Minor wound evaluation and preparation for closure

AUTHOR: John C Brancato, MD, FAAP, FACEP
SECTION EDITOR: Anne M Stack, MD
DEPUTY EDITOR: Michael Ganetsky, MD

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INTRODUCTION

This topic will discuss the preparation of acute minor wounds for laceration repair. Wounds that involve joints, nerves, flexor tendons, or other underlying structures may require operative care and are **not** considered minor wounds.

The basic approach to wound closure, local anesthesia, and alternative methods of closure are discussed in detail separately.

- (See "Skin laceration repair with sutures".)
- (See "Clinical use of topical anesthetics in children".)
- (See "Subcutaneous infiltration of local anesthetics".)
- (See "Minor wound repair with tissue adhesives (cyanoacrylates)".)
- (See "Closure of minor skin wounds with staples".)

BACKGROUND

Annually, approximately 6 million wounds are treated in emergency departments in the United States [1] and nearly 1 million patients receive laceration care in England [2]. Most wounds in children occur on the head, and the most common mechanism of injury is application of blunt force [3,4]. Management of these minor wounds has two goals: avoidance of infection and achievement of a functional scar that is cosmetically acceptable [3].

EVALUATION

The assessment of minor wounds includes:

- Determination of allergies (eg, to local anesthetics, antibiotics, or latex)
- Status of tetanus immunization (table 1)
- Mechanism of injury
- Presence of foreign body
- Extent of the wound, neurovascular or tendon injury
- Cosmetic significance of the wound

Wound age — The optimal length of time between injury and laceration repair has not been adequately defined [5]. In patients without risk factors for poor wound outcome, most simple lacerations that are small (eg, <5 cm in length), do not have gross contamination, and are not located on the lower extremities can be closed up to 12 to 18 hours later with little risk of infection [6,7]. By contrast, closure beyond 12 hours after injury should be avoided for large wounds (longer than 5 cm in length), contaminated wounds, or lacerations in individuals with risk factors for poor outcomes. (See 'Risks for poor outcome' below.)

Evidence for this approach comes from observational studies. In a prospective, observational study of 372 patients who underwent suture repair of simple lacerations that were not grossly infected, wounds closed up to 19 hours after injury had a significantly higher rate of healing than those closed later (92 versus 77 percent), although head wounds closed >19 hours after injury maintained a high rate of healing (96 percent) [6]. In a separate, multicenter, prospective, observational study of over 2660 patients undergoing closure of lacerations in an emergency department, infection was not associated with closure before or after 12 hours but was associated with obvious contamination, wound length >5 cm, location on the lower extremity, and diabetes mellitus [8].

Mechanism of injury — Clarification of the mechanism of injury helps to determine the presence of a foreign body and the prognosis for development of infection or scarring. A simple cut through the skin by a sharp object causes minimal damage to the surrounding tissues and has a relatively low risk for infection or significant scarring. Tearing of the skin, as occurs when the chin strikes the floor, produces irregular wound margins and damage to the surrounding tissues; these lacerations have a moderate risk of infection and scarring [9]. Direct compression injuries, as occur from a blow to the head, split the skin, injure the adjacent soft tissues, and classically cause a stellate laceration; these wounds have the highest risk of infection [9]. Other considerations include:

- Bite wounds must be evaluated for associated injuries and risk of infection. (See "Animal bites (dogs, cats, and other mammals): Evaluation and management" and "Human bites: Evaluation and management".)

- Crush injuries may involve devitalized tissue that must be debrided to decrease the risk of infection.

- Stab wounds should be evaluated for depth; surgical consultation may be necessary if underlying structures (eg, fascia) have been penetrated or damaged. (See "Approach to the initially stable child with blunt or penetrating injury" and "Initial evaluation and management of penetrating thoracic trauma in adults" and "Initial evaluation and management of abdominal stab wounds in adults".)

Foreign body — We recommend that children with wounds in which the bottom cannot be completely visualized and/or caused by broken glass or associated with other loose foreign bodies undergo plain radiographs. Bedside ultrasound, when used by a properly trained physician, can also be helpful for detecting foreign bodies, including nonradiopaque substances. (See "Infectious complications of puncture wounds", section on 'Imaging'.)

Identifying and removing foreign bodies is important because retained foreign bodies increase the risk of delayed wound healing and infection [10,11]. Any foreign body that can be easily seen should be removed. If the object can be reliably palpated, the wound can be minimally extended to remove it, provided there is no risk to underlying structures. A nonirritant foreign body, such as glass or metal that is not in a critical area (eg, a joint space) or adjacent to a vital structure (eg, major blood vessel) and will not cause ongoing irritation may be left in place if unable to be removed, and the wound sutured. Irritant material, such as wooden splinters, can be a source of later infection and should be removed.

