Management Of Wounds In The Pediatric Emergency Department

The parents of a 13-year-old bring their son to the emergency department after the glass coffee table on which he was sitting broke under his weight, about a half-hour ago. The patient has sustained multiple lacerations to both forearms. The parents state that they were able to stop all bleeding prior to coming to the ED, but they continue to maintain pressure over a larger cut on his right arm. You wonder how many of these lacerations are going to require closure. The boy’s past medical history reveals that as a toddler he had several ear infections that were treated with uncomplicated bilateral tympanostomy tube placement under general anesthesia. He has also been under general anesthesia twice for dental procedures. There have been no hospitalizations or other surgeries, and he is immunocompetent. His developmental history reveals a diagnosis of autism at age 3. He is nonverbal and attends school in a highly structured classroom setting. His parents state that he can be “hard to handle” in strange or stressful situations. You immediately begin to run through various wound closure options in your mind while you ask yourself, “Will I be able to use routine sedation protocols, or will this child need something more?”

While you finish taking the boy’s history from his parents, a medical student who is working with you arrives to let you know that a patient has sustained multiple lacerations to the face. The student asks you if this is something routinely repaired by emergency medicine clinicians and says, “I was taught that anything on the face should be a full moon,” you mutter to the student. The boy’s past medical history reveals that as a child he had several ear infections that were treated with uncomplicated bilateral tympanostomy tube placement under general anesthesia. He has also been under general anesthesia twice for dental procedures. There have been no hospitalizations or other surgeries, and he is immunocompetent. His developmental history reveals a diagnosis of autism at age 3. He is nonverbal and attends school in a highly structured classroom setting. His parents state that he can be “hard to handle” in strange or stressful situations. You immediately begin to run through various wound closure options in your mind while you ask yourself, “Will I be able to use routine sedation protocols, or will this child need something more?”

Upon completion of this article, you should be able to:
1. Recognize the prevalence and etiologies of pediatric wounds presenting to an emergency department.
2. Describe the steps in initial assessment and evaluation of patients who present with wounds.
3. Identify risk factors associated with wound repair complications or poor outcomes.
4. Describe the steps in wound closure by primary intention.
5. Recognize special circumstances which may warrant additional management decisions in wound care.

CME Objectives

Date of most recent review: August 10, 2010
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Medium: Print and Online
Method of participation: Print or online answer form and evaluation
Prior to beginning this activity, see “Physician CME Information” on the back page.
referred to plastic surgeons.” You ponder that statement before giving your answer.

Rare is the emergency department (ED) shift — urban, suburban, or rural — that does not include a visit from a pediatric patient with an open wound. Once the jurisdiction of the primary care providers (ie, the pediatric or family practice office), management of even minor wounds is becoming less common in that setting as concerns over time, reimbursement, and liability are sending more children to urgent care clinics and EDs for initial evaluation of their injuries.1

Injury follow up has also become a more commonplace occurrence in the ED, where the initial repair took place, as improper or esthetically unpleasant repairs as well as infectious complications continue to be common causes for litigation against the emergency clinician. A Google™ search conducted by the authors returned over 43,700 hits for “litigation for wound repair” and over 11,500 hits for “expert witness for wound repair.”

Much of the medical literature concerning pediatric wounds is categorized into 3 etiology-based categories: injury-related wounds (lacerations, avulsions, and punctures), bites, and burns. Literature reviews were published in Pediatric Emergency Medicine Practice within the past year on such topics as mammalian bites and burns in the pediatric population.2,3 In this issue of Pediatric Emergency Medicine Practice we will focus on the evaluation and management of the patient with an injury-related open wound using the best available evidence from the literature.

