associated with severe infection, gangrene, purpura, disseminated intravascular coagulation, and death in patients with immune compromise. Symptom onset is 7-14 days after the bite. The fatality rate is 25%. The organism is sensitive to many antibiotics, including penicillin, the cephalosporins, and clindamycin.[60,72]

The decision to suture a wound produced by a dog bite depends on the location of the bite. Lacerations of the scalp, face, and trunk can be sutured after adequate irrigation and debridement. Lacerations of the distal extremities should not be sutured. Lacerations of the proximal extremities probably can be closed.[60,92-94] Bites to the hand and bites in high-risk patients should be treated with antibiotics, with the gold standard being amoxicillin/clavulanate for five days. Low-risk dog bites do not require prophylactic antibiotics. A prospective randomized study of low-risk noninfected dog bites demonstrated no statistically significant difference in infection rates between the treatment and control groups.[95]

Table 12. Indications for Admission with Human Bites to the Hand[38]

- Wound greater than 24 hours old
- Established infection
- Penetration of the joint or tendon sheath
- Presence of foreign body
- Unreliable patient or poor home situation
- Diabetic or otherwise immune compromised

Cat bites have a higher incidence of wound infection than dog bites and a higher risk of tendon infection due to the puncture-like injury inflicted by the cat's teeth. *Pasteurella multocida* is the major pathogen found in infected cat bites.[60,97] Infection with this organism typically presents within several hours after the bite and can be complicated by bone and joint infections. Treatment for cat bites is similar to that for dog bites. However, small puncture wounds should not be closed primarily. Most patients should be started on an antibiotic, such as amoxicillin/clavulanate. Cosmetically important wounds can be considered for delayed primary closure.

Rabies Prophylaxis

In the United States, rabies rarely is found in dogs. The most common reservoirs in the United States are raccoons, skunks, bats, foxes, rodents, lagomorphs, and cats. Rabies also has been found in horses, mules, cattle, sheep, goats, coyotes, and ferrets.[60] Rabies almost never is found in squirrels, small rodents, and rabbits. The most common mode of rabies transmission is through the bite of a rabid animal, although other routes of transmission have been documented, such as via mucosal exposure.

When faced with a patient with an animal bite or scratch, wound care should be addressed first. The wound should be irrigated with a 1% benzalkonium chloride solution. This has been shown to be effective in killing the rabies virus.[97] The current CDC recommendations for which patients require rabies prophylaxis are summarized Table 14. The likelihood of rabies in domestic animals varies by region. A bite that is the result of an unprovoked attack is more likely to indicate a rabid animal than a provoked attack. If there is a question as to whether rabies immunization should be initiated, contact the local health department.

The rabies vaccine, human diploid cell vaccine (HDCV), produces an active immune response that takes 7-10 days to develop and persists for about two years. It is given in a dose of 1 mL intramuscularly on days 0, 3, 7, 14, and 28. The rabies immune globulin (RIG) provides a rapid, passive immunity with a half-life of only 21 days. It is given in a single dose of 20 IU/kg. The full dose should be infiltrated around the wound if anatomically possible, or intramuscularly at a site distant from the vaccine. In a patient who has had pre-exposure prophylaxis for occupational or travel indications, the RIG should not be given. The RIG and HDCV are safe in pregnancy.[99]

Table 13. Animal Bite Wounds with Increased Risk for Infection[60,96]

- Patient older than 50 years old
- Puncture or hand wound
- Wound that is sutured
- Wound greater than 24 hours old
- Full-thickness skin puncture
- Wounds requiring debridement
- Wounds involving joints, tendons, or ligaments
- Wounds associated with fractures
- Wounds in patients with high-risk hosts

Table 14. Post-Exposure Prophylaxis Recommendations[99]

ANIMAL	DISPOSITION	RECOMMENDATION
• Dogs, cats, ferrets	Healthy and available for 10 days observation	No prophylaxis unless animal develops symptoms
	Rabid or suspected rabid	Immediate vaccination
• Skunks, raccoons, foxes, lagomorphs, large rodents, other mammals	Consider individually	Consult health department