Direct wound inspection may fail to detect all foreign bodies, particularly if the base of the wound cannot be seen. One prospective study evaluated the ability of inspection of the base of the wound to identify the presence of glass fragments [12]. Glass was present in 33 of 226 wounds. The glass was directly visualized in 10 children (4 percent). It was detected radiographically in 7 percent of the wounds that were fully visualized and in 21 percent of the wounds that were not fully visualized. All but one of the lacerations containing glass were at least 0.5 cm deep. Puncture wounds, wounds on the head or foot, and wounds sustained by stepping on glass or in a motor vehicle accident are more likely to contain retained glass [13,14].

Radiologic evaluation is helpful if the foreign body is radiopaque and is an appropriate adjunct to visual inspection [15,16]. A cadaver study was performed to determine the sensitivity of plain

radiographs in the detection of nonleaded glass in wounds [17]. Variously colored and sized fragments of nonleaded glass were placed into a fresh frozen cadaver foot that was radiographed using four standard foot projections. The sensitivity of plain radiographs to detect glass fragments was 90 percent; the false positive rate was 10 percent; and interobserver reliability was good. Radiographic detection of glass was affected by size (fragments smaller than 15 mm were detected less often), but not by color or location.

Extent of wound — The base of the wound must be identified whenever possible. Injury to underlying structures, such as a fracture beneath a laceration or penetration of a joint space in a finger laceration, has significant implications for management.

Neurovascular deficit or injury to adjacent structures — Careful assessment of circulation and sensation, including two point discrimination in hand injuries, will identify neurovascular injury. Any wound overlying a tendon should be assessed for tendon function and the base of the wound should be carefully explored, with tourniquet and loupes if necessary, to identify an injured tendon. The position of the body part at the time of injury must be considered. As an example, an injury might be missed if a laceration occurred with the finger in flexion and the wound is inspected only with the digit in extension. Similarly, the ends of a tendon that has been completely severed may retract from view.

Wounds that involve joints, nerves, flexor tendons, or other underlying structures (eg, fascia, major blood vessels) may require operative exploration and warrant consultation with the appropriate surgical specialist [3].

Risks for poor outcome — Any one of the following conditions may increase the risk for poor outcome (eg, infection, delayed healing, or poor cosmetic outcome) [3,10,18-21]:

- Wound-related:
  - Retained foreign body
  - Heavy contamination
  - Delayed presentation (>24 hours for facial and scalp wounds and >18 hours for wounds in other parts of the body)
  - Deep wounds with associated tissue trauma
  - Wounds caused by glass or ice

  Given the higher risk for infection, closure by secondary intention is preferred. (See 'Secondary intention' below.)

- Patient-related:

- Diabetes mellitus
- Obesity
- Peripheral arterial disease
- Malnutrition (protein, vitamin C deficiency)
- Chronic renal failure
- Use of steroids or other immunosuppressive agents
- Tendency to form keloids
- Connective tissue disorders (eg, Ehlers-Danlos or Marfan syndrome, osteogenesis imperfecta)

When managing patients with one or more of these conditions, the physician should recognize and counsel the patient, and, if appropriate the caregiver regarding the increased risk of infection or poor cosmetic outcome. For physicians who are not experienced in managing such wounds, consultation with the appropriate surgical specialist is warranted. (See 'Secondary intention' below.)

Cosmetic significance — Wounds that are located in cosmetically sensitive areas, such as large wounds that involve the vermilion border of the lip, cartilaginous regions of the nose or ear, or facial lacerations that have tissue missing will present a challenge to good cosmetic outcomes. Consultation with an appropriate surgical specialist is appropriate when the managing physician has limited experience with repairing such wounds. (See "Assessment and management of lip lacerations", section on 'Indications for subspecialty consultation or referral' and "Assessment and management of facial lacerations", section on 'Indications for subspecialty consultation or referral' and "Assessment and management of auricle (ear) lacerations", section on 'Indications for subspecialty consultation or referral'.)

In addition, the orientation of the wound relative to skin tension lines affects cosmetic outcomes. Relaxed skin tension lines (RSTL) arise from the normal draping of skin on the body (eg, lines on the back angle slightly downward and away from the spine) and from muscle tone and body movement (eg, forehead wrinkles) (figure 1 and figure 2). Wounds that are oriented perpendicular to these lines have greater potential for scarring [22].

Type of closure — The decision of whether to perform primary closure, allow a wound to heal by secondary intention, or perform a tertiary (ie, delayed primary) closure is dependent upon the age of the injury as well as the mechanism and degree of contamination.

