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EXTRA!

Acute Traumatic Wounds: Evaluation, Cleansing, and Repair in the ED

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CLINICAL CHALLENGES

- **What are the most important factors** to consider in the initial evaluation of traumatic wounds and lacerations?
- **What are the safest and most cost-effective** methods of wound cleansing and closure?
- **Which wound characteristics** should prompt consultation with a specialist?

Traumatic wounds are a common presentation in the emergency department. While most minor traumatic wounds and lacerations will heal well, appropriate management is required to preserve function and cosmesis as well as to prevent infection and other complications. This supplement reviews evidence-based recommendations for management of acute traumatic wounds, including evaluation, cleansing, anesthesia, selection of closure methods and materials, and post-repair instruction. Management of high-risk wounds and special considerations for the evaluation and repair of facial lacerations are also reviewed.

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EB MEDICINE

Introduction

Many of the wound care techniques used today were first practiced by ancient Egyptian, Greek, and Roman physicians, but certain aspects of wound management have evolved as medical technology has improved and new evidence has emerged, particularly in recent decades.[1-3] Traumatic wounds are among the most common conditions treated in the emergency department (ED). Approximately 7 million patients in the United States require treatment for traumatic lacerations each year, which is a rate of 1 laceration every 4.5 seconds. These injuries account for >5% of all ED visits annually.[4] The most common location of lacerations is the upper extremity (35%), followed by lacerations to the face (28%), trunk (14.5%), lower extremity (12.5%), and head/neck (10%).[5,6]

Complications of wound care that may lead to malpractice claims include missed foreign bodies, wound infection, joint capsule violation, or failure to detect nerve or tendon injury.[7] Although the economic burden of an individual malpractice case may be relatively small, the overall financial impact of these claims is significant due to the large numbers of patients who present with wounds; litigation associated with wound management complications accounted for 3% to 11% of all dollars paid out in malpractice claims.[7]

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This issue of *Emergency Medicine Practice: Trauma Extra!* reviews the evaluation and treatment of minor traumatic wounds in the ED, with a focus on evidence-based recommendations for the evaluation, cleansing, and repair of wounds.

For a detailed review of wound management in pediatric patients, see the October 2017 issue of *Pediatric Emergency Medicine Practice* titled, "Pediatric Wound Care and Management in the Emergency Department," available at **https://www.ebmedicine.net/topics/trauma/pediatric-wound-care**

Pathophysiology

Anatomy

The primary functions of the skin include thermoregulation, barrier protection against the physical environment, and sensory, metabolic, and immune functions.[8] Skin is thickest on the palms of the hands and the soles of the feet (4-5 mm), and thinnest on the eyelids (1 mm). The skin has 3 layers: the epidermis, dermis, and hypodermis. The epidermis is the outermost layer, providing protection from the physical environment. Beneath the epidermis, the dermis is a dense, collagenous layer of connective tissue that provides the primary structural substance; this layer has hair follicles, vascular structures, cutaneous nerves, and sebaceous and eccrine glands. The hypodermis, the innermost layer, contains subcutaneous adipose tissue.[3,9] Simple lacerations are confined to the epidermis, dermis, and hypodermis, while complex lacerations involve deeper, subcutaneous fascial layers such as muscle and tendon.

Mechanism of Injury

Lacerations may be caused by penetrating trauma, cutting, blunt trauma, puncture wounds, or mammalian bites. Each mechanism has characteristics that provide a unique pattern of injury; for example, lacerations caused by simple shearing from a knife have little kinetic energy, so the damage to surrounding tissue is often minimal.[3,10] Blunt injuries cause lacerations as a result of a hard object striking the skin at an angle; these lacerations have irregular stellate shapes and ragged edges, and a significant amount of kinetic energy is transferred to the surrounding tissue.[3] Lacerations from more severe mechanisms of action have a higher likelihood of neurovascular injury or fracture. Injuries with devitalized tissue may be prone to bacterial proliferation and infection.[11]

Puncture wounds are often caused by stepping on a foreign object, and the most frequent location of puncture wounds is on the plantar aspect of the foot.[12] These injuries are most commonly caused by nails (>90%), or by glass, wood, or other metal objects. The most critical factors affecting management of puncture wounds are the depth of the wound and the presence of a foreign body.[12]

For a detailed review of the management of mammalian bites, see the April 2016 issue of *Emergency Medicine Practice* titled, "Mammalian Bites in the Emergency Department: Recommendations for Wound Closure, Antibiotics, and Postexposure Prophylaxis," available at **https://www.ebmedicine.net/topics/toxicology-environmental/mammalian-bites**

Phases of Wound Healing

Wound healing is divided into 3 phases: (1) hemostasis and inflammation; (2) proliferation; and (3) maturation and remodeling.[2] Each stage in the healing process is critical to achieving a strong, functional, and aesthetically appealing scar.

Hemostasis and Inflammation

Blood vessels damaged by laceration vasoconstrict to prevent additional blood loss to the injured area. Platelet aggregation, degranulation, and activation of the coagulation cascade lead to fibrin clot formation.[2,3] Neutrophils enter the wound at 24 to 48 hours after injury and remove debris, damaged tissue, and bacteria. Macrophages enter the wound at 48 to 96 hours and assist with phagocytosis and recruitment of other cells. T lymphocytes peak at 1 week after injury and bridge the transition between the inflammatory phase and the proliferative phase.[2,3]

Proliferative Phase

The proliferative phase begins on day 4 and lasts through day 21. During this phase, fibroblasts and endothelial cells infiltrate the wound and become active. Fibroblasts synthesize and deposit collagen, and endothelial cells contribute to the formation of new capillaries.[2]

Epithelialization occurs during this stage, as basal cells at the edge of the wound begin to migrate across the surface. These cells undergo rapid mitotic division and continue migration until the wound is covered and the epithelium is reestablished.[2]

Maturation and Remodeling

During maturation and remodeling, the newly synthesized and deposited collagen begins reorganization. The amount of collagen in a healing wound will peak after several weeks. However, tensile strength continues to rise for months as scar remodeling continues, ultimately resulting in a mature scar. Scars never fully achieve the strength of uninjured tissue.[2]

Differential Diagnosis

The diagnosis of traumatic laceration is often readily apparent. In some cases, the mechanism of injury may alter management (eg, concern for the presence of a foreign body in a puncture wound or the need for rabies prophylaxis following a mammalian bite). Emergency clinicians should consider nonaccidental trauma in pediatric patients if the details of the injury are unclear.

Prehospital Care

In the prehospital setting, it is imperative to identify and stop all active bleeding. Minor lacerations can be managed with gauze dressings while en route to the ED. Bulky dressings alone may be adequate for hemostasis. However, life-threatening injuries to the extremities require the application of a tourniquet; life-threatening injuries at junctional sites such as the groin or axilla warrant wound packing with hemostatic gauze and compression; and life-threatening injuries to the chest and abdomen should be managed with hemostatic gauze and compression.[13,14] Thorough evaluation and management of life-threatening traumatic injury is outside the scope of this review; the most recent Advanced Trauma Life Support® guidelines and the STOP THE BLEED® program are resources for more information on the management of patients with severe bleeding.

Emergency Department Evaluation

History

The key components of the patient history for traumatic wounds are mechanism of injury, time since injury, and past medical history. Certain medical conditions may impair wound healing and closure. Alterations in clotting factors found in patients with hemophilia may lead to delays in hemostasis.[3] Many common medications, including aspirin, clopidogrel, ticlopidine, and dipyridamole, function to inhibit platelet aggregation and, as a consequence, delay hemostasis.[15] Patient age, diabetes, renal failure, obesity, malnutrition, and immunocompromised status all confer a higher risk for infection. Allergy status is particularly important in patients with allergies to local anesthetics and latex.

Patients who are unvaccinated or undervaccinated require tetanus vaccination and possibly tetanus immune globulin for high-risk wounds.[16] The highest risk for tetanus is in the elderly, immigrants, and persons without education beyond grade school. Wounds that are more prone to tetanus include contaminated wounds, deep puncture wounds, and injuries with crushed and devitalized tissue.[16]

Physical Examination

Examination of wounds should include documentation of the location, size, depth, and shape; wounds should also be examined for signs of contamination, foreign bodies, infection, or devitalized tissue. Wound size, contamination with foreign material, and location other than the head or neck are factors associated with higher infection rates.[17-20] Assessment of the patient's neurovascular status is crucial, as this helps determine the extent of the injury. Expert consultation may be warranted if deeper structures such as tendons, muscles, or bones appear to be involved on wound exploration.

CASE 1

A 69-year-old man presents to the ED after sustaining a laceration to the palmar surface of his left hand. A resident is with the patient when you enter the exam room, and has already noted in the chart that the patient is diabetic. The patient reports that he accidentally cut himself on broken glass while discarding trash. You examine the wound and find no palpable foreign bodies and no evidence of neurovascular injury or injury to deeper structures in his hand.

What is the best next step in the management of this patient? Should you obtain imaging or proceed to wound preparation and closure?

Diagnostic Studies

Laboratory Studies

Laboratory studies are rarely required to manage and treat wounds that present to the ED acutely. If there is a delay in presentation or a concerning patient medical history, further testing may be needed.