References

1. Hollander JE, Singer AJ, Valentine SM, et al. Risk factors for infection in patients with traumatic lacerations. *Acad Emerg Med* 2001;8:716-720.
2. McCaig LF, Nghi L. National Hospital Ambulatory Medical Care Survey: 2000 Emergency Department Summary. Advance data from Vital and Health Statistics, no. 326. Hyattsville, MD: National Center for Health Statistics, 2000.
3. Singer AJ, Hollander JE, Quinn JV. Evaluation and management of traumatic lacerations. *N Engl J Med* 1997;337:1142-1148.
4. Singer AJ, Mach C, Thode HC Jr, et al. Patient priorities with traumatic lacerations. *Am J Emerg Med* 2000;18:683-686.
5. Hollander JE, Singer AJ. Laceration management. *Ann Emerg Med* 1999; 34:356-367.
6. Howell JM, Chisholm CD. Outpatient wound preparation and care: A national survey. *Ann Emerg Med* 1992;21:976-981.
7. Hollander JE, Singer AJ, Valentine S, et al. Wound registry: Development and validation. *Ann Emerg Med* 1995; 25:675-685.
8. Lammers RL. Principles of Wound Management. In: Roberts JR, Hedges JR, eds. *Clinical Procedures in Emergency Medicine*, 3rd ed. St. Louis: W. B. Saunders Co.; 1998:535.
9. American College of Emergency Physicians: Clinical policy for the initial approach to patients presenting with penetrating extremity trauma. *Ann Emerg Med* 1999;33:612-636.
10. Centers for Disease Control: Recommendations for prevention of HIV transmission in health care settings. *MMWR* 1987;36(suppl):2S.
11. Caliendo JE. Surgical masks during laceration repair. *J Am Coll Emerg Phys* 1976;5:278-279.
12. Bodiwala GG, George TK. Surgical gloves during wound repair in the accident and emergency department. *Lancet* 1982;2:91-92.