The presence of a cellulitis or abscess (ie, redness, warmth, swelling, and pain with or without pus drainage) is an absolute contraindication to wound closure. In the absence of these findings, the decision to close a wound must be made based upon clinical judgment [3,23].

Primary closure — Wounds caused by clean, sharp objects that may undergo primary closure at any time up to 12 to 18 hours from the time of injury; location on the trunk or proximal extremity and the patient's lack of other risk factors (see above) favor success in later closure. Wounds of the head and neck may be closed up to 24 hours after injury because of the rich vascular supply of the face and scalp.

Secondary intention — Indications for secondary closure (ie, by granulation) include [6]:

- Deep stab or puncture wounds that cannot be adequately irrigated
- Contaminated wounds
- Abscess cavities
- Presentation after a significant delay (eg, >24 hours) (see 'Wound age' above)
- Noncosmetic animal bites (see "Animal bites (dogs, cats, and other mammals): Evaluation and management", section on 'Wound management')

Delayed primary closure — Delayed primary closure should be considered for uncomplicated wounds that present after the safe period for primary closure.

Examples of such wounds include:

- Animal and human bites, which likely harbor high bacterial loads coupled with complex injuries to the soft tissue (ie, crushing, avulsions, and multiple perforations)
- Wounds older than 24 hours that were insufficiently cleansed, debrided, or decontaminated
- Wounds older than 24 hours that present in the setting of advanced age, diabetes mellitus, renal impairment, impaired nutrition, smoking, obesity, and chronic steroid use [8,24-29]

Delayed primary closure consists of initial cleaning and debridement of the wound followed by at least a four- to five-day waiting period prior to wound closure. The waiting period permits the host defense system to decrease bacterial load. Although evidence is lacking, oral prophylactic antibiotics are sometimes prescribed to further diminish the risk of infection in wounds that will not be immediately closed [30].

At the time of closure, additional debridement may be needed and excessive accumulated granulation tissue trimmed back to the wound margins. For this reason, unless the provider has extensive experience with delayed primary closure, referral to a cosmetic surgeon or other wound expert is advised.

PREPARATION FOR CLOSURE

Hemostasis — Hemostasis is necessary for adequate inspection of the wound and typically is accomplished by the application of direct pressure for 10 to 15 minutes with a gauze pad. Persistent bleeding may require the use of 1 percent lidocaine with epinephrine either injected or applied directly to the wound. (See "Subcutaneous infiltration of local anesthetics", section on 'Lidocaine' and "Digital nerve block", section on 'Use of epinephrine'.)

The direct application of surgical absorbable gelatin foam (Gelfoam) to the wound is an alternative method of achieving hemostasis. Gelfoam should not be used in infected wounds or at the skin closure site because it may delay healing.

Tourniquets may be used to stem bleeding from extremity wounds. After the extremity has been elevated for one minute to permit venous drainage, a sphygmomanometer is placed on the upper arm or thigh. It should be inflated to a pressure 20 to 30 mmHg above the patient's systolic blood pressure. Large extremity tourniquets may be used for 30 to 60 minutes [31].

For finger and toe lacerations, drainage of blood and hemostasis may be achieved by rolling the finger of a surgical glove with a hole cut in the tip down to the base of the digit. Alternatively, a Penrose drain may be applied proximally. Digital tourniquets may be used for 20 to 30 minutes [31].

Bleeding from small arterial vessels may not respond to these measures, and clamping and ligation of the arteries sometimes is required. "Blind" clamping of blood vessels is not recommended because it may cause damage to the nerves, tendons, and other structures that accompany blood vessels. If necessary, ligation of arteries in the distal extremities should be performed by a surgeon. Electrocautery, however, may be associated with a less optimal cosmetic outcome [21].

Debridement — Debridement has been considered by many to be equally or more important than irrigation in the management of the contaminated wound. It removes permanently devitalized tissue which, if retained, impairs the wound's ability to resist infection. Devitalized fat, muscle, and skin exhibit similar capacity to enhance bacterial infection [32].

The decision to excise or modify a wound must take into consideration the cosmetic consequences. The excision cannot damage underlying structures and there must be sufficient remaining tissue to close the wound without undue tension. Consideration of the relationship to the relaxed skin tension lines (RSTL) is essential (see 'Cosmetic significance' above). Lacerations that are oblique or perpendicular to these lines are at increased risk of scarring.

Therefore, any excision should be parallel to the RSTL. A jagged laceration in which some of the components are parallel to the RSTL may result in a better cosmetic repair than a wound that has been excised [33].