Imaging Studies

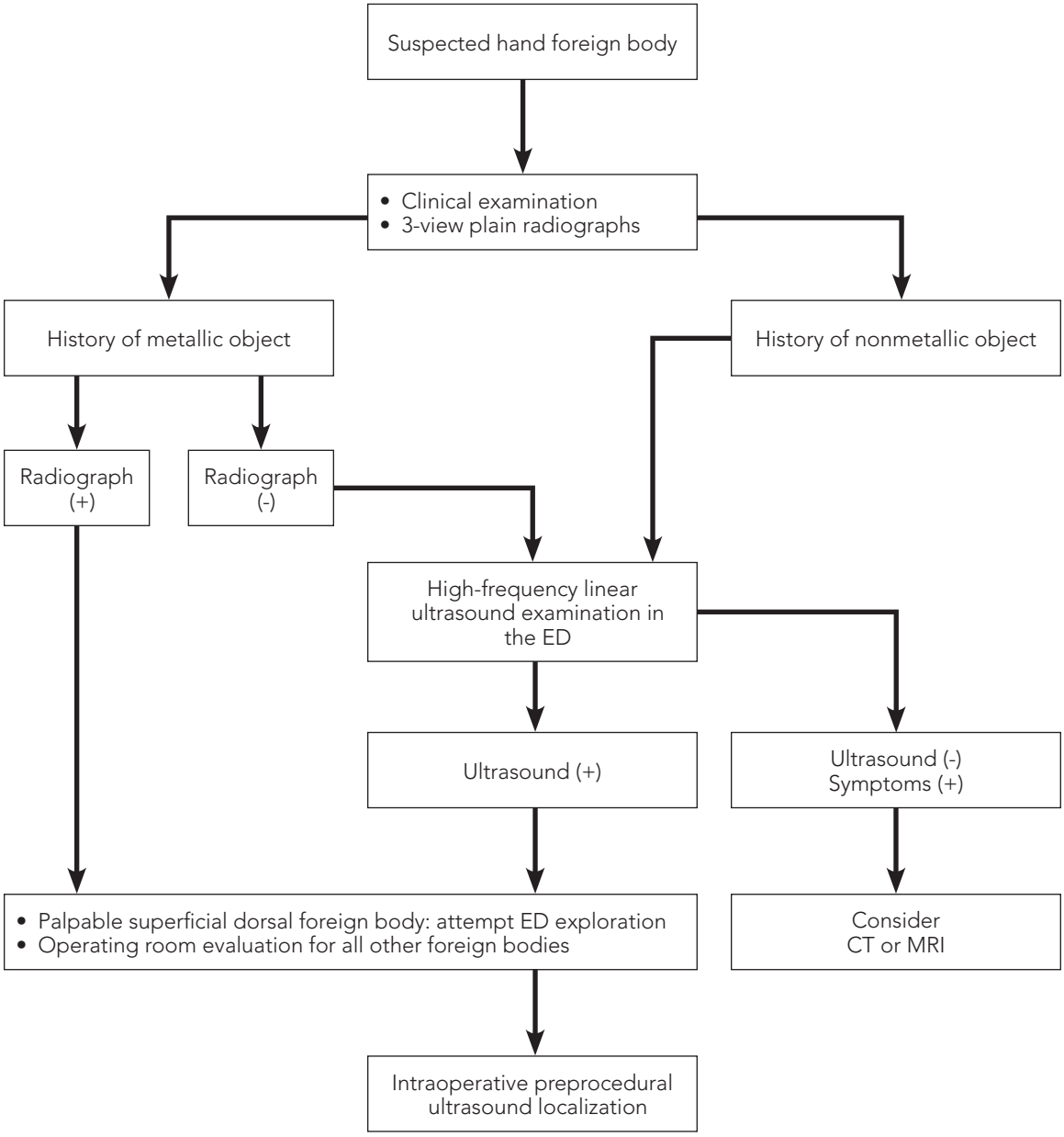
Up to 38% of foreign bodies are missed on initial physical examination; delay in management of a foreign body may lead to complications such as infection, delayed wound healing, inflammation, or loss of function.[21] Radiographs can be used to detect radiopaque foreign bodies. Ultrasound is useful for detecting radiolucent foreign bodies such as wood, plastic, or cactus spines.[22] However, ultrasound is operator dependent and cannot be relied upon to rule out foreign bodies conclusively.[22] Emergent magnetic resonance imaging and computed tomography should be obtained if there is concern for neurovascular compromise. Ipaktchi et al proposed an imaging algorithm to detect foreign bodies in the hand **(see Figure 1, page 7)**.[23] While this algorithm was developed in the context of wounds to the hand, it can be applied to other types of superficially located foreign bodies.

CASE 1

You decide that imaging is indicated for this patient because you are concerned for retained foreign bodies that may be missed on physical examination. You order radiographs of the hand to look for the presence of glass fragments. No fragments are detected on the x-rays, so you prepare to repair the laceration.

How should you cleanse and close this wound? Does the patient have any risk factors that should be taken into consideration?

Figure 1. Proposed Diagnostic Algorithm to Enhance the Detection of Radiolucent Foreign Objects in the Hand



Abbreviations: CT, computed tomography; ED, emergency department; MRI, magnetic resonance imaging.
Reprinted from Kyros Ipaktchi, Andrew DeMars, Jung Park, et al. Retained palmar foreign body presenting as a late hand infection: proposed diagnostic algorithm to detect radiolucent objects. *Patient Safety in Surgery*. 2013. Volume 7, Issue 1. Reproduced under a Creative Commons Attribution 2.0 Generic license. https://pssjournal.biomedcentral.com/articles/10.1186/1754-9493-7-25

Treatment

Patients with lacerations prioritize return to normal function, avoidance of infection, and cosmesis.[24] Therefore, treatment strategies should reflect these patient priorities. There are 3 methods used to close a wound: *primary closure*, *secondary closure*, and *delayed primary closure*. Primary closure with sutures, staples, or adhesives is recommended when acute wounds have adequate approximation. In secondary closure, the wound is allowed to heal with the formation of granulation tissue; this method is preferred when there is poor wound approximation, contamination, or delay in presentation. In delayed primary closure, the wound is cleaned and observed for several days, then surgically closed.

Closure Decisions and Time Since Injury

Time since injury is an important factor in determining whether or not a wound can be repaired using primary closure. The optimal or "golden period" for safe laceration repair is variable and dependent on wound site, wound length, and pre-existing conditions.[17] For many years, it was recommended that wounds should be closed within 6 hours of the injury, and a 1973 study linked wound infection with bacterial proliferation levels at 3 to 5 hours after injury.[25] However, more recent studies have found no difference in infection rates when wounds are closed more than 6 hours after injury.[26] In a 2010 study, researchers observed 425 patients with superficial, subcutaneous, deep cut, and crush wounds throughout the body. Forty-five patients had wounds older than 6 hours, including 5 patients with injuries sustained >19 hours prior to presentation. All patients were re-evaluated in 7 days. Only 3 of 45 wounds (6.7%) that were more than 6 hours old were infected, while 30 of 363 wounds (9.1%) that were closed before the 6-hour mark showed signs of infection. A 2012 meta-analysis of 4 studies with 3724 patients found no significant increase in infection rates when wounds were closed via primary closure after the cutoff periods set in the studies.[27]

A frequently cited study by Berk et al challenged the recommended 19-hour cutoff for wound closure except for wounds on the scalp or head, which could be closed beyond the 19-hour mark and did not have a "golden period."[28] However, the patient follow-up rate in this study was 54.8%, and the primary outcome was dehiscence rather than infection. Additionally, only clean, simple wounds were included due to a shortage of gloves and surgical supplies in the underdeveloped country where this study was conducted.[28]

As routine wound decontamination methods have improved over the past several decades, a greater number of wounds can be managed with primary closure, and there is no consensus on a true "golden period."[17] The American College of Emergency Physicians' clinical policy for penetrating injury of the extremity emphasizes that the decision on closure is multifactorial and cannot be made based on timing alone; instead, clinicians should consider age, wound location, degree of contamination, mechanism of injury, pre-existing disease, and the

patient's ability to adhere to follow-up care.[29] The policy states that most lacerations presenting within an 8- to 12-hour window can undergo primary wound closure safely, but also emphasizes that some more-contaminated wounds may become infected if repaired during this time period, while other wounds can be closed safely up to 24 hours post injury. Clinicians are advised to consider delayed primary closure in wounds of any age if primary closure poses a significant infection risk (eg, due to contamination or patient immune factors). In such cases, the wound could be cleaned and dressed with saline solution-soaked fine-mesh gauze, with the patient instructed to follow up in 72 to 96 hours for debridement, repeat cleansing, and delayed repair.[29]

The ideal treatment window for retained foreign body removal is within 24 hours of injury. This allows for visualization of the entry and exit wounds, as inflammation, induration, and scarring will not yet have developed.[22] Close outpatient follow-up for foreign bodies that cannot be removed in the ED is necessary, as delayed treatment may lead to complications such as infection, delayed wound healing, inflammation, and loss of function.[22]

Wound Irrigation

Wound irrigation is among the most important steps in wound care. Irrigation removes devitalized tissue, dirt, and bacteria.[30] Normal saline (NS) is most commonly used. However, there is evidence that the use of tap water for wound irrigation may be preferable as well as cost effective.[31-34] In a randomized controlled trial of 663 patients, Weiss et al found infection rates of 6.4% in wounds irrigated with NS and 3.5% in wounds irrigated with tap water.[34]

Effective irrigation is dependent on volume and pressure of the solution used. Irrigation volumes of 50 to 100 mL per cm of laceration length have been reported to be ideal. However, the volume of irrigation should be tailored to the wound characteristics and degree of suspected contamination.[35] Irrigating wounds at exceedingly high psi can damage tissue and impair its natural defenses.[36] Irrigating wounds with NS from syringes sized 20- to 65-mL is common. Singer et al found that both 35-mL and 65-mL syringes with a 19-gauge needle were effective at performing irrigation in the range of 25 to 35 psi, which is useful for contaminated wounds.[37] Irrigation at a pressure of 13 psi is effective for cleansing uncontaminated wounds without causing tissue trauma; this can be achieved using a 12-mL syringe and a 22-gauge needle.[38] Intravenous bags and plastic bottles achieve pressures of only 4 psi and 2.3 psi, respectively, and therefore their use should be discouraged.[37] No experimental or clinical data have demonstrated improved benefit from pulsed lavage versus continuous lavage for traumatic lacerations.[39]

Older literature found lower rates of infection in wounds cleansed with iodine as compared to those cleansed with NS,[40,41] but more recent studies have shown no difference in infection rates with the use of iodine versus NS.[42,43] In a study

comparing irrigation with NS, 1% povidone-iodine solution, or Pluronic® F-68 (Shur-Clens®) surfactant, no significant difference in infection rates was found among the cleansing agents.[44] A 2010 meta-analysis of 9 randomized controlled trials with 3614 patients compared the use of povidone iodine and chlorhexidine; chlorhexidine was shown to be more beneficial than iodine for preventing skin infections, while also resulting in cost savings.[45] However, this meta-analysis was focused on preoperative skin antiseptic use, which may not be comparable to wounds that present to the ED. The cytotoxic effects of antiseptic agents must also be considered, as those effects may impact wound healing.[46]

Aseptic Versus Sterile Technique

A systematic review and meta-analysis of 12,275 patients found no difference in infection rates with the use of sterile versus nonsterile gloves during wound closure.[47] Use of sterile gloves is no longer routinely recommended, but may be preferred by some clinicians due to closer fit for procedures.

Anesthesia

Most wounds require anesthesia for proper evaluation, irrigation, and cleansing. There are several methods available to anesthetize wounds, including topical agents, intradermal injections, regional nerve blocks, and procedural sedation in special circumstances.

Topical Anesthetics

The use of topical anesthetics is a safe, effective, and less painful method of anesthesia for many types of lacerations.[48] Topical anesthetics reduce the need for intradermal injections during suture repair and decrease patient discomfort if an injection is required.[49] Many studies have demonstrated equivalent or superior analgesic efficacy for topical formulations compared with conventional intradermal infiltration.[50] A 1980 study found that a topical solution of tetracaine, epinephrine/adrenaline, and cocaine (TEC or TAC) worked equally well for pain control as intradermal anesthesia, with a similar rate of infection.[51] A later study found that a solution of 4% lidocaine, 0.1% epinephrine/adrenaline, and 0.5% tetracaine (LET or LAT) worked equally as well as TEC, was less expensive, and did not involve the potential adverse effects of cocaine.[52] LET contains epinephrine, and caution must be used when applying it over areas of potential vascular compromise (eg, nose, digits, ears, penis). Use of LET is contraindicated on mucous membranes.[52-54]

A 2017 updated meta-analysis of 25 randomized controlled trials including 3278 patients determined that the application of a topical anesthetic was an effective, noninvasive method of obtaining anesthesia for superficial laceration repair. The study also pointed out that several cocaine-free alternatives were available and provided similar levels of anesthesia.[50] Although many studies of LET have focused on its use in younger children, a 2017 study by Vandamme et al showed that LET could also achieve pain control in children >8 years old and in adults.[55]

One major disadvantage of topical anesthetics is the slow rate of onset, which may be up to an hour.[53] Early application at triage may aid in offsetting this disadvantage.[53,54] Topical application of EMLA (eutectic mixture of local anesthetics) cream has also been shown to reduce pain before minor procedures.[53,54,56]

Intradermal Anesthesia

Injectable anesthetics remain the mainstay of treatment due to ease of use and time restraints in the ED. Lidocaine is the most commonly used local anesthetic in the United States today. Epinephrine is often added to lidocaine to prolong its action, reduce toxicity, and provide some degree of hemostasis in lacerations.[57] It is important to know the maximum doses of injectable anesthetics prior to their administration in order to prevent local anesthetic systemic toxicity, which is a rare but potentially life-threatening complication. **Table 1** provides dosing recommendations for commonly used local anesthetics.