13. Ruthman JC, Hendricksen D, Miller RF, et al. Effect of cap and mask on infection rates. *Ill Med J* 1984;165:397-399.
14. Whorl GJ. Repairing skin lacerations: Does sterile technique matter? *Can Fam Physician* 1987;33:1185-1187.
15. Villasenor RA, Harris DF II, Barrun GJ, et al. Powder free surgical gloves. *Ophthalmic Surg* 1984;15:241-243.
16. Cruse PJE, Foord R. A five-year prospective study of 23,649 surgical wounds. *Arch Surg* 1973;107:206-210.
17. Hollander JE, Richman PB, Werblud M, et al. Irrigation in facial and scalp lacerations: Does it alter outcome? *Ann Emerg Med* 1998;31:73-77.
18. Wray RC. Force required for wound closure and scar appearance. *Plast Reconstr Surg* 1983;72:380-382.
19. Cardany CR, Rodeheaver G, Thacker J, et al. The crush injury: A high risk wound. *JACEP* 1976;5:965-970.
20. American College of Emergency Physicians. *Foresight* Issue 16, September 1990.
21. Chisholm CD, Wood CO, Chua G, et al. Radiographic detection of gravel in soft tissue. *Ann Emerg Med* 1997;29:725-730.
22. Lammers RL, Magill T. Detection and management of foreign bodies in soft tissue. *Emerg Med Clin North Am* 1992;10:767-781.
23. Courter BJ: Radiographic screening for glass foreign bodies—what does a "negative" foreign body series really mean? *Ann Emerg Med* 1990;19: 997-1000.
24. Chisholm CD, Wood C, Chua G, et al. Radiographic detection of gravel foreign bodies in soft tissues [abstract]. *Acad Emerg Med* 1996;3:542.
25. Lammers RL. Soft tissue foreign bodies. *Ann Emerg Med* 1988;17:1336-1347.
26. Howell JM, Chisholm CD. Wound care. *Emerg Med Clin North Am* 1997; 15:417-425
27. Dire DJ, Hogan DE. Double-blind comparison of diphenhydramine versus lidocaine as a local anesthetic. *Ann Emerg Med* 1993;22:1419-1422.
28. Ernst AA, Marvez-Valls E, Nick TG, et al. Comparison trial of four injectable anesthetics for laceration repair. *Acad Emerg Med* 1996;3: 228-233.
29. Kelly AM, Cohen M, Richards D. Minimizing the pain of local infiltration anesthesia for wounds by injecting into the wound edges. *J Emerg Med* 1994;12:593-595.
30. Brogan GX, Giarrusso E, Hollander JE, et al. Comparison of plain, warmed, and buffered lidocaine for anesthesia of traumatic wounds. *Ann Emerg Med* 1995;26:121-125.
31. Cristoph RA, Buchanan L, Begalla K, et al. Pain reduction in local anesthetic administration through pH buffering. *Ann Emerg Med* 1988;17:117-120.
32. Brogan GX, Singer AJ, Valentine SM, et al. Comparison of wound infection rates using plain versus buffered lidocaine for anesthesia of traumatic wounds. *Am J Emerg Med* 1997;15:25-28.
33. Li J. Premixed buffered lidocaine retains efficacy after prolonged room temperature storage. *Am J Emerg Med* 2000;18:235-236.
34. Knapp JF. Updates in wound management for the pediatrician. *Pediatr Clin North Am* 1999;46:1201-1213.
35. Syverud SA, Jenkins JM, Schwab RA. A comparative study of the percutaneous versus intraoral technique for mental nerve block. *Acad Emerg Med* 1994;1:509-513.
36. Seropian R, Reynolds BM. Wound infections after preoperative depilatory versus razor preparation. *Am J Surg* 1971;121:251-254.
37. Haury B, Rodeheaver G, Vensko J, et al. Debridement: An essential component of traumatic wound care. *Am J Surg* 1978;135:238-242.
38. Simon B, Hern HG Jr. Wound Management Principles. In: Marx JA, Hockberger R, Walls R, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*, 5th ed. St. Louis: Mosby, Inc.; 2002:742.