Hair removal — Hair need not be removed unless it interferes with wound closure or knot formation [34,35]. Lubrication to comb the hair away from wound margins or simple clipping with scissors is all that is necessary in most cases. Shaving to skin level increases the risk of infection and can leave small particles in the wound [36]. Eyebrows should not be clipped or shaved because they may grow back irregularly [20].

Irrigation — Irrigation is the most important means of decreasing the incidence of wound infection because soil or small foreign bodies that remain in a wound reduce the inoculum of bacteria required to cause infection [37,38]. The use of a splash shield decreases splatter and minimizes the exposure to potentially infectious fluids [39,40]. Irrigation is performed after adequate local anesthesia has been administered or peripheral nerve block has been performed. (See "Skin laceration repair with sutures", section on 'Local or regional anesthesia'.)

Irrigation may not be necessary for all low-risk wounds, particularly those in well-vascularized locations [3,7]. An observational study compared infection and cosmetic outcome in over 1,900 patients who had facial or scalp lacerations that were low risk for infection and were treated with or without irrigation [41]. Bite wounds, contaminated wounds, and wounds that were more than six hours old were excluded. The incidence of wound infection and optimal cosmetic appearance were similar in the two groups (approximately 1 percent for infection and 79 percent for appearance).

Irrigation solution — Isotonic (normal) saline is frequently used for wound irrigation, although tap water may be an acceptable alternative. Meta-analyses of three studies in adults and two studies in children compared irrigation with normal saline or tap water for preparation of acute lacerations [42]. No clinically significant differences in wound infection rates were seen. Thus, running tap water may be an acceptable alternative to isotonic saline. In addition, when easily available, warmed saline may offer a comfort advantage to room-temperature irrigation [43].

High-level evidence does not exist to support the use of any particular irrigant additive, nor any particular additive over another. The addition of dilute iodine or other antiseptic solutions (eg, chlorhexidine, hydrogen peroxide) is generally unnecessary and has minimal action against bacteria, and some additives impede wound healing and have other adverse effects [3,44,45]. Betadine surgical scrub solution should **not** be used for this purpose because it contains ionic

detergent that may be toxic to wound tissue. (See "Basic principles of wound management", section on 'Irrigation'.)

Irrigation pressure — Ideal irrigation pressures are unknown. However, most experts recommend pressures of 5 to 8 lbs per square inch (PSI) [46]. Early studies found that high-pressure syringe irrigation effectively removed bacteria from the surface of the wound and resulted in decreased infection rates, whereas low-pressure irrigation had no clinical effect [37,47]. However, another study compared the irrigation efficacy of high-pressure, low-volume irrigation and low-pressure, high-volume irrigation in an animal wound model and found them to be equally effective [48].

Very high-pressure irrigation (greater than 25 PSI) should be reserved for highly contaminated wounds or debridement of devitalized tissue. A concern is that high-pressure irrigation may increase damage and infection rates by dissecting through loose connective tissue [11,20]. However, in an animal study of the side-effects of high-pressure irrigation, bacteria did not accompany the irrigation fluid into adjacent tissues [11]. Another animal study showed decreased bacterial levels in wounds treated with high-pressure versus bulb irrigation (average reduction of 70 versus 44 percent) and no increased risk of bacteremia [49]. Thus, for highly contaminated wounds, the benefits of reduced bacterial load outweigh the risk of adjacent tissue damage.

Irrigation pressures of 5 to 8 PSI can be achieved by using a 19-gauge syringe or catheter on a 60 cc syringe [50] or attached to tubing from a pressurized bag of intravenous solution (eg, under a 400 mmHg blood pressure cuff). Lower pressures (0.5 to 1 PSI) are generated with bulb syringe irrigation. The pressures generated by these methods may vary widely. As a general rule, pressures derived from intravenous bags are lower than from these syringes (4 to 10 PSI versus 15 to 40 PSI in one study) [39].

Volume — The volume of irrigation solution depends upon the location and cause of the wound. Smaller, cleaner wounds and those in highly vascular areas usually require less volume. As an example, a simple 1 cm forehead laceration may be adequately cleansed with 150 to 200 mL, whereas a 4 cm wound on the lower leg that was caused by a fence may require 500 mL or more.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Minor wound

management".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, “The Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on “patient info” and the keyword(s) of interest.)

- Basics topics (see "Patient education: Taking care of cuts, scrapes, and puncture wounds (The Basics)" and "Patient education: Stitches and staples (The Basics)")

SUMMARY AND RECOMMENDATIONS

- **Evaluation** – The assessment of minor wounds includes determination of allergies (eg, to local anesthetics, antibiotics, or latex), status of tetanus immunization (table 1), mechanism of injury, presence of foreign body, extent of the wound, neurovascular or tendon injury, and cosmetic significance of the wound. (See 'Evaluation' above.)