Table 1. Dosing Recommendations for Commonly Used Local Anesthetics[57,58]

Agent	Maximum Dose Without Epinephrine	Maximum Dose With Epinephrine	Duration of Action	Notes
Lidocaine	5 mg/kg	7 mg/kg	30-90 min[a]	1% = 10 mg/mL 2% = 20 mg/mL
Bupivacaine	2.5 mg/kg	3 mg/kg	200 min+[a]	0.5% = 5 mg/mL
Mepivacaine	7 mg/kg	8 mg/kg	45-90 min	--
Ropivacaine	3 mg/kg	--	200 min+	--

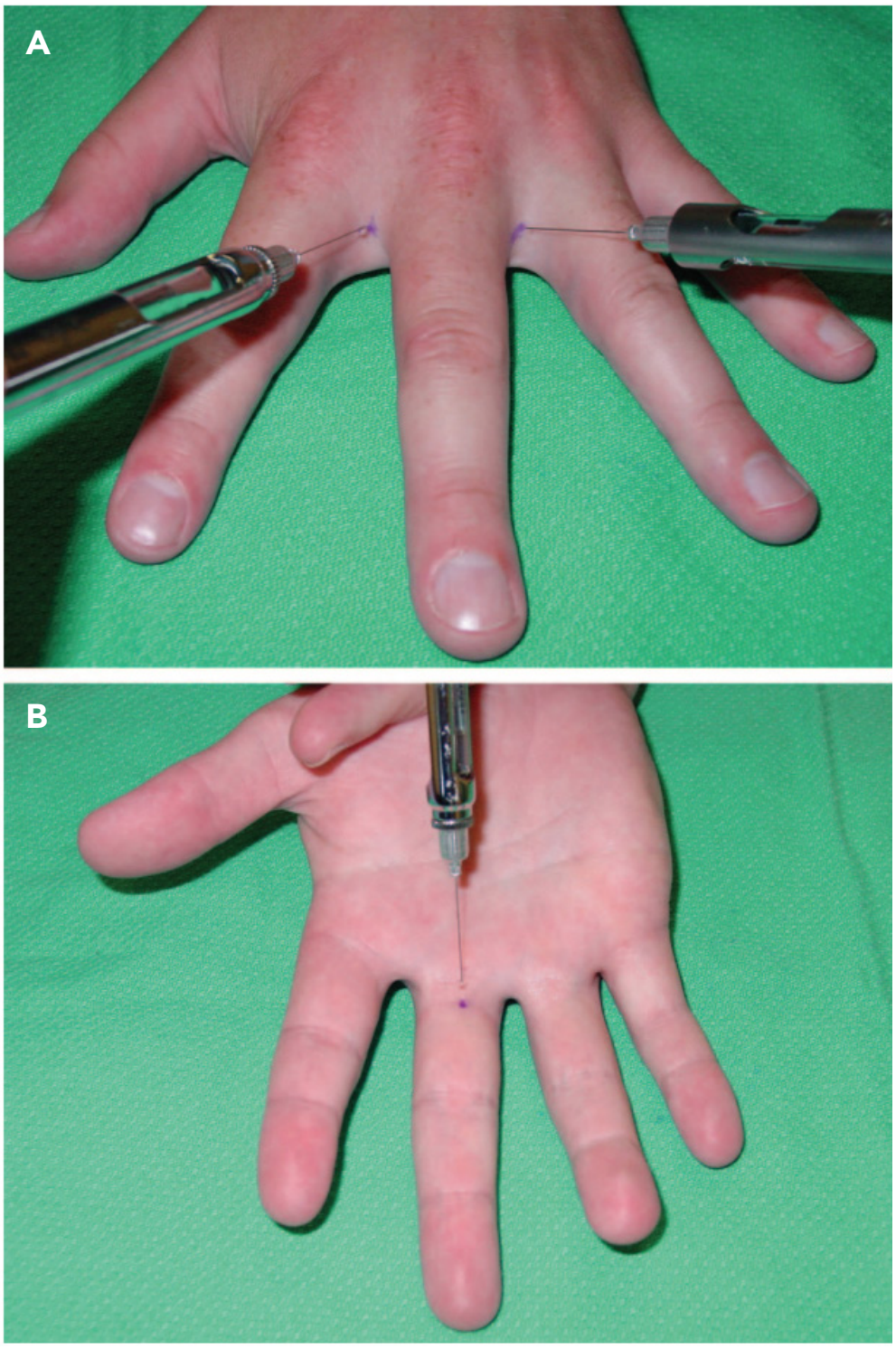
[a]Duration of action may be longer when used in combination with epinephrine.
Adapted from: https://rebelem.com/local-anesthetic-systemic-toxicity-last/
Used with permission of Dr. Anand Swaminathan and REBEL EM, https://rebelem.com/

Methods that can reduce pain associated with infiltration include slowing the rate of injection, injecting within the wound instead of through intact skin, warming the anesthetic, and buffering 1% lidocaine with sodium bicarbonate to increase the pH.[59-62] The use of cryotherapy (ie, applying an ice cube to the skin) for a duration of 2 minutes before subcutaneous local anesthetic injections can significantly reduce perceived pain from local anesthetic injections in patients presenting for repair of lacerations.[63]

Nerve Blocks

Regional nerve blocks are used to anesthetize areas that would require a large dose of intradermal anesthetic or multiple injections, or in areas of the body where it is preferable to avoid the distortion of tissue that can occur with local infiltration of anesthetics. Digital nerve blocks are useful for repair of wounds to the fingers or toes. While the 2-injection dorsal digital nerve block technique is often used, a single-injection volar digital nerve block is becoming more common. **(See Figure 2, page 12.)** This method achieves a similar level of anesthesia as the 2-injection technique.[64-66]

Figure 2. Digital Block Techniques



A. Two-injection dorsal approach digital block technique. The needle is inserted through the dorsal web space, and anesthetic is deposited on both sides of the digit with 2 separate injections.
B. Single-injection volar subcutaneous block technique. The needle is inserted into the subcutaneous space at the level of the proximal digital flexion crease in the midline midway between the neurovascular bundles.

Reprinted from Jason Williams and Donald Lalonde. Randomized comparison of the single-injection volar subcutaneous block and the two-injection dorsal block for digital anesthesia. *Plastic and Reconstructive Surgery,* Volume 118, Issue 5, pages 1195-1200, https://journals.lww.com/plasreconsurg/Abstract/2006/10000/Randomized_Comparison_of_the_Single_Injection.23.aspx Used with permission.

Typically, epinephrine is avoided at anatomical sites with end arteries due to concerns of ischemia and gangrene distal to the site of drug infiltration.[67] However, a meta-analysis of 4 randomized controlled trials found insufficient evidence to recommend use of or avoidance of epinephrine in digital blocks.[67] Additionally, a systematic review of 7 studies concluded that the use of lidocaine with epinephrine in standard commercial concentrations for digital blocks is not harmful and may have some advantages such as improved hemostasis, decreased anesthetic requirement, and increased duration of anesthesia.[68]

For additional information on topical anesthetics and regional nerve blocks, see the November 2019 issue of *Emergency Medicine Practice* titled, "Emergency Department Pain Management: Beyond Opioids," available at **https://www.ebmedicine.net/topics/pain-management/nonopioid**

Anesthesia Adjuncts and Procedural Sedation

Patient cooperation is necessary to ensure adequate repair of lacerations. While most adults do not require more than topical or intradermal anesthesia, additional medication may be needed for some patients. With appropriate training and protocols, inhaled nitrous oxide is considered safe for use in adults and children for analgesia and sedation during laceration repairs in the ED.[69] It has the advantage of being a sedative agent that does not require a painful injection, and it offers shallower levels of sedation than other methods and a rapid recovery of mental state.[70] Patients who require a more extensive repair or who are unable to cooperate with closure of the wound using the methods described in this section may require procedural sedation, which is beyond the scope of this review.

Sutures

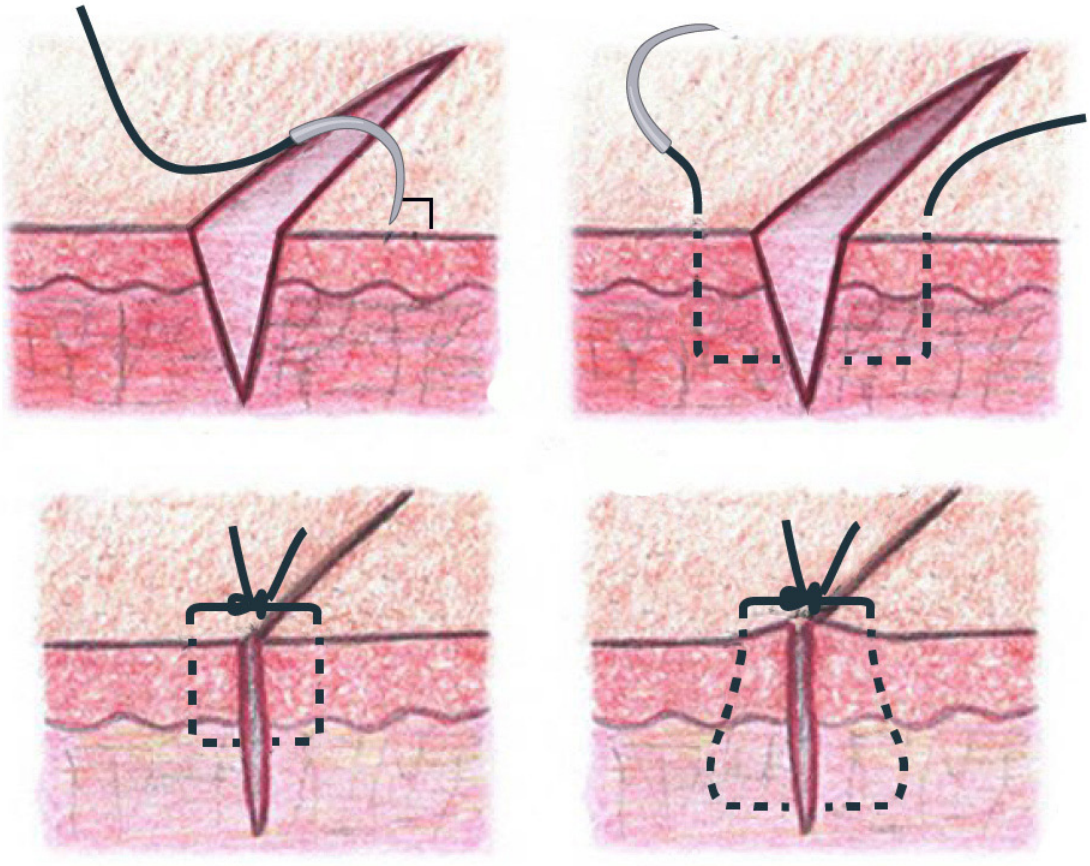
Among all wound closure methods, sutures are the strongest and most versatile, and allow for the most accurate approximation of wound edges. The first step in suturing is to determine which type of suture to use: absorbable or nonabsorbable. Absorbable sutures are made of synthetic polymers or collagen and are eventually degraded by enzymes, losing tensile strength within 60 days. An advantage of absorbable sutures is that patients do not need to return to the ED for suture removal. Nonabsorbable sutures are nonbiodegradable and maintain their tensile strength for >60 days. They are most often used to close the outermost layer of skin and are generally avoided in deep vascularized tissues. Monofilament material (nylon, polypropylene) is preferred for nonabsorbable sutures due to its strength and relatively low tissue reactivity.[71] Absorbable sutures are noninferior to nonabsorbable sutures for patient satisfaction and cosmetic outcome.[72] Some studies (although limited) showed no significant difference in any aspect of cosmesis, patient satisfaction, or infection when comparing absorbable and nonabsorbable sutures for facial wounds.[73]