Critical Appraisal Of The Literature

PubMed searches were performed for topics including laceration, wound repair, wound irrigation, topical anesthesia, cyanoacrylate, tissue adhesives, wound complications, suture material, absorbable sutures, and nonabsorbable sutures. This search produced numerous articles published between 1966 and the present. Research for this article focused primarily on articles from the past decade and included randomized, controlled trials as well as review articles on various topics. Studies involving surgical or obstetric patients were excluded, since these differed substantially from the topic at hand; however, several studies that involved adult as well as pediatric patients were included. A search of Cochrane Database of Systematic Reviews produced several relevant reviews, which are also included in this discussion.

A paucity of national guidelines and/or pathways which standardize pediatric wound management was discovered. For example, a PubMed search of English-language articles using the term “wound repair algorithm” limited to the pediatric population returned 47 hits, only 1 of which dealt with generalized care in the ED; the other 46 articles all focused on specific injuries or diseases, mostly orthopedic or dermatologic in nature.4 A similar search using the term “wound repair guidelines” yielded 92 hits, with only 2 targeting general wound care and 7 dealing with pediatric burn management.5

Most recent wound literature deals with acute and/or chronic wound management in high-risk adult populations, specifically diabetic wound care, ostomy wound care, and care of chronic pressure-induced ulcerations in immobile populations.6 Fortunately for our patients — but unfortunately from an educational point of view — these types of wounds are rarely seen in the pediatric ED.

As for pediatric wounds, the etiologies have not varied much in recent decades. The most relevant literature based on good evidence focuses on issues related to the treatment of acute wounds, specifically infectious complications and antimicrobial resistance patterns and the safety and efficacy of newer agents for pediatric sedation.

A search of the Agency for Healthcare Research and Quality (AHRQ) National Guideline Clearinghouse (http://www.guideline.gov) yielded only 1 brief guideline for school nursing personnel on how to address abrasions and lacerations in pre-
school and school settings. This lack of nationally standardized guidelines or clinical pathways for acute wound management allows clinicians to make management decisions on a case-by-case basis at the risk of increasing medicolegal liability in the event of complications or undesirable outcomes.

**Epidemiology And Etiology**

Unintentional injuries are one of the leading causes of visits to the ED, urgent care clinic, and physician’s office. According to data from the National Center for Health Statistics for 2006, 42.4 million out of 119.2 million ED visits (35.6%) were for injury-related problems. Approximately 7.8 million of these (18.4%) were by patients under 15 years of age. Open wounds to the head (847,000 visits) and non-head wounds (675,000 visits) accounted for nearly 20% of all visits for children under 15 years of age.

Each year, over 200,000 children receive emergency care for playground injuries, 40% of which are for lacerations, abrasions, and contusions. In addition, the National Safety Council reports that every 40 seconds someone in the United States seeks medical attention for a dog bite. Consequently, the American Society of Plastic Surgeons listed laceration repair and animal bite repair as the second and ninth, respectively, most common indications for reconstructive procedures in 2008.

**Physiology**

The process of wound healing begins within moments after the initial trauma. Regardless of the mechanism of injury, healing is comprised of 3 classic phases: the inflammatory or substrate phase, the proliferative phase, and the remodeling phase. These 3 phases are not strictly sequential in time but instead may overlap to a considerable degree. In addition, there is a stage of re-epithelialization, which begins within a few hours of injury and progresses over the first 1 to 3 days.

The inflammatory phase occurs in direct response to tissue damage and is mediated by numerous chemoattractant and mitogenic factors, such as platelet-derived growth factor and arachidonic acid with its derivative prostaglandins and thromboxanes. Following any initial bleeding there is vasoconstriction, clot formation, and margination and migration of leukocytes to the site of injury to begin the process of natural wound debridement. The length of the inflammatory phase varies with the extent of the wound, the presence of contamination or infection after the injury, and local tissue and host immune factors. Any chronic or immunocompromising illness such as diabetes mellitus, chemotherapy, or HIV infection may delay, prolong, or disrupt wound healing.