- **Identifying foreign bodies** – Children with wounds in which the bottom cannot be completely visualized and/or caused by broken glass or associated with other loose foreign bodies should undergo plain radiographs. Bedside ultrasound, when used by a properly trained physician, can also be helpful for detecting foreign bodies, including nonradiopaque substances. (See 'Foreign body' above.)

- **Indications for specialist consultation** – Wounds with cosmetic significance, associated neurovascular or tendon injury, or that occur in patients with risk for poor healing may warrant consultation with the appropriate surgical specialist, especially when the managing physician has limited experience with wound repair. (See 'Cosmetic significance'

above and 'Neurovascular deficit or injury to adjacent structures' above and 'Risks for poor outcome' above.)

- **Debridement** – All devitalized tissue and foreign material should be removed prior to wound repair. Additional debridement or wound modification may be desirable to improve cosmetic outcomes. (See 'Debridement' above.)

- **Role of hair removal** – Hair need not be removed unless it interferes with wound closure. Lubrication to comb the hair away from wound margins or simple clipping with scissors is all that is necessary in most cases. Eyebrows should not be clipped or shaved because they may grow back irregularly. (See 'Hair removal' above.)

- **Irrigation** – Irrigation is the most important means of decreasing the incidence of wound infection. The use of a splash shield decreases splatter and minimizes the clinician's exposure to potentially infectious fluids. (See 'Irrigation' above.)

  - Isotonic (normal) saline is frequently used for uncomplicated wounds, although tap water may be an acceptable alternative. A dilute (ie, 1:10 mixture of povidone/iodine solution [Betadine]) and isotonic saline may provide useful antiseptic activity for contaminated wounds. (See 'Irrigation solution' above.)

  - Irrigation should be performed by using a 19-gauge syringe or catheter on a 60 cc syringe or a pressurized bag of intravenous normal saline solution (eg, 1 L bag under a 400 mmHg blood pressure cuff). (See 'Irrigation pressure' above.)

  - The volume of irrigation solution depends upon the location and cause of the wound. (See 'Volume' above.)

- **Determining type of closure** – The decision of whether to perform primary closure, allow a wound to heal by secondary intention, or perform a tertiary (ie, delayed primary) closure is dependent upon the age of the injury as well as the mechanism and degree of contamination. (See 'Type of closure' above.)

REFERENCES

1. National Hospital Ambulatory Medical Care Survey: 2010 Emergency Department Summary Tables https://www.cdc.gov/nchs/data/ahcd/nhamcs_emergency/2010_ed_web_tables.pdf (Accessed on June 07, 2016).

2. Hospital Accident & Emergency Activity 2018-19. In: Hospital Accident & Emergency Activity. September 12, 2019. https://digital.nhs.uk/data-and-information/publications/statistical/hospital-accident--emergency-activity/2018-19 (Accessed on November 22, 2019).
3. Hollander JE, Singer AJ. Laceration management. Ann Emerg Med 1999; 34:356.
4. Hollander JE, Singer AJ, Valentine S. Comparison of wound care practices in pediatric and adult lacerations repaired in the emergency department. Pediatr Emerg Care 1998; 14:15.
5. Eliya MC, Banda GW. Primary closure versus delayed closure for non bite traumatic wounds within 24 hours post injury. Cochrane Database Syst Rev 2011; :CD008574.
6. 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.
7. Mankowitz SL. Laceration Management. J Emerg Med 2017; 53:369.
8. Quinn JV, Polevoi SK, Kohn MA. Traumatic lacerations: what are the risks for infection and has the 'golden period' of laceration care disappeared? Emerg Med J 2014; 31:96.
9. Stamou SC, Maltezou HC, Psaltopoulou T, et al. Wound infections after minor limb lacerations: risk factors and the role of antimicrobial agents. J Trauma 1999; 46:1078.
10. Hollander JE, Singer AJ, Valentine SM, Shofer FS. Risk factors for infection in patients with traumatic lacerations. Acad Emerg Med 2001; 8:716.
11. Wheeler CB, Rodeheaver GT, Thacker JG, et al. Side-effects of high pressure irrigation. Surg Gynecol Obstet 1976; 143:775.
12. Avner JR, Baker MD. Lacerations involving glass. The role of routine roentgenograms. Am J Dis Child 1992; 146:600.
13. Montano JB, Steele MT, Watson WA. Foreign body retention in glass-caused wounds. Ann Emerg Med 1992; 21:1360.
14. Steele MT, Tran LV, Watson WA, Muelleman RL. Retained glass foreign bodies in wounds: predictive value of wound characteristics, patient perception, and wound exploration. Am J Emerg Med 1998; 16:627.
15. Russell RC, Williamson DA, Sullivan JW, et al. Detection of foreign bodies in the hand. J Hand Surg Am 1991; 16:2.
16. Donaldson JS. Radiographic imaging of foreign bodies in the hand. Hand Clin 1991; 7:125.
17. Arbona N, Jedrzynski M, Frankfather R, et al. Is glass visible on plain radiographs? A cadaver study. J Foot Ankle Surg 1999; 38:264.
18. Cruse PJ, Foord R. A five-year prospective study of 23,649 surgical wounds. Arch Surg 1973; 107:206.