The decision to use a specific suture type is often guided by the wound location. For high-tension wounds that will require suture strength for a longer period, the preferred material is polyglyconate (absorbable monofilament). For facial wounds, a fast-absorbing gut suture is best, as its time of retention of tensile strength and time needed for wound healing are similar.[74] Suture size also matters because of the potential for cosmetic injury. The smaller the suture size, the lower the tensile strength;[75] larger-diameter material produces more damage to the tissue and leaves larger holes in the skin, so the thinnest suture material should be used while ensuring appropriate tensile strength.

Simple Interrupted Suture

Simple interrupted sutures are appropriate for most wounds. The needle is introduced through the outer layer of the skin and exits at the level of the dermis on one side of the wound; the needle is then reinserted through the opposite wound edge at the level of the dermis, exiting through the superficial layer. To ensure proper wound eversion, the needle should enter and exit the skin at an equal distance from the wound and at an angle of 90 degrees. **(See Figure 3.)**

Figure 3. Simple Interrupted Suture



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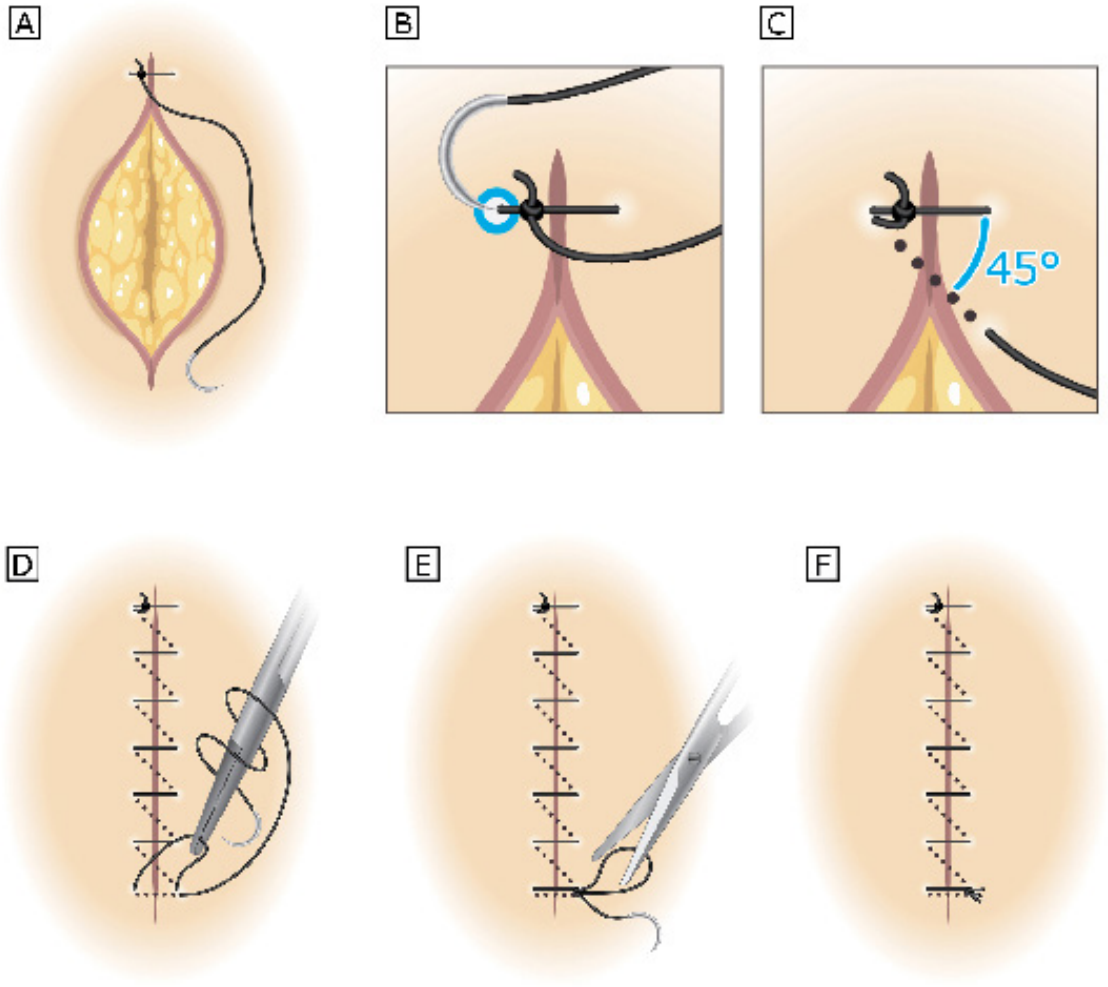
Continuous Running Suture

The continuous running suture technique is best used on long, linear lacerations. It can be performed rapidly, has an even distribution of tension across the wound, and the suture is not cut during wound closing. The running suture. This technique is contraindicated if there is a risk of hematoma formation, and it should not be used for wounds under tension; if a suture breaks, then the integrity of the closure is lost. To perform the procedure, a simple interrupted stitch is placed at the end of the laceration. After tying the knot, the suture is not cut and instead is reintroduced into the skin on the opposite side, pulling across the wound at a 45-degree angle. **(See Figure 4.)**

Figure 4. Continuous Running Suture

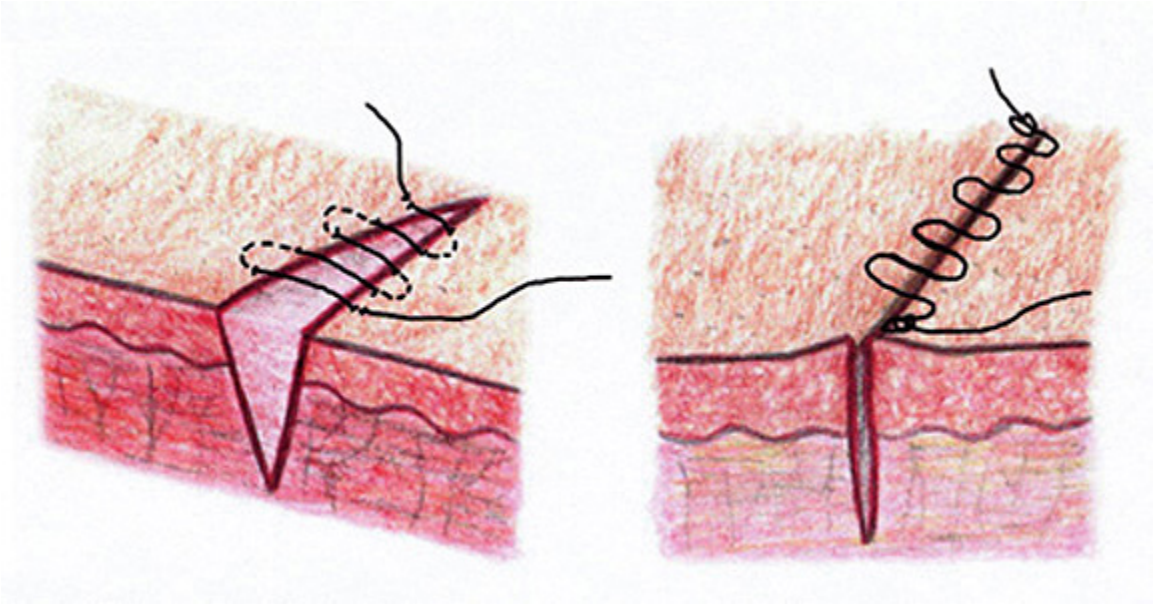


(A) The closure is started with the standard technique of a percutaneous simple interrupted suture, but the suture is not cut after the initial knot is tied. (B and C) The needle is then used to make repeated bites, starting at the original knot by making each new bite through the skin at an angle of 45 degrees to the wound orientation. (D) The cross stays on the surface of the skin will be at an angle of 90 degrees to the wound. (E and F) The final bite is made at an angle of 90 degrees to the wound orientation to bring the suture out next to the previous bite. The final bite is left in a loose loop, which acts as a free end for tying the knot.

Running Subcuticular Suture

The running subcuticular suture is one of the more complex wound closure techniques and requires taking horizontal bites through the dermis on alternating sides of the wound. First, an anchor knot is placed on the edge of the wound. Without cutting the suture, horizontal bites are made at the dermal-epidermal junction. When the last bite is taken, a loop is left in the suture and is used as a tail to tie the knot. The benefit of this technique is that it eliminates the bite marks made by percutaneous sutures and provides close approximation of the wound edges. **(See Figure 5.)**

Figure 5. Running Subcuticular Suture



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Mattress Suture

Mattress sutures are best used for areas that are under increased tension. The vertical mattress suturing technique involves placing a simple interrupted stitch wide and deep into the wound; a second, more superficial interrupted stitch is placed closer to the wound in the opposite direction. **(See Figure 6, page 17.)** Vertical mattress sutures are useful in thin or lax skin.

Horizontal mattress sutures also use a simple interrupted suture; however, before tying the knot, another bite is taken on the same side as the suture line, lateral to the exit point and passing to the other side, where the knot is tied. **(See Figure 7, page 17.)** A horizontal mattress suture is a good technique for closing wounds with poor circulation at the wound edges.