39. Rodeheaver G, Bellamy W, Kody M, et al. Bactericidal activity and toxicity of iodine-containing solutions in wounds. *Arch Surg* 1982;117:181-186.
40. Custer J, Edlich RF, Prusak M, et al. Studies in the management of the contaminated wound. V. An assessment of the effectiveness of Phisohex and Betadine surgical scrub solutions. *Am J Surg* 1971;121:572-575.
41. Howell JM, Stair TO, Howell AW, et al. The effect of scrubbing and irrigation with normal saline, povidone iodine and cefazolin on wound bacterial counts in a guinea pig model. *Am J Emerg Med* 1993;11:134-138.
42. Branemark PI, Ekholm R. Tissue injury caused by wound disinfectants. *J Bone Joint Surg* [Am] 1967;49:48-62.
43. Lineweaver W, Howard R, Soucy D, et al. Topical antimicrobial toxicity. *Arch Surg* 1985;120:267-270.
44. Stevenson TR, Thacker JG, Rodeheaver GT, et al. Cleansing the traumatic wound by high pressure syringe irrigation. *JACEP* 1976;5:17-21.
45. Rodeheaver GT, Pettry D, Thacker JG, et al. Wound cleansing by high pressure irrigation. *Surg Gynecol Obstet* 1975;141:357-362.
46. Madden J, Edlich RF, Schauerhamer R, et al. Application of principles of fluid dynamics to surgical wound irrigation. *Curr Top Surg Res* 1971;3: 85-93.
47. Rodeheaver G, Pettry D, Turnbull V, et al. Identification of the wound infection-potentiating factors in soil. *Am J Surg* 1974;128:8-14.
48. Dire DJ, Welsh AP. A comparison of wound irrigation solutions used in the emergency department. *Ann Emerg Med* 1990;19:704-708.
49. Faddis D, Daniel D, Boyer J. Tissue toxicity of antiseptic solutions: A study of rabbit articular and periarticular tissues. *J Trauma* 1977;17:895-897.
50. Oberg MS, Lindsey D. Do not put hydrogen peroxide or povidone iodine into wounds! *Am J Dis Child* 1987;141:27-28.
51. Edlich RF, Rodeheaver GT, Morgan RF, et al. Principles of emergency wound management. *Ann Emerg Med* 1988;17:1284-1302.
52. Singer AJ, Hollander JE, Subramanian S, et al. Pressure dynamics of various irrigation techniques commonly used in the emergency department. *Ann Emerg Med* 1994;24:36-40.
53. Morgan WJ, Hutchison D, Johnson HM. The delayed treatment of wounds of the hand and forearm under antibiotic cover. *Br J Surg* 1980 Feb; 67(2): 140-141.
54. Baker MD, Lanuti M. The management and outcome of lacerations in urban children. *Ann Emerg Med* 1990;19:1001-1005.
55. Berk WA, Osbourne DD, Taylor DD. Evaluation of the "golden period" for wound repair: 204 cases from a third world emergency department. *Ann Emerg Med* 1988;17:496-500.
56. Marshall KA, Edgerton MT, Rodeheaver GT, et al. Quantitative microbiology: Its applications to hand injuries. *Am J Surg* 1976;131:730.
57. Edlich RF, Panek PH, Rodeheaver GT, et al. Physical and chemical configuration of sutures in the development of surgical infection. *Ann Surg* 1973; 177:679.
58. Edlich RF, Thacker JG, Buchanan L, et al. Modern concepts of treatment of traumatic wounds. *Adv Surg* 1979;13:169.
59. Farion K, Osmond MH, Harting L, et al. Tissue adhesives for traumatic lacerations in children and adults (Cochrane review). *Cochrane Database Syst Rev* 2002; (3):CD003326.
60. Kroot LJ. Emergency wound management. In: Tintinalli JE, Kelen GD, Stapczynski JS, eds. *Emergency Medicine: A Comprehensive Study Guide*,