19. Baker MD, Lanuti M. The management and outcome of lacerations in urban children. Ann Emerg Med 1990; 19:1001.
20. Singer AJ, Hollander JE, Quinn JV. Evaluation and management of traumatic lacerations. N Engl J Med 1997; 337:1142.
21. Singer AJ, Quinn JV, Thode HC Jr, et al. Determinants of poor outcome after laceration and surgical incision repair. Plast Reconstr Surg 2002; 110:429.
22. Trott, AT. Wounds and Lacerations, Mosby-Year Book, St. Louis 1997. p.15.
23. Rappaport NH. Laceration repair. Am Fam Physician 1984; 30:115.
24. Anderson K, Hamm RL. Factors That Impair Wound Healing. J Am Coll Clin Wound Spec 2012; 4:84.
25. Avishai E, Yeghiazaryan K, Golubnitschaja O. Impaired wound healing: facts and hypotheses for multi-professional considerations in predictive, preventive and personalised medicine. EPMA J 2017; 8:23.
26. Greenhalgh DG. Management of the skin and soft tissue in the geriatric surgical patient. Surg Clin North Am 2015; 95:103.
27. Leaker SH. The role of nutrition in preventing pressure ulcers. Nurs Stand 2013; 28:66.
28. Maroz N, Simman R. Wound Healing in Patients With Impaired Kidney Function. J Am Coll Clin Wound Spec 2013; 5:2.
29. Sorg H, Tilkorn DJ, Hager S, et al. Skin Wound Healing: An Update on the Current Knowledge and Concepts. Eur Surg Res 2017; 58:81.
30. Lammers RL, Aldy KN.. Principles of Wound Management. In: Roberts and Hedges' Clinical Procedures in Emergency Medicine and Acute Care, 7th edition, Roberts JR, Custalow CB, Th omsen TW (Eds), Elsevier, Philadelphia 2019. p.621.
31. Trott AT. Wounds and Lacerations, Mosby-Year Book, St. Louis 1997. p.15.
32. Haury B, Rodeheaver G, Vensko J, et al. Debridement: an essential component of traumatic wound care. Am J Surg 1978; 135:238.
33. McNamara, RN, DeAngelis M. Laceration repair with sutures, staples, and wound closure ta pes. In: Textbook of Pediatric Emergency Procedures, 2nd, King, C, Henretig, F (Eds), Wolter s Kluwer|Lippincott, Williams, & Wilkins, Philadelphia 2008. p.1018.
34. Howell JM, Morgan JA. Scalp laceration repair without prior hair removal. Am J Emerg Med 1988; 6:7.
35. Tang K, Yeh JS, Sgouros S. The Influence of hair shave on the infection rate in neurosurgery. A prospective study. Pediatr Neurosurg 2001; 35:13.