Figure 6. Vertical Mattress Suture

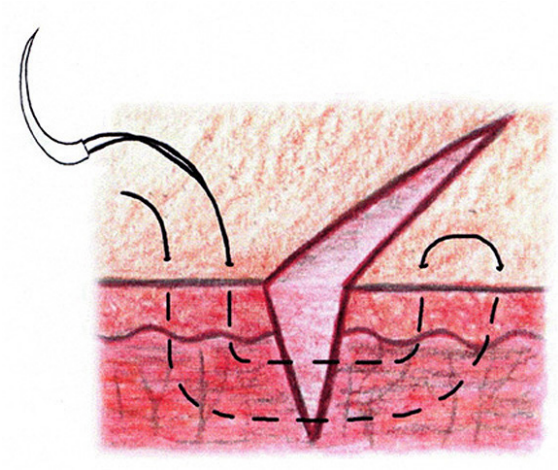

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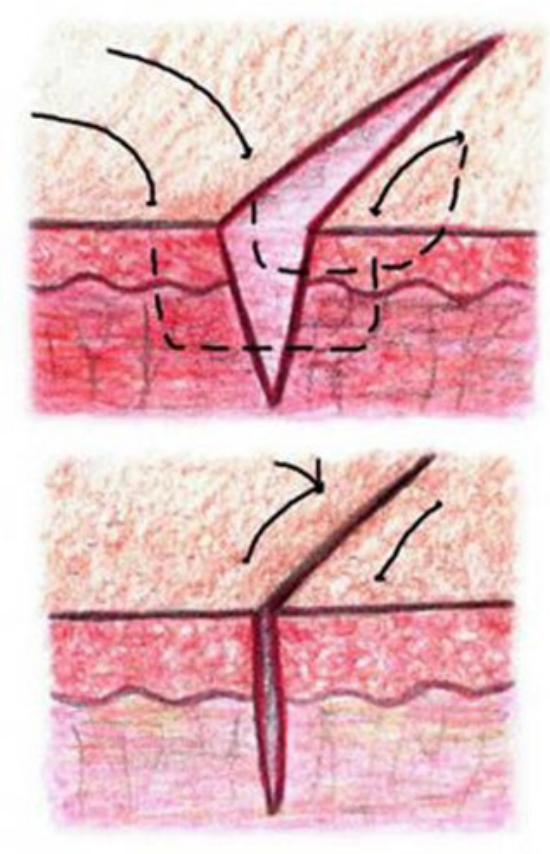
Figure 7. Horizontal Mattress Suture



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Corner Stitch

For a patient who has a stellate or X-shaped laceration, the half-buried mattress or corner stitch is the ideal technique. The corner stitch should be placed first to approximate the flap edge. The remainder of the wound can be closed using simple interrupted sutures. To perform the procedure, the needle is introduced through one side of the wound, then passes horizontally through the flap at the level of the dermis. The technique is completed by exiting the skin through the other side and tying the knot. **(See Figure 8, page 18.)**

Tissue Adhesive

Tissue adhesives are made from liquid monomers that polymerize into a stable bond when they come into contact with moisture.[76] The adhesive lasts for approximately 5 to 10 days and gradually sloughs off as new epithelial skin grows. Tissue adhesives are easy to use, do not require anesthesia, take less time to apply than suturing, and provide favorable cosmetic results.[77]

Figure 8. Corner Stitch

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Tissue adhesives are best for low-tension wounds with linear edges; they are similar in strength to size 4-0 sutures.[78] When applying the adhesive, the wound should be held together so that the margins are well approximated, as adhesive in the wound could lead to an adverse reaction.[79] If adhesive is introduced to the wound, it should be wiped away immediately with dry gauze. If the adhesive has already polymerized, a petroleum-based product such as an antibiotic ointment or petroleum jelly can be used to remove it.[80]

Tissue adhesives have the additional benefit of having some bacteriostatic effect.[81] However, a systematic review of 11 studies found there was a small but statistically significant increased rate of dehiscence and erythema when using tissue adhesive.[82]

Staples

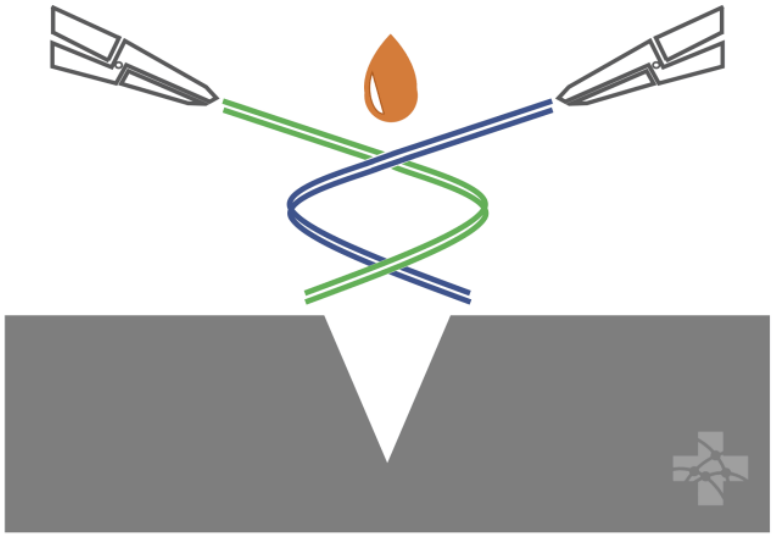
Staples are quick, easy to use, and can be cost-effective. However, among the closure methods, staples are the least precise and should be limited to use for linear and nonfacial lacerations. Staples should not be used on the face, neck, hands, or feet. When placing staples, have staple removal kits on hand so that

any misfired or misplaced staples can be removed. A meta-analysis of randomized controlled trials involving the closure of surgical wounds found that staples had a decreased infection rate but less favorable cosmetic outcomes as compared to sutures.[83,84]

Hair Apposition

The hair apposition technique allows for a faster and more cost-effective approach than traditional methods for closing scalp lacerations.[85] In order to use this technique, the wound should be simple and noncontaminated, and have no active bleeding and enough hair near the wound to twist.[86] After the wound is cleaned and prepared, several strands of hair from opposite sides of the wound are twisted around each other 360 degrees. **(See Figure 9.)** Once the hairs are twisted together, tissue adhesive should be applied to the twist to keep it in place. The patient will not need a return visit, as the tissue adhesive will dissolve and the hair will untwist itself in time. The hair apposition technique is less expensive, less painful, and faster than other techniques.[87,88]

Figure 9. Hair Apposition Technique



Source: https://www.aliem.com/trick-of-trade-modified-hair-apposition/
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Adhesive Tape

The application of adhesive tape is a simple, painless, and quick method of laceration repair. The drawback is that the tape falls off easily when placed under any tension or exposed to moisture. Topical liquid adhesives such as benzoin or Mastisol® can be used to increase adhesion if there is concern that the tape will come off.[89] Adhesive tape should only be used for simple wounds that are under low tension, or for superficial skin tears.

Adhesive tape should be placed perpendicular to the wound with about 2 mm of space between each piece of tape. The cosmetic outcome of using tape for closure of small wounds (<4 cm in length) is similar to the outcome with use of cyanoacrylate tissue adhesives.[90] When treating an elderly patient or a patient with thin skin who may need sutures as well, it may be helpful to first place the adhesive tape perpendicular to the wound, then suture through the tape; the tape helps to hold the sutures in place and prevents them from shearing through the skin.[91]

Prophylactic Antibiotics

Prophylactic antibiotics are not recommended for routine use in wound care.[92] Appropriate wound cleaning has been shown to be most important for decreasing post-repair wound infections.[93,94] However, prophylactic antibiotics do have a role in select circumstances, such as in the presence of infection-potentiating factors or mechanisms of injury, or in injured persons with predisposition to infection.[95,96] Antibiotics should be given to patients with bite wounds on the hand, human or cat bite wounds, deep dog bite wounds, wounds with open fractures, or wounds with exposed joints or tendons.[97,98]

Topical antibiotic ointments are used in wound care as a form of barrier protection and prophylaxis. One study found topical antibiotics to be effective at preventing wound infection,[99] and a meta-analysis found that skin infection is less likely to occur with the use of topical antibiotics than without it.[100] In addition to providing a barrier to infection, topical ointments create a moist environment that leads to better wound healing and easier removal of sutures.[101]

CASE 1

For your patient who had sustained a laceration on the hand from broken glass, you closed the wound using the horizontal mattress technique with absorbable sutures. Because the patient had multiple risk factors for infection (diabetes, advanced age, and the location of the wound on an area other than the head or neck), you prescribed prophylactic oral antibiotics; you also administered a tetanus vaccination due to his age and inability to confirm his vaccination status.

Post-Repair Wound Care

The sutured or stapled area that was repaired should be covered with a nonadherent dressing for 24 to 48 hours. A moist environment increases the rate of epithelization and a covered wound has been shown to heal faster than an exposed wound.[102] Post-repair instruction has typically included keeping the wound covered for 48 hours, with the dressing replaced periodically thereafter; however, more recent data on surgical site dressings have shown no detrimental effects from keeping the dressing on for <48 hours, without replacement after that period.[103]

Repaired lacerations can be cleansed with tap water 8 hours after closure without increased infection rates.[104] Patients should be instructed to use soap and tap water to cleanse the wound, then blot gently to dry the area.[105] A study comparing early (≤12 hours after repair) and delayed (>48 hours after repair) showering found no statistically significant difference in infection rates between the early and delayed groups.[106]

Sun Exposure

A healing laceration should not be exposed to direct sunlight because of the risk for hyperpigmentation.[107] Although the supporting data are not robust, it is reasonable to recommended that patients use sunscreen on healing lacerations or abrasions to help prevent the development of hyperpigmentation.[108]

Special Circumstances

Specialist Consultation

Most lacerations can be repaired in the ED by an emergency clinician, but there are several indications for specialist consultation, including wounds with joint involvement, neurovascular injury, tendon/muscle injury, retained foreign bodies, or amputation, as well as wounds resulting from blast or high-pressure injury. Lacerations on the eyelid, medial canthus, lip, hand, and some intraoral wounds may also require specialist consultation due to the close association between the quality of closure and subsequent cosmesis and function.[109] The type of specialist to be consulted will depend on the laceration location, mechanism of injury, and deeper structure involvement, as well as specialist availability and hospital policy. Specialists in plastic surgery, general surgery, orthopedics, oral-maxillofacial surgery, and otolaryngology are most likely to be consulted for wound management.[110]

Facial Lacerations

Facial lacerations can range from simple cutaneous lacerations to more complex injuries such as on the ear, eyelid, or nose. While most patients with traumatic lacerations tend to prioritize function and avoidance of infection, patients presenting with facial lacerations are often most concerned with cosmetic outcome.[24]

CASE 2

A 19-year-old woman presents to the ED with a laceration through the vermillion border of her upper lip. She tells you that she sustained the laceration approximately 23 hours earlier while playing softball.

Given the location of the laceration and the length of time since the injury, is primary closure appropriate for this wound?