5th ed. New York: McGraw Hill; 2000:293.
61. Quinn J, Wells G, Sutcliffe T, et al. Tissue adhesive versus suture wound repair at 1 year: Randomized clinical trial correlating early, 3-month and 1-year cosmetic outcome. *Ann Emerg Med* 1998;32:645-649.
62. Singer AJ, Quinn JV, Clark RE, Hollander JE; TraumaSeal Study Group. Closure of lacerations and incisions with octylcyanoacrylate: A multicenter randomized controlled trial. *Surgery* 2002;131:270-276.
63. Quinn JV, Maw JL, Ramotar K, et al. Octylcyanoacrylate tissue adhesive wound repair versus suture wound repair in a contaminated wound model. *Surgery* 1997;122:69-72.
64. Yamamoto LG. Preventing adverse events and outcomes encountered using Dermabond. *Am J Emerg Med* 2000;18:511-515.
65. Singer AJ, Quinn JV, Clark RE, et al. Closure of lacerations and incisions with octylcyanoacrylate: A multicenter randomized controlled trial. *J Fam Pract* 2002; 51:517.
66. Orlinsky M, Goldberg RM, Chan L, et al. Cost analysis of stapling versus suturing for skin closure. *Am J Emerg Med* 1995;13:77-81.
67. Kanegaye JT, Vance CW, Chan L, et al. Comparison of skin stapling devices and standard sutures for pediatric scalp lacerations: A randomized study of cost and time benefits. *J Pediatr* 1997;130:808-813.
68. Bickman KR, Lambert RW. Evaluation of skin stapling for wound closure in the emergency department. *Ann Emerg Med* 1989;18:1122.
69. Austin PE, Dunn KA, Eily-Cofield K, et al. Subcuticular sutures and the rate of inflammation in uncontaminated wounds. *Ann Emerg Med* 1995;25: 328-330.
70. Milewski DJ, Thomson H. Is a fat stitch necessary? *Br J Surg* 1980;67: 393-394.
71. Forsch RT. Soft tissue injury and laceration repair. *Clin Fam Pr* 2000;2: 551-564.
72. Noeller T, Cydulka RK. Laceration repair techniques. *Emerg Med Rep* 1996;17:21.
73. Panek PH, Prusak MP, Bolt D, et al. Potentiation of wound infection by adhesive adjuncts. *Am Surg* 1972;38:343-345.
74. Dire DJ, Cpopola M, Dwyer DA, et al. Prospective evaluation of topical antibiotics for preventing infections in uncomplicated soft-tissue wounds repaired in the emergency department. *Acad Emerg Med* 1995;2:4-10.
75. Knapp JF. Updates in wound management for the pediatrician. *Ped Clin NA* 1999; 46:1201-1204.
76. Winter GD. Formation of scab and the rate of epithelization of superficial wounds in the skin of the young domestic pig. *Nature* 1962;193:293.
77. Linsky CB, Rovee DT, Dow T. Effect of dressing on wound inflammation and scar tissue. In: Hildrick-Smith G, Dineen P, eds. *The Surgical Wound*. Philadelphia, Lea & Fiebiger; 1981:191-206.
78. Hsu SS, Groleau G. Tetanus in the emergency department: A current review. *J Emerg Med* 20:357-365.
79. Centers for Disease Control. Tetanus surveillance—United States 1995-1997. *MMWR* 1998;47:1-13.
80. Gergen PJ, McQuinllan GM, Kiely M, et al. A population-based serologic survey of immunity to tetanus in the United States. *N Engl J Med* 1995; 332:761-813.
81. Scher KS, Balders A, Wheeler WE, et al. Inadequate tetanus protection among the elderly. *South Med J* 1985;78:153.
82. Cummings P, Del Beccaro MA. Antibiotics to prevent infection of simple wounds: A meta-analysis of randomized studies. *Am J Emerg Med* 1995; 13:396-400.
83. Burke DF. The effective period of preventitive antibiotic therapy in experimental lesions incisions and dermal lesions. *Surgery* 1961;50:161.
84. Edlich RF, Rodeheaver GT, Thacker JG, et al. Technical factors in wound management. In: Edlich RF, Rodeheaver GT, Thacker JG, et al, eds. *Fundamentals of Wound Management in Surgery*. South Plainfield, NJ, Chirargecom, Inc. 1977.
85. Ordog G. The bacteriology of dog bite wounds. *Ann Emerg Med* 1986; 15:1324-1329.
86. Kelly IP, Cunney RJ, Smyth EG, et al. The management of human bite injuries to the hand. *Injury* 1996;27:481.
87. Medeiros I, Saconato H. Antibiotic prophylaxis for mammalian bites. *Cochrane Database Syst Rev* 2001; (2): CD 001738.
88. Centers for Disease Control and Prevention Public Health Service guidelines for the management of healthcare worker exposures to HIV and recommendations for post-exposure prophylaxis. *MMWR* 1998;47:1.
89. Groopman J, Salahuddin S, Sarngadharan M. HTLV-III in saliva of people with AIDS-related complex and healthy homosexual men at high risk for AIDS. *Science* 1984;226:447.
90. Morgan MG, Mardel SN. Clenched fist actinomycosis in a penicillin-allergic woman. *J Infect* 1993;26:222.
91. Callahan ML. Human and animal bites. *Top Emerg Med* 1982;4:1-15.
92. Brogan TV, Bratton SL, Dowd MD, et al. Severe dog bites in children. *Pediatrics* 1995;96:947.
93. Dire DJ. Management of animal bites. *Acad Emerg Med* 1994;1:178.
94. Wolf KD. Management of animal bite injuries to the face: Experience with 94 patients. *J Oral Maxillofac Surg* 1998;56:838.
95. Dire DJ, Hogan DE, Walker JS. Prophylactic oral antibiotics for low risk dog bite wounds. *Pediatr Emerg Care* 1992;8:194-199.
96. Brown CG, Ashton JJ. Dog bites: The controversy continues. *Am J Emerg Med* 1985;3:83-84.
97. Dire DJ. Cat bite wounds: Risk factors for infection. *Ann Emerg Med* 1991; 20:973-979.
98. Hopman L, Stewaer CE. Rabies. *Emerg Med Serv* 1986;May:22G-22 J
99. Centers for Disease Control Website www.cdc.gov. Human rabies prevention—United States 1999—Recommendations of the advisory committee on immune practices, 1999. Accessed on 12/6/2002.
100. Mehta PH, Dunn KA, Bradfield JF, et al. Contaminated wounds: Infection rates with subcutaneous sutures. *Ann Emerg Med* 1996;27:43-48.