36. Horgan MA, Piatt JH Jr. Shaving of the scalp may increase the rate of infection in CSF shunt surgery. Pediatr Neurosurg 1997; 26:180.
37. Stevenson TR, Thacker JG, Rodeheaver GT, et al. Cleansing the traumatic wound by high pressure syringe irrigation. JACEP 1976; 5:17.
38. Rodeheaver G, Pettry D, Turnbull V, et al. Identification of the wound infection-potentiating factors in soil. Am J Surg 1974; 128:8.
39. 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. Pigman EC, Karch DB, Scott JL. Splatter during jet irrigation cleansing of a wound model: a comparison of three inexpensive devices. Ann Emerg Med 1993; 22:1563.
41. Hollander JE, Richman PB, Werblud M, et al. Irrigation in facial and scalp lacerations: does it alter outcome? Ann Emerg Med 1998; 31:73.
42. Fernandez R, Griffiths R. Water for wound cleansing. Cochrane Database Syst Rev 2012; :CD003861.
43. Ernst AA, Gershoff L, Miller P, et al. Warmed versus room temperature saline for laceration irrigation: a randomized clinical trial. South Med J 2003; 96:436.
44. Moscati RM, Reardon RF, Lerner EB, Mayrose J. Wound irrigation with tap water. Acad Emerg Med 1998; 5:1076.
45. Loeb T, Loubert G, Templier F, Pasteyer J. [Iatrogenic gas embolism following surgical lavage of a wound with hydrogen peroxide]. Ann Fr Anesth Reanim 2000; 19:108.
46. Edlich RF, Rodeheaver GT, Morgan RF, et al. Principles of emergency wound management. Ann Emerg Med 1988; 17:1284.
47. Rodeheaver GT, Pettry D, Thacker JG, et al. Wound cleansing by high pressure irrigation. Surg Gynecol Obstet 1975; 141:357.
48. Pronchik D, Barber C, Rittenhouse S. Low- versus high-pressure irrigation techniques in Staphylococcus aureus-inoculated wounds. Am J Emerg Med 1999; 17:121.
49. Tabor OB Jr, Bosse MJ, Hudson MC, et al. Does bacteremia occur during high pressure lavage of contaminated wounds? Clin Orthop Relat Res 1998; :117.
50. Morse JW, Babson T, Camasso C, et al. Wound infection rate and irrigation pressure of two potential new wound irrigation devices: the port and the cap. Am J Emerg Med 1998; 16:37.

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GRAPHICS

Wound management and tetanus prophylaxis

Previous doses of tetanus toxoid*	Clean and minor wound		All other wounds¶	
	Tetanus toxoid-containing vaccineΔ	Human tetanus immune globulin	Tetanus toxoid-containing vaccineΔ	Human tetanus immune globulin◇
<3 doses or unknown	Yes§	No	Yes§	Yes
≥3 doses	Only if last dose given ≥10 years ago	No	Only if last dose given ≥5 years ago¥	No

Appropriate tetanus prophylaxis should be administered as soon as possible following a wound but should be given even to patients who present late for medical attention. This is because the incubation period is quite variable; most cases occur within 8 days, but the incubation period can be as short as 3 days or as long as 21 days. For patients who have been vaccinated against tetanus previously but who are not up to date, there is likely to be little benefit in administering human tetanus immune globulin more than 1 week or so after the injury. However, for patients thought to be completely unvaccinated, human tetanus immune globulin should be given up to 21 days following the injury; Td or Tdap should be given concurrently to such patients.

DT: diphtheria-tetanus toxoids adsorbed; DTP/DTwP: diphtheria-tetanus whole-cell pertussis; DTaP: diphtheria-tetanus-acellular pertussis; Td: tetanus-diphtheria toxoids absorbed; Tdap: booster tetanus toxoid-reduced diphtheria toxoid-acellular pertussis; TT: tetanus toxoid.

* Tetanus toxoid may have been administered as DT, DTP/DTwP (no longer available in the United States), DTaP, Td, Tdap, or TT (no longer available in the United States).

¶ Such as, but not limited to, wounds contaminated with dirt, feces, soil, or saliva; puncture wounds; avulsions; or wounds resulting from missiles, crushing, burns, or frostbite.

Δ The preferred vaccine preparation depends upon the age and vaccination history of the patient:

- <7 years: DTaP.
- Underimmunized children ≥7 and <11 years who have not received Tdap previously: Tdap. Children who receive Tdap at age 7 through 9 years should receive another dose of Tdap at age 11 through 12 years.
- ≥11 years: A single dose of Tdap is preferred to Td for all individuals in this age group who have not previously received Tdap; otherwise, Td or Tdap can be administered without preference. Pregnant women should receive Tdap during each pregnancy.

◇ 250 units intramuscularly at a different site than tetanus toxoid; intravenous immune globulin should be administered if human tetanus immune globulin is not available. Persons with HIV infection or severe

immunodeficiency who have contaminated wounds should also receive human tetanus immune globulin, regardless of their history of tetanus immunization.

§ The vaccine series should be continued through completion as necessary.