There are several options for primary closure of simple cutaneous lacerations on the face. In a small survey of emergency clinicians regarding the choice of closure method for facial lacerations, tissue adhesive was the method used most commonly (32% of closures), followed by sutures (30%);[111] the third most common method was a combination of tissue adhesive and Steri-Strips™ adhesive strips (18.6%).[111] The depth (48%) and site (23%) of the laceration were the most common reasons given for selecting a particular closure method.[111]

"No-needle" alternatives such as a combination of tissue adhesive and adhesive strips can be preferable to suturing facial lacerations.[112] These methods decrease the associated pain, the time spent in the ED, and the need for a follow-up visit for the patient, while also reducing the use of resources in the ED. "No-needle" methods are also beneficial in patients prone to keloids or hypertrophic scar formation.[113] In a head-to-head comparison of tissue adhesive to adhesive strips, there was no difference in cosmetic outcome as determined by both patients and plastic surgeons.[112]

If suturing is the selected method of closure, the smallest possible suture that can withstand the wound tension should be utilized. Size 5-0 and 6-0 sutures are recommended for epidermal closure, but specific recommendations vary depending on the injury location within the face.[114] **(See Table 2.)**

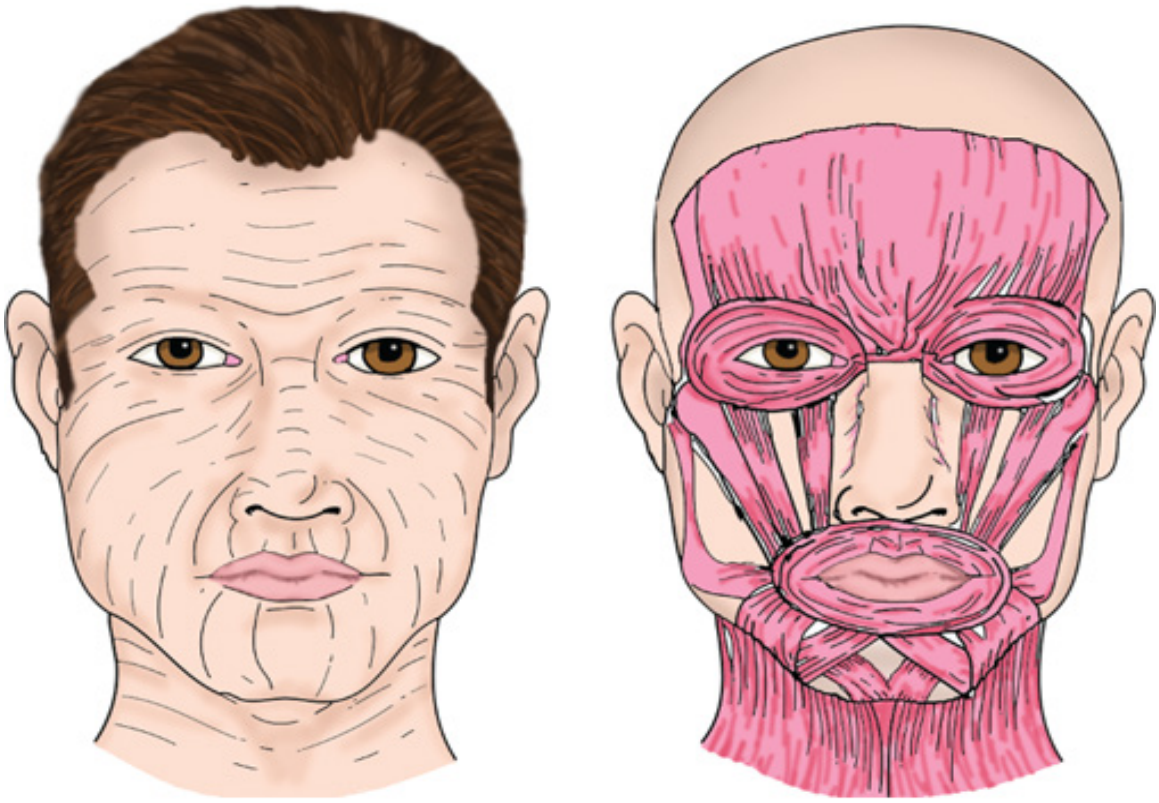
Table 2. Optimal Suture Material for Facial Wounds

Site of Injury	Optimal Suture Size	Optimal Suture Material(s)	Good Alternative Choice
Cheek, forehead, nose skin	5-0, 6-0	Nylon, prolene	Cat gut or chromic for pediatric patients or patients who will not return for removal
Ear skin	4-0	Nylon	Chromic
Eyelid skin	6-0, 7-0	Vicryl	Chromic
Frontalis (forehead) muscle	3-0, 4-0	Vicryl	Chromic
Galea	3-0, 4-0	Vicryl	Chromic
Lip or intraoral mucosa	4-0	Chromic	Vicryl
Lip muscle	4-0	Vicryl	Chromic
Lip skin	5-0, 6-0	Nylon	Chromic
Nasal mucosa	5-0	Chromic	None
Scalp skin	3-0, 4-0	Nylon, staples, chromic	None
Subcutaneous tissue	4-0, 5-0	Vicryl	Chromic

Prolene can be substituted whenever nylon is recommended.
Data from Semer NB. Practical plastic surgery for non-surgeons. Philadelphia: Hanley and Belfus; 2001.
Adapted from *Emergency Medicine Clinics of North America,* Volume 31, Issue 2, Frank Sabatino and Joshua B. Moskovitz, "Facial Wound Management," Pages 529-538, Copyright 2013, with permission from Elsevier.

For facial lacerations, particular attention should be paid to involvement of any muscles of facial expression, which should be tested during the initial evaluation of the wound and prior to any closure.[114] In general, repair of facial lacerations with orientation parallel to skin tension lines (and therefore perpendicular to the fibers of facial muscles) result in the best cosmetic outcomes.[113] The orientations of skin tension lines and facial muscle fibers are illustrated in **Figure 10**.

Figure 10. Skin Tension Lines



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Eyelid Lacerations

Eyelid structures are delicate and are organized in 5 layers: skin, subcutaneous tissue, orbicularis oculi muscle, tarsal plate, and conjunctiva.[113] These layers are closely involved with other structures of the eye so care must be taken when repairing eyelid lacerations. The orbicularis oculi muscle fibers not only control eyelid closure, but also form the medial and lateral canthi and interact with the lacrimal ducts; the meibomian glands and eyelash follicles are found within the tarsal plate.

Superficial lacerations without involvement of other layers or structures can be repaired by the emergency clinician using size 6-0 or 7-0 sutures. Tissue adhesive should be avoided in or around the eye and eyelid. Eyelid lacerations that are

accompanied by ptosis, disruption of the lid margin, injury to the lacrimal duct, or involvement of the conjunctiva or tarsal plate of the lid should prompt consultation with an ophthalmologist or oculoplastic specialist. A wound within 8 mm of the medial canthus should prompt concern for lacrimal duct injury. Failure to recognize these injuries and consult appropriately can result in negative cosmetic and functional outcomes.[109,112,113]

Intraoral Lacerations

Intraoral lacerations may occur on the buccal mucosa or on the mucosal reflections, with lacerations on the reflections easily missed. The oral mucosa, similar to other mucosal surfaces within the body, is highly vascular and therefore quick to heal. Small intraoral lacerations do not necessarily require repair, but all lacerations require proper irrigation and inspection for foreign bodies such as tooth fragments and food particles.[113,114] Indications for repair include wound length >2 cm, the presence of a tissue flap that interferes with chewing, or a laceration large enough to trap food particles.[109,113] Similar guidelines should be followed regarding tongue lacerations: small lacerations (<1 cm) and nongaping wounds do not need to be closed primarily.[109] Intraoral lacerations that require repair should be closed with chromic gut sutures. Proper oral hygiene during healing should be encouraged. Prophylactic antibiotics have been advised for intraoral lacerations due to concern for infection, but there is little high-level evidence available to guide this practice.[115]

Lip Lacerations

The skin, vermillion (red portion of the lip), and mucosa are the 3 anatomical portions that compose the lip.[112,114] Lacerations that traverse the vermillion border (where the skin and vermillion meet) are of particular concern, as the quality and precision of the repair will impact both cosmesis and function.

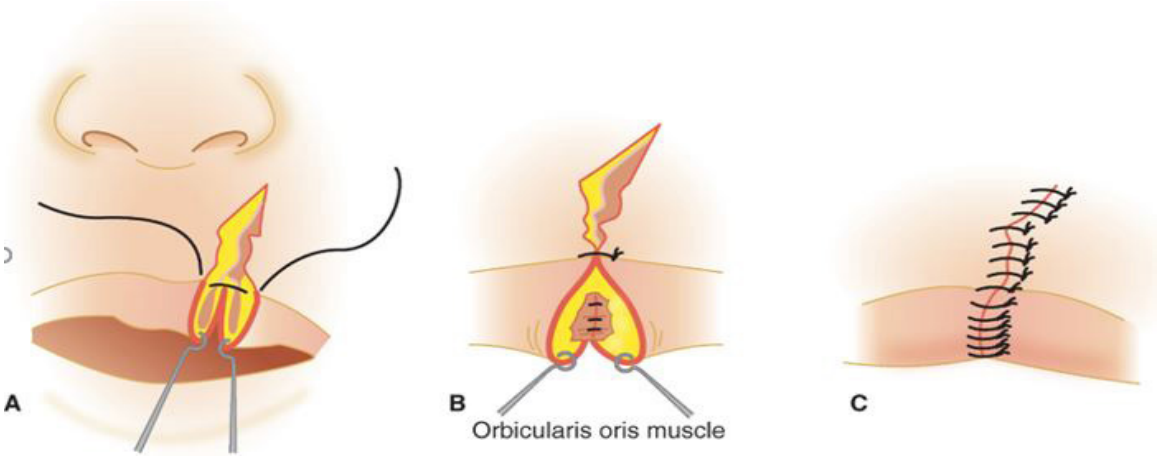
Anesthesia to the upper and lower lips can be achieved with infraorbital and mental nerve blocks, respectively.[109] Mucosal lacerations, as with intraoral lacerations, do not require primary closure if the laceration is small and there is satisfactory spontaneous approximation of the wound edges. Small-caliber (5-0) absorbable sutures can be utilized for mucosal lacerations requiring repair, with care taken to place sutures close to the wound edges (within 2-3 mm) to prevent puckering of the external skin or involvement of adjacent structures.

Through-and-through lip lacerations should be repaired in layers, beginning with the mucosal layer. After the mucosal layer is repaired, the laceration should be reirrigated from the skin side, followed by closure of the orbicularis oris muscle, and then the skin layers.