Physician CME Questions

To earn CME credit for this semester of Emergency Medicine Reports*, please refer to the enclosed Scantron form for directions on taking the test and submitting your answers.*

121. Which of the following is helpful in reducing the pain associated with infiltration of a local anesthetic?
    A. Injecting through the intact skin surrounding the wound
    B. Injecting with a large-gauge needle
    C. Rapid injection of the anesthetic
    D. Buffering lidocaine with bicarbonate

122. Which statement is true regarding wound preparation?
    A. Use of a completely sterile set-up, including gown and mask, has been shown to decrease the incidence of wound infection when closing simple lacerations.

B. Debridement of devitalized tissue is not necessary when preparing to close a wound.
C. All foreign bodies must be removed from wounds.
D. Soaking a wound in antiseptic solution has been shown to be as beneficial as irrigation.
E. Eyebrows never should be shaved.

123. Which of the following wound preparation techniques should be avoided?
A. Vigorous scrubbing of the wound
B. Irrigating the wound with povidone-iodine solution
C. Low pressure irrigation with a bulb syringe
D. All of the above

124. Which of the following statements is true regarding timing of wound closure?
A. All wounds seen in the ED should be closed immediately.
B. Wounds that can be cleaned easily and completely may be closed primarily in the ED.
C. Animal and human bites require primary closure.
D. Delayed primary closure and secondary closure can delay final healing of a wound.

125. Which statement about tetanus is true?
A. Lack of immunization is the greatest risk factor for contracting tetanus.
B. Tetanus toxoid is contraindicated in pregnancy.
C. Only patients with tetanus-prone wounds require tetanus prophylaxis.
D. Injuries account for all cases of tetanus.

126. Which statement regarding rabies prophylaxis is true?
A. Rabies immune globulin (RIG) and HDCV are contraindicated in pregnancy.
B. If there is any confusion about whether a patient should receive rabies prophylaxis, the local health department should be contacted.
C. Rabies commonly is found in squirrels, small rodents, and rabbits.
D. RIG should be given to a patient with a high-risk animal bite, even if that patient has undergone pre-exposure rabies prophylaxis for occupational or travel indications.

127. Which of the following is true when tissue adhesives are being used for wound repair?
A. The adhesive liquid should not be allowed to enter the wound.
B. Antimicrobial ointment should be placed over the repaired wound.
C. Less vigorous wound cleaning and debridement is acceptable.
D. They can be used for gaping lacerations without the need for deep sutures.

128. Which statement is true regarding mammalian bites?
A. *Capnocytophaga canimorsus* is a potentially fatal organism that has been isolated from infected cat bites.
B. All dog bites require prophylactic antibiotics.
C. Cat bites have a lower incidence of infection than dog bites.
D. Bites of the hand should not be sutured.
E. *Pasturella multocida* is not a major pathogen found in infected cat bites.

129. Which of the following statements is true regarding wound irrigation?
A. Hydrogen peroxide and detergents are acceptable agents for wound irrigation.
B. Saline is the most readily available, economical, and effective irrigant.
C. Most authors recommend an irrigation pressure of greater than 5-8 lbs per square inch.
D. Irrigation using a plastic bottle or IV bag generates as much pressure as a 19-gauge needle and a syringe.

130. Indications for the use of prophylactic antibiotics include which of the following?
A. Delayed closure of 12-24 hours
B. Patients with immune compromise
C. Extremity bite wounds
D. Wounds that involve the tendons, bones, or joints
E. All of the above

In Future Issues: **Use of Ultrasound in the ED**

Emergency Medicine Reports

CME Objectives

To help physicians:

- quickly recognize or increase index of suspicion for specific conditions;
- understand the epidemiology, etiology, pathophysiology, and clinical features of the entity discussed;
- be educated about how to correctly perform necessary diagnostic tests;
- take a meaningful patient history that will reveal the most important details about the particular medical problem discussed;
- apply state-of-the-art therapeutic techniques (including the implications of pharmaceutical therapy discussed) to patients with the particular medical problems discussed;
- understand the differential diagnosis of the entity discussed;
- understand both likely and rare complications that may occur;
- and provide patients with any necessary discharge instructions.