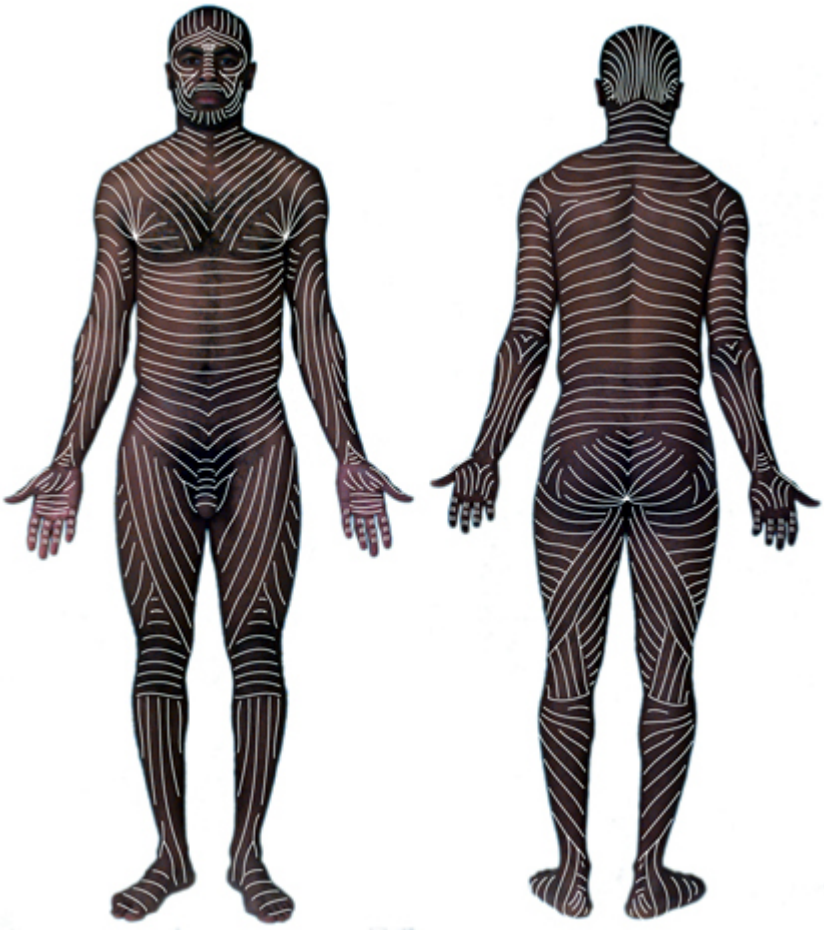
¥ Booster doses given more frequently than every 5 years are not needed and can increase adverse effects.

References:

1. *Liang JL, Tiwari T, Moro P, et al. Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2018; 67:1.*
2. *Havers FP, Moro PL, Hunter P, et al. Use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccines: Updated recommendations of the Advisory Committee on Immunization Practices - United States, 2019. MMWR Morb Mortal Wkly Rep 2020; 69:77.*

Graphic 61087 Version 34.0

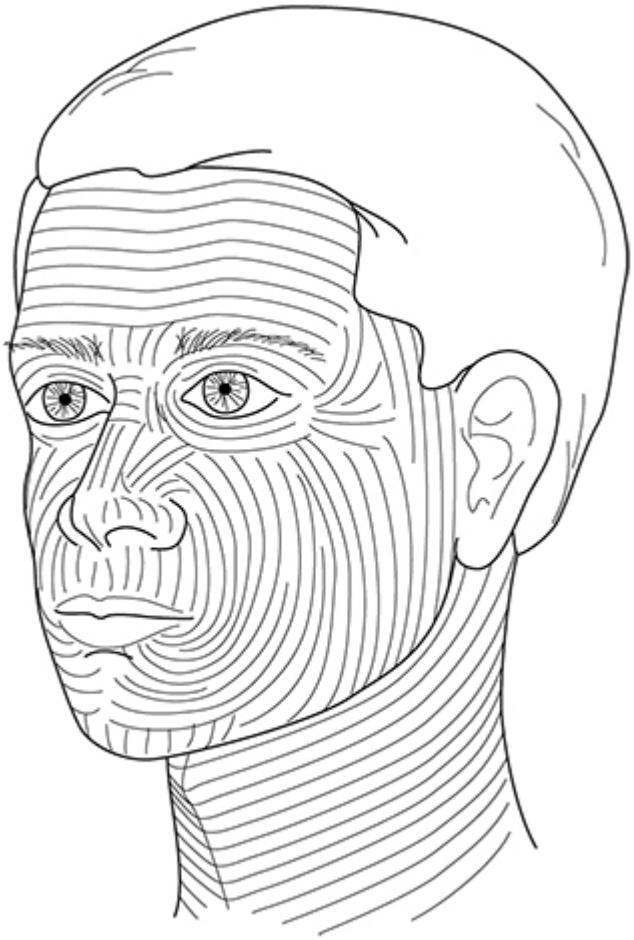
Whole-body Langer's lines



Schematic drawing of the cleavage (Langer's) lines in the skin. Surgical incisions made in the direction of these lines, which run parallel to the predominant direction of the collagen fiber bundles in the dermis, have less tendency to gape.

Graphic 57566 Version 4.0

Langer's lines of the face



Graphic 50913 Version 2.0