The proliferative phase is predominated by macrophage-induced formation of a new cellular matrix, recruitment and replication of fibroblasts, and angiogenesis. Collagen from the fibroblasts is the main building-block of the final scar. Angiogenesis provides vital oxygen and nutrients and gives the healing wound its pink color over 2 to 4 days. Malnutrition may compromise normal wound healing during this phase. Good daily intake of calories and protein should be emphasized. Vitamins A and C are essential for wound healing during the proliferative phase, as are zinc and iron. Any deficiencies in these nutrients can significantly delay or disrupt the normal healing process.

During the remodeling phase, collagen cross-linking occurs, forming a stronger tissue. A gradual decrease in vascularity causes the scar to appear paler and flatter. The remodeling phase may take as long as 6 to 9 months, with the final tissue regaining approximately three-fourths of its preinjury strength.

Re-epithelialization is necessary to provide wound cover, prevent secondary infection, prevent contamination, and control loss of moisture. Epithelial cells migrate from the margins to the center of the wound at a rate of approximately 1 mm per day. Failure to provide an epithelial cover by means of natural healing, surgical wound closure, or skin grafting can prolong the period of inflammation, increase the risk of infection, and promote the formation of granulation tissue — the “proud flesh” alluded to in historical medical texts.

**Differential Diagnosis**

Emergency department management of acute pediatric wounds typically involves no differential thought processing. The cause of wounds needing intervention is normally clear-cut. In those cases where a mechanism of injury is unknown or even suspect, the treatment and disposition of the patient’s wound(s) are still based upon the physician’s clinical assessment upon presentation. An exception to this rule would be the injury that is several days old and presents with an infectious complication. The differential diagnosis of infectious agents is covered in the sections on bite wounds (see page 15) and antibiotic prophylaxis (see page 17).

**Prehospital Care**

The focus of prehospital wound care should be to achieve hemostasis and minimize contamination. In minor injuries, prehospital care is generally carried out by a parent or teacher and may or may not include cleaning the wound — a fact that the emergency clinician should be sure to elicit in the history. For
larger, more significant wounds, emergency medical services (EMS) personnel may become involved, positioning the patient to maximize comfort while minimizing active bleeding and applying pressure with clean materials to control any significant bleeding. For wounds surrounding or involving the nose and mouth, attention should focus on suctioning and protecting the patient’s airway. In any wound causing significant bleeding, the possibility of an arterial bleed should be considered; pressure should be applied until the patient reaches the hospital, where the source can be determined under the best possible conditions.

**Emergency Department Evaluation**

When the clinician is confronted with a fearful child with active bleeding and an anxious parent, it is easy to overlook pertinent facts that will affect the repair and the long-term outcome. It is important to allay fears and anxiety while at the same time obtaining a thorough history and carefully evaluating the injury. Often talking calmly to family members about their child’s history and how the injury occurred will engender trust and decrease anxiety. When they are available, child life personnel can be instrumental in helping to achieve these goals. Although it may be necessary to anesthetize the wound to permit a thorough evaluation, it is critical for the provider to at least assess the status of hemostasis and the severity of the wound to begin planning the repair.

Understandably, a significant number of legal cases revolve around associated injuries to underlying tissues (eg, tendons, nerves, and bones) that were overlooked during the initial examination. In addition, undetected foreign bodies can increase the risk of infection and lead to poor scar formation, making them a common complaint in lawsuits. Therefore, a careful history and thorough physical examination are essential in the evaluation of pediatric wounds.

**History**

Critical factors that should be elicited as part of any history, particularly as they relate to wound care, include the child’s medications, allergies, and immunization status (with special attention to tetanus vaccinations) as well as any coexisting illnesses or conditions. Examples of medical problems that could affect either the repair procedure itself (eg, autism) or the child’s ability to heal after wound repair (eg, chemotherapy) are listed in Table 1.