Repair of lip lacerations that involve the vermillion border need near-exact approximation; the most minute misalignment can be drastically noticeable and cosmetically unattractive.[109] First, the wound edges of the vermillion border

should be approximated with a single stitch that can be left untied. Leaving the suture untied ensures that precise alignment is maintained during closure of the underlying tissue and that any necessary adjustments can be made during the repair.[113,114] Using a surgical marker to mark the edges of the vermillion border can aid in precise alignment. The orbicularis oris muscle should be repaired next, followed by the remainder of the vermillion and skin, then the vermillion border stitch can be tied off. **(See Figure 11.)**

Figure 11. Lip Laceration Repair



A. The first suture is placed to align the vermilion skin junction.
B. The orbicularis oris muscle fascia is then repaired with 5-0 absorbable sutures.
C. The irregular edges of the skin are then approximated with 6-0 nonabsorbable sutures.
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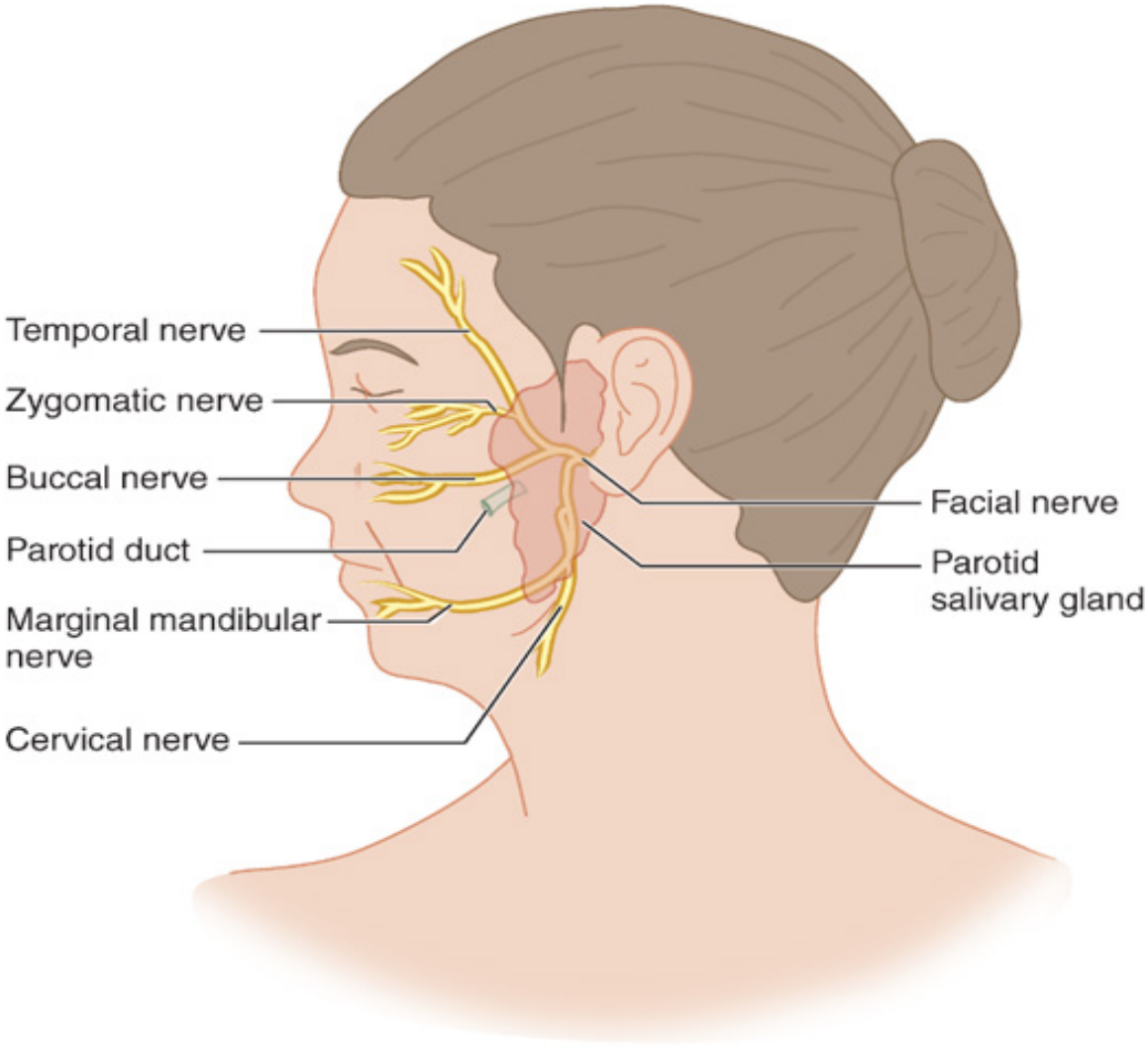
Cheek Lacerations

The parotid glands and the facial nerves require special consideration when evaluating lacerations to the cheek and face. The parotid gland is located within the cheek, beginning deep in the preauricular area and terminating via the parotid duct near the second maxillary molar. **(See Figure 12, page 26.)** Facial paralysis or arterial bleeding should raise suspicion for facial nerve or parotid duct injury and should prompt specialist consultation. Parotid duct injury can be evaluated by visualizing with a catheter inserted intraorally into the parotid duct papilla. If direct visualization is difficult or obscured, saline injected in the catheter and observed within the wound can confirm parotid duct injury.

Uncomplicated lacerations to the cheek without involvement of deeper structures can be repaired by the emergency clinician. Injury to structures such as the facial nerve or parotid duct should prompt specialist consultation, as operative repair may be required.[113] Through-and-through lacerations of the cheek should be repaired in layers, beginning intraorally. The cheek laceration should be re-irrigated after the buccal mucosa has been closed, and then the subcuta-

neous layers and skin can be closed.[113] Pre- and post-repair testing of the facial nerve is advised.

Figure 12. Cheek Anatomy



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CASE 2

Because your patient with a lip laceration presented 23 hours after the injury occurred, you had some concern about the safety of primary closure for this wound. However, you recognized that proper alignment of the vermillion border is critical for adequate function and cosmesis following lip lacerations, so primary repair was likely the appropriate management choice. Although you were familiar with the technique for repairing a lip laceration involving the vermillion border, you decided it would be best to call for a plastic surgery consultation.

Controversies

Absorbable Sutures for Percutaneous Closure

A prospective, randomized controlled trial of pediatric patients presenting with traumatic lacerations found that repair with absorbable sutures resulted in improved cosmesis and reduced frequency of wound dehiscence; however, these results did not reach statistical significance, and a large proportion (34%) of patients were lost to follow-up.[116] A 2014 randomized controlled trial including both adults and children found no difference in cosmetic outcome between lacerations repaired with Vicryl-Rapide™ (polyglactin 910) absorbable sutures and lacerations repaired with Prolene® (polypropylene) nonabsorbable sutures in a blinded evaluation by plastic surgeons at 3 months post repair. There was also no statistically significant difference in wound complications such as infection and dehiscence.[117] Other studies have produced similar results, establishing noninferiority of the use of absorbable sutures for laceration repair in the ED.[118,119] Absorbable sutures should be considered for use in the pediatric population and in patients with suspected or demonstrated poor compliance.

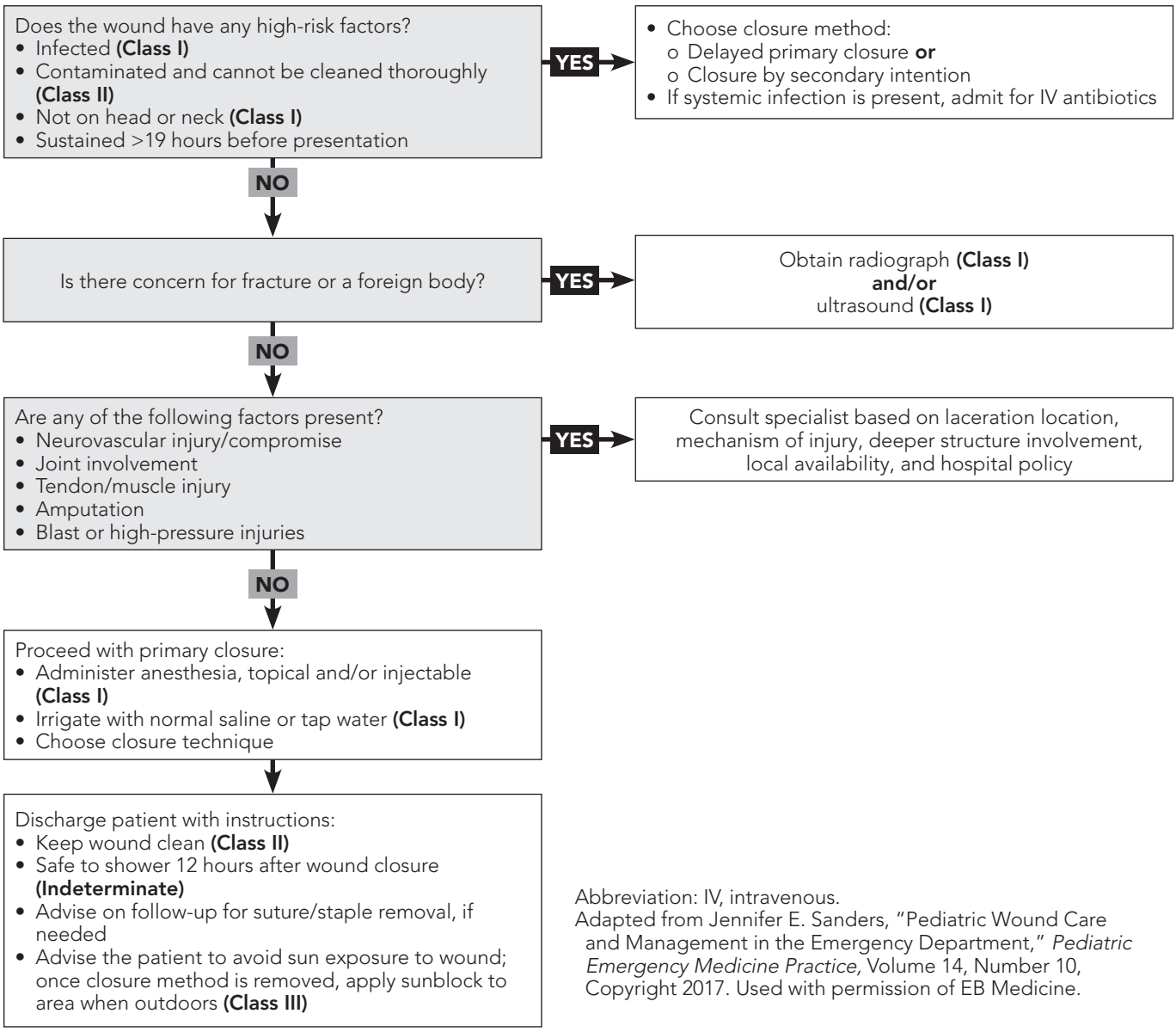
Disposition

The vast majority of lacerations can be repaired in the ED, with safe discharge home after repair. Patients discharged from the ED should be provided with basic wound care instructions including expected healing course and any follow-up requirements. For wounds repaired with nonabsorbable sutures, patients should be instructed to follow up for suture removal.

Time- and Cost-Effective Strategies

- Multiple studies have shown that tap water may be preferable to NS for wound irrigation; there is no change in infection rates as compared to the use of NS and it is more cost effective.[31-33]
- Virtual visits for wound rechecks to ensure that lacerations are healing properly can be time- and cost-effective.[120]
- Application of tissue adhesive is a time-saving alternative to suturing for repair of low-tension wounds with linear edges.[77,78]
- The hair apposition technique allows for a faster and more cost-effective approach than traditional methods for closing scalp lacerations.[85]

Clinical Pathway for Management of Acute Traumatic Wounds in the Emergency Department



Abbreviation: IV, intravenous.