Emergency Medicine Reports
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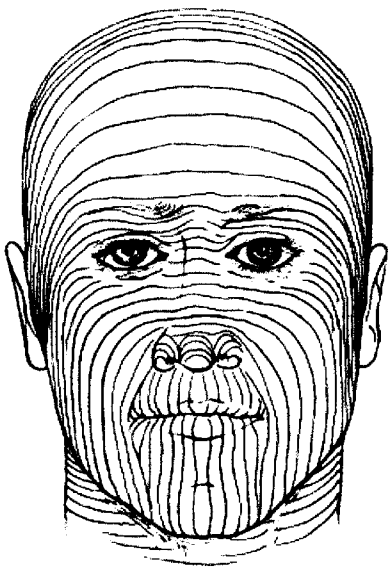
Wound Management

Properties of Commonly Used Local Anesthetics

AGENT (BRAND NAME)	CLASS	CONCENTRATION (%)	ONSET (MIN)	DURATION (HR)	MAXIMAL DOSE (MG/KG)
Procaine (Novocaine)	Ester	0.5-1.0	2-5	0.25-0.75	7
Procaine with epinephrine				0.5-1.5	9
Lidocaine (Xylocaine)	Amide	0.5-2.0	2-5	1-2	4.5
Lidocaine with epinephrine				2-4	7
Bupivacaine (Marcaine)	Amide	0.125-0.25	2-5	4-8	2
Bupivacaine with epinephrine				8-16	3

Adapted from: Hollander JE, Singer AJ. Laceration management. *Ann Emerg Med* 1999;34:356-367.

Langer's Lines



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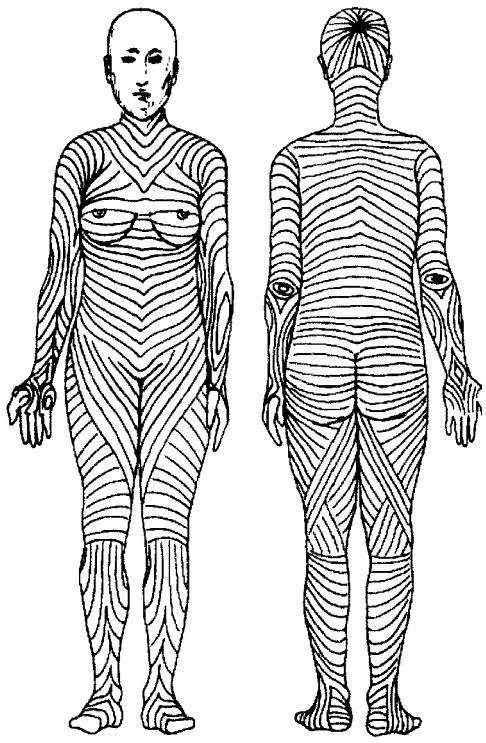
Langer's Lines



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Wounds Managed with Secondary or Delayed Primary Closure

- Wounds that already are infected
- Wounds that are heavily contaminated and/or with visible debris
- Those with extensive tissue damage involving both the wound and surrounding skin
- Most bites on the trunk or extremities
- Those with a retained foreign body
- A major tissue defect that cannot be closed without excessive tension

Indications for Use of Tissue Adhesives

LOCATION	INDICATION
Face	Most cutaneous closures
Lips and mucosa	Not recommended
Extremities and torso	Cutaneous closures, deep sutures recommended; not over the joint
Hands and feet	Minor lacerations only; generally not recommended

Contraindications to Tissue Adhesive Use

- Below skin surface
- Areas with dense natural hair
- Near or on eye
- Areas of tight skin tension, such as over a joint
- Patients with immune compromise, poor wound healing, collagen vascular disease, or coagulopathy
- Known allergy to cyanoacrylate or formaldehyde

Available Forms of Tetanus Toxoid

DTP	Diphtheria and tetanus toxoids and pertussis vaccine; use for those younger than 7 years old
DT	Diphtheria and tetanus toxoids; use for those younger than 7 years old when pertussis is contraindicated
DTaP	Diphtheria and tetanus toxoids and acellular pertussis vaccine; use for those younger than 7 years old
Td	Tetanus and diphtheria toxoids; use for those older than 7 years old