It is important to understand as much about the mechanism of injury as possible. Such details will elucidate the extent of injury or contamination that a clinician should be aware of. There are a significant number of legal cases each year that revolve around missed injury involving the underlying tissues including tendons, nerves, and bones. Also undiscovered foreign bodies are a common item under litigation as these can lead to increased risk of infection and poor scar formation.

The time that has elapsed since the wound occurred is also critical. For over thirty years, researchers have tried to pin down the exact window of time in which a wound has to be closed primarily before the risk of infection outweighs the benefits of closure, and yet there are no finite cut-offs. Wounds to the face and scalp appear to tolerate longer periods of time prior to closure, likely due to the high vascularity of these areas. The largest study looking at this question used a cut-off of 6 hours. The American College of Emergency Physicians clinical policy on penetrating wounds on an extremity, published in 1999, recommended a 12-hour window for optimum closure. In 2005, Wedmore reviewed the timing of wound closure and concluded that 6 to 10 hours from the time of the wound is optimal for most wounds and suggested considering allowance of up to 12 hours for wounds of the face and scalp. Keeping this in mind, each wound and the circumstances surrounding it should be considered when making the decision for primary closure or healing by secondary intent or secondary closure.

**Important Physical Findings**

As for any patient, an assessment of vital signs is key, especially when blood loss may be significant. Tachycardia and hypotension would be obvious signs of rapid blood loss, but tachycardia alone can be confounding, since an anxious child will most certainly have a rapid heart rate.

In examining the child with a wound, the emergency clinician is best served by examining the wound itself last. Although this may sound counterintuitive, critical information can be gained without unnerving the injured child. While some children may not be cooperative enough for a

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**Table 1. Historical Components That May Affect Wound Management**

- Mechanism of injury
- Timing of injury
- Tetanus status
- Time of most recent oral intake
- Environment in which injury occurred
- Allergies or reactions to previous wound repairs
- Medical problems that will affect the procedure (eg, autism, attention deficit–hyperactivity disorder)
- Medical problems that may impair healing ability:
  - Diabetes
  - Immuno compromised state
  - Steroid use
  - Obesity
formal assessment, they can often be “tricked” into allowing a full assessment.

The neurovascular status of the involved area is a vital component of the evaluation. For example, in laceration of the forearm, feel for pulses and ask the child to move his or her fingers. If the patient will not do so, placing your hand on the palmar surface of the fingers and asking the child to push your hand allows you to feel the strength of movement without appreciating a full movement. You can observe the contralateral extremity and ask the child to show on that arm, as an example, where the injury is. At this point, you can remove the covering or bandage and assess the wound itself.

**Wound Assessment**

Even a quick glance at the wound with proper illumination can provide the emergency clinician with a great deal of useful information. Before touching the wound, it is possible to discern the degree of hemostasis. The clinician can also assess the size, shape, and depth of the wound, as well as the vitality of the affected tissues. Gentle manipulation of the wound with gloved hands can be used to evaluate how the wound edges fit back together and can aid in planning the repair.

This first encounter can also provide a sense of how likely the patient is to cooperate during the repair. The child’s age and anxiety level, the demeanor of the parent (eg, calm or agitated), and the location and severity of the wound all influence decisions concerning procedural sedation.

**Diagnostic Studies**

Rarely are diagnostic studies needed in the child with an acute laceration. Clearly, trauma patients will need a work up dependent on the mechanism of injury, but such evaluation is seldom indicated for the commonplace isolated wound or laceration.

**Laboratory Studies**

Sparse data exists to indicate laboratory evaluation of wounds. In general, laboratory studies will be indicated based on the past medical history of the patient or circumstances surrounding the wound itself. One example is that of a wound in which it is difficult to achieve hemostasis. The more emergent problem to rule out is the arterial source of bleeding underlying the injury, but certainly a bleeding diathesis may present itself in a childhood wound and may represent the first true test of the child’s ability to form a clot. In this case, coagulation studies and a platelet count may be useful.