Adapted from Jennifer E. Sanders, "Pediatric Wound Care and Management in the Emergency Department," *Pediatric Emergency Medicine Practice*, Volume 14, Number 10, Copyright 2017. Used with permission of EB Medicine.

Class of Evidence Definitions

Each action in the clinical pathways section of *Emergency Medicine Practice* receives a score based on the following definitions.

Class I
- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness

Level of Evidence:
- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

Class II
- Safe, acceptable
- Probably useful

Level of Evidence:
- Generally higher levels of evidence
- Nonrandomized or retrospective studies: historic, cohort, or case control studies
- Less robust randomized controlled trials
- Results consistently positive

Class III
- May be acceptable
- Possibly useful
- Considered optional or alternative treatments

Level of Evidence:
- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

Indeterminate
- Continuing area of research
- No recommendations until further research

Level of Evidence:
- Evidence not available
- Higher studies in progress
- Results inconsistent, contradictory
- Results not compelling

1. **"My patient said he still felt a foreign body near his wound, but I didn't see anything, so I proceeded with the laceration repair."**
   There should be a high index of suspicion for a retained foreign body in a wound, if the mechanism of injury supports it. Appropriate imaging, including x-rays, ultrasound, and computed tomography or magnetic resonance imaging (if necessary) should be used, as indicated by the history and type of potential foreign body.

2. **"My patient has diabetes but the laceration on her hand looked fine after I sutured it. I advised her to have the sutures removed in 7 to 10 days."**
   There is a higher risk of wound infection associated with diabetes, advanced age, larger wound size, contamination, and a location not on the head or neck. Other conditions that impair wound healing include renal failure, obesity, malnutrition, and immunocompromised status. Prophylactic antibiotics should be considered for patients with these risk factors.

3. **"The patient was in too much pain to move her finger so I could examine it, so I just sutured the laceration and told her to follow up with her primary care provider."**
   Assessment for fractures, neurovascular compromise, and injury to tendons and other adjacent structures is an important component of wound evaluation. Pain control and administration of an anesthetic may be required before a patient can cooperate fully with the examination.

4. **"The laceration looked really dirty, so I decided to clean and irrigate it with iodine."**
   There is no significant difference in rates of infections with the use of antiseptics for irrigation versus NS or tap water. Antiseptics may impede wound healing due to cytotoxic effects.

5. **"My patient was anxious to be discharged quickly, so I repaired his complicated lip laceration myself."**
   Proper alignment of the vermillion border in lip laceration repairs is critical, as a 1 mm misalignment can be detrimental to both cosmesis and function. Specialist consultation should be considered for lacerations that violate the vermillion border, the eyelid margin, the lacrimal duct, or the tarsal plate, or for injuries that result in ptosis.

6. **"It was a really busy shift and the laceration looked typical to me. I didn't ask in detail how the patient came to be injured."**
   Certain mechanisms of injury, such as high-pressure injuries, require surgical consultation for potential operative debridement. The extent of tissue damage may not be readily apparent on initial visual inspection.

7. **"The laceration appears to be under some tension, but this adhesive should work just fine."**
   Tissue adhesive should be limited to use in low-tension linear wounds. Wounds under high tension or with jagged edges will likely respond poorly to repair with adhesives.

8. **"The wound looks okay, but I'll give the patient some antibiotics just in case."**
   Prophylactic antibiotics are not recommended for routine use in wound care.[92] Antibiotics have a role in management of wounds that are at high risk for infection.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study is included in bold type following the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, are noted by an asterisk (*) next to the number of the reference.

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CME Questions

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1. **Which of the following factors does NOT contribute to impaired wound healing?**
   A. Diabetes
   B. Obesity
   C. Location of the wound in an area other than the head or neck
   D. Hypertension

2. **Which of the following statements regarding wounds with a possible retained foreign body is CORRECT?**
   A. Radiographs can be used to rule out any type of foreign body.
   B. Ultrasound can be a useful adjunct for detection of nonradiopaque foreign bodies.
   C. Radiographs will always detect a foreign body that is made of wood or plastic.
   D. If there is no palpable foreign body after irrigation, a retained foreign body can be ruled out.

3. **Which of the following fluids has been shown to be as effective as normal saline for wound irrigation?**
   A. Chlorhexidine
   B. 1% povidone-iodine solution
   C. Tap water
   D. Hydrogen peroxide

4. **Which of the following suture techniques is likely to result in the best cosmetic outcome?**
   A. Simple interrupted suture
   B. Corner stitch
   C. Vertical mattress suture
   D. Running subcuticular suture

5. Which of the following patients should receive prophylactic antibiotics?

A. A patient with diabetes who has a bite wound to the hand.
B. A patient who has superficial intraoral lacerations.
C. A patient who has a deep scalp laceration that has been well irrigated and repaired.
D. A patient who has a laceration above the elbow with no joint involvement.

6. Which of the following lacerations would NOT require specialist consultation?

A. Eyelid laceration accompanied by ptosis
B. Cheek laceration with arterial bleeding
C. Oral mucosal laceration measuring 2 cm in length
D. Laceration involving the medial canthus

7. Which of the following statements regarding facial lacerations is CORRECT?

A. Facial lacerations with orientation perpendicular to skin tension lines result in the best cosmetic outcome.
B. The largest possible suture that can withstand the wound tension should be utilized when repairing a facial laceration.
C. Facial muscle paralysis may indicate injury to the parotid duct.
D. Any deep lip lacerations require repair to the orbicularis oculi muscle.

Answer Key

1. **Answer: D.** Higher rates of infection are associated with age, diabetes, larger wound size, contamination with foreign material, and location of the wound in an area other than the head or neck. Other conditions that impair wound healing include renal failure, obesity, malnutrition, and immunocompromised status. See the **Emergency Department Evaluation – History** section for more information.

2. **Answer: B.** If there is concern for a radiopaque foreign body, plain films are indicated. Ultrasound is useful in detecting nonradiopaque foreign bodies; radiolucent objects such as wood, plastic, and cactus spines are detectable with ultrasound. [22] However, ultrasound is operator dependent and cannot be relied on to rule out a foreign body.[22] If indicated, magnetic resonance imaging or computed tomography may aid in the diagnosis of a retained foreign body or other injuries. See the **Diagnostic Studies – Imaging Studies** section for more information.

3. **Answer: C.** Normal saline is most commonly used to irrigate wounds, but multiple studies have shown that irrigation with tap water has a similar rate of infection and is more cost effective. See the **Treatment – Wound Irrigation** section for more information.

4. **Answer: D.** The running subcuticular suture uses horizontal bites through the dermis, eliminating bite marks through the skin and achieving optimal wound approximation. See the **Treatment – Sutures – Suture Techniques** section for more information.

5. **Answer: A.** Prophylactic antibiotics are not recommended for routine use in wound care but do have a role in some circumstances, such as the presence of infection-potentiating factors or in patients with predisposition to infection. Antibiotic prophylaxis is recommended for human bites, cat bites, deep dog bites, bite wounds on the hand, open fractures, and wounds with exposed joints or tendons, as well as for wound closure on a lymphedematous area. See the **Treatment – Prophylactic Antibiotics** section for more information.

6. **Answer: C.** There are many laceration characteristics that should prompt specialist consultation from the ED; however, lacerations of the oral mucosa can be repaired primarily by an emergency clinician. Lacerations that involve the lacrimal duct, parotid duct, lid margin, tarsal plate, or facial nerve are among the indications for consultation. See the **Special Circumstances – Specialist Consultation** section for more information.

7. **Answer: C.** Facial muscle paralysis indicates injury to the facial nerve, and also raises concern for injury to other nearby structures such as the parotid duct. See the **Special Circumstances – Facial Lacerations** section for more information.

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CME Objectives: Upon completion of this activity, you should be able to: (1) describe the initial steps of wound evaluation in the emergency department; (2) prepare a wound for closure, including irrigation and anesthesia; (3) select the appropriate methods and materials for wound closure; and (4) identify wounds that are at high risk for complications.

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QUICK READ

Points & Pearls

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Acute Traumatic Wounds: Evaluation, Cleansing, and Repair in the Emergency Department

Points

- The "golden period" for safe laceration repair is variable and dependent on wound site, length, pre-existing conditions, and degree of wound contamination.
- Irrigation at a pressure of 13 psi is effective for cleansing noncontaminated wounds and reducing infection without causing tissue trauma; this can be achieved using a 12-mL syringe and a 22-gauge needle.
- LET is effective at obtaining anesthesia for superficial laceration repair, but must be used with caution in areas of potential vascular compromise.
- A single-injection volar digital nerve block achieves a similar level of anesthesia as the dorsal 2-injection technique. **(See Figure 2.)**
- Absorbable sutures are noninferior to nonabsorbable sutures for patient satisfaction and cosmetic outcome.
- The continuous running suture technique is best used on long, linear lacerations; it should not be used for wounds under tension and is contraindication if there is risk for hematoma formation.
- The running subcuticular suture is a complex wound closure technique, but it gives optimal wound approximation and avoids the bite marks made by percutaneous sutures.
- Mattress sutures are best used in areas that are under tension. Vertical mattress sutures are useful in thin or lax skin, while horizontal mattress sutures are useful for closing wounds with poor circulation at the wound edges.
- The corner stitch (a half-buried mattress suture) is ideal for repair of stellate or X-shaped lacerations.
- Tissue adhesives provide satisfactory cosmetic results but are best used on low-tension wounds with linear edges.
- The hair apposition technique is a fast and cost-effective method for closing simple, uncontaminated scalp lacerations.
- Prophylactic antibiotics are not recommended for routine use in wound care. However, patients should receive prophylactic antibiotics if they are at high risk for infection (eg, diabetes, renal failure, or immunocompromised status), or if the mechanism of injury confers a high risk for infection (eg, human bite, open fracture).
- "No-needle" alternatives such as a combination of tissue adhesive and adhesive strips can be preferable to suturing for facial lacerations.
- Superficial eyelid lacerations can be repaired in the ED, but specialist consultation is needed if there is involvement of underlying layers or structures, or if the injury is accompanied by ptosis.
- Small intraoral lacerations do not necessarily require repair, but do require proper irrigation and inspection for foreign bodies such as tooth fragments and food particles
- Repair of a lip laceration that violates the vermillion border requires precision to ensure that both function and cosmesis are preserved.
- Injury to deep structures in the cheek such as the facial nerve or parotid duct should prompt specialist consultation.

Pearls

- Ultrasound is useful for detecting radiolucent foreign bodies; however, ultrasound is operator dependent and cannot be conclusively relied upon to rule out foreign bodies.
- Irrigating wounds with tap water is cost effective and is not associated with higher rates of infection than irrigation with NS.
- Studies have shown no significant difference in infection rates with the use of sterile versus nonsterile gloves.
- Early application of topical anesthetic at triage may aid in offsetting the disadvantage of the slow rate of onset.
- When treating an elderly patient or a patient who has thin skin, it may be helpful to first place adhesive tape perpendicular to the wound, then suture through the tape; the tape helps hold the sutures in place and prevents them from shearing through the skin.