Pearls and Pitfalls of Tissue Adhesive Use

PROBLEM	PREVENTION
Adhesive sticks to gloves	Use vinyl gloves instead of latex; adhesive easily is removed with gentle traction
Gauze sticks to skin	Dampen gauze with water or saline
Adhesive runs into eyes	Position sensitive areas uphill from area where adhesive is being applied and surround area with damp gauze
Adherence to plastic forceps	Use metal instruments; less adherent
Seepage into wound	Do not release wound edges until polymerization is complete; may remove with petrolatum-based ointment
Hematoma formation	Insure complete hemostasis prior to wound closure
Adherence to skin sutures	Do not apply adhesive over or near skin sutures that already have been placed

Suture Size and Timing of Removal

LOCATION OF WOUND	SUTURE SIZE	TIMING OF REMOVAL
Scalp	4-0, 5-0	5-8 days
Face	5-0, 6-0	3-5 days
Chest/abdomen	3-0, 4-0	7-10 days
Back	3-0, 4-0	12-14 days
Upper extremity	4-0, 5-0	8-10 days
Lower extremity	3-0, 4-0	8-12 days
Foot	3-0, 4-0	10-12 days
Joint–extensor surface	3-0, 4-0	10-14 days
Joint–flexor surface	4-0, 5-0	8-10 days

Characteristics of Suture Material

SUTURE MATERIAL	KNOT SECURITY	TENSILE STRENGTH	TISSUE REACTIVITY	SECURITY*
ABSORBABLE—VARIABLE RETENTION OF TENSILE STRENGTH				
Chromic gut	fair	fair	most	10-14 d
Polyglactin (Vicryl)	good	good	minimal	30 d
Polyglycolic acid (Dexon)	best	good	minimal	30 d
NONABSORBABLE—HOLD MOST OF TENSILE STRENGTH FOR MORE THAN 60 DAYS				
Nylon (Ethilon)	good	good	minimal	n/a
Polypropylene (Prolene)	least	best	least	n/a
Silk	best	least	most	n/a

* Retention of 50% of tensile strength

Tetanus-Prone Wounds

Wounds that are:
- 6 hours old
- > 1 cm deep
- contaminated
- stellate
- denervated, ischemic
- infected

Indications for Prophylactic Antibiotics

- Extremity bite wounds
- Punctures
- Intraoral lacerations that are sutured
- Orocutaneous lip wounds
- Highly contaminated wounds
- Involvement of tendons, bones, or joints
- Delayed closure greater than 12-24 hours
- Patients with immune compromise

Animal Bite Wounds with Increased Risk for Infection

- Patient older than 50 years old
- Puncture or hand wound
- Wound that is sutured
- Wound greater than 24 hours old
- Full-thickness skin puncture
- Wounds requiring debridement
- Wounds involving joints, tendons, or ligaments
- Wounds associated with fractures
- Wounds in patients with high-risk hosts

Simplified Tetanus Prophylaxis in the Acute Wound

PRIMARY IMMUNIZATION	TD	TIG
Not complete	Yes	Yes
Completed, < 5 yrs	No	No
Last booster > 5 yrs	Yes	No

Post-Exposure Prophylaxis Recommendations

ANIMAL	DISPOSITION	RECOMMENDATION
• Dogs, cats, ferrets	Healthy and available for 10 days observation	No prophylaxis unless animal develops symptoms
	Rabid or suspected rabid	Immediate vaccination
• Skunks, raccoons, foxes, lagomorphs, large rodents, other mammals	Consider individually	Consult health department

Indications for Admission with Human Bites to the Hand

- Wound greater than 24 hours old
- Established infection
- Penetration of the joint or tendon sheath
- Presence of foreign body
- Unreliable patient or poor home situation
- Diabetic or otherwise immune compromised

Supplement to *Emergency Medicine Reports*, December 16, 2002: "Update on Wound Management." *Authors:* **Lisa Freeman, MD, FACEP**, Assistant Professor, Associate Program Director, Department of Emergency Medicine, University of Texas Health Sciences Center, Houston; **Rajeev Pethe, MD**, Department of Emergency Medicine, University of Texas Health Sciences Center, Houtson.