**Imaging Studies**

Imaging may be helpful in cases where glass or metallic objects caused the wound. Rocks or debris may show up on radiographic studies but are best detected during the clinician’s manual exploration of the wound. Since most contaminants are not visible on routine radiographs, the clinician should not rely solely on these films. Ultrasound may be another useful modality for those who have been trained in its use and may be more cost-effective for the patient in addition to avoiding radiation exposure.

**Treatment**

**Wound Outcomes And Goals Of Care**

Before a discussion of the evidence regarding proper wound care, it is appropriate to review the literature that pertains to poor outcomes. Many wound outcome studies look at rates of infection and/or cosmetic appearance at some time after the initial injury. In 2001, Hollander et al studied 5521 consecutive patients with traumatic wounds. Structured assessments were done at the time of repair and again at the time of suture removal. The overall infection rate was 3.5%, which is consistent with other published data. Certain factors were found to increase the risk of infection, including older age (adjusted odds ratio [OR] 1.01 per year, 95% confidence interval [CI], 1.00-1.02), diabetes (adjusted OR 6.7; 95% CI, 1.7-26.4), wide wounds (adjusted OR 1.05 per mm wide; 95% CI, 1.02-1.08), and the presence of a foreign body in the wound (adjusted OR 2.6; 95% CI, 1.3-5.2). These factors are not controllable by the clinician. Wounds on the head or neck were less likely to get infected (adjusted OR 0.28; 95% CI, 0.18-0.45).

In a multicenter, randomized, controlled trial, Hollander worked with Singer to compare tissue adhesives with sutures in determining outcomes in both traumatic and surgical wounds. They looked at infection rates 5 to 10 days after closure and the appearance of the wound at 3 months. A total of 814 adult patients at 10 sites were enrolled and randomized to either adhesive or standard sutures. Wound and patient characteristics were noted at the initial encounter and at follow-up, with impressive follow-up rates of 94%. They found that predictors of wound infection included the use of epinephrine during wound closure, a wide wound (mean difference 3.7 mm; 95% CI, 1.5-5.9), and significant trauma to skin adjacent to the wound (risk ratio 7.5; 95% CI, 1.7-32.2). (See Table 2 on page 6.) Of the 12 infected wounds, 9 were closed with adhesives (infection rate 2.0%) in contrast to 3 infections noted in wounds closed with standard methods (0.6%); however, the numbers are too small to draw definitive conclusions. In this study, clinical judgment of cosmetic outcome at 3 months was measured using a standardized assessment form. Ninety-four percent of patients followed up, and 82% were judged to have an “optimal” result.

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**Table 2 on page 6.** Of the 12 infected wounds, 9 were closed with adhesives (infection rate 2.0%) in contrast to 3 infections noted in wounds closed with standard methods (0.6%); however, the numbers are too small to draw definitive conclusions. In this study, clinical judgment of cosmetic outcome at 3 months was measured using a standardized assessment form. Ninety-four percent of patients followed up, and 82% were judged to have an “optimal” result.
Primary Closure Versus Healing By Secondary Intention

The ideal timing for wound closure was addressed previously, in the section on history taking (see page 4). When primary closure is either not indicated or not an option based on the injured child’s presentation, the emergency clinician should be well versed in other possible approaches.

The technique of delayed primary closure dates back to at least World War I, and there is literature to support its use based on the acceptable infection rate of only 3% in those high-risk wounds. The technique involves cleaning the wound thoroughly and then debriding it as appropriate upon presentation. A fine gauze is applied within the wound, and then the entire wound is covered by a thick, impermeable dressing to prevent further contamination and to absorb the drainage wicked away by the gauze. The wound should be examined by a healthcare professional at day 3 or 4 for another round of cleaning and debridement. Closure can then be performed if the wound appears to be clean and healing satisfactorily.14

For obvious reasons, this multistage approach is not suitable for most children with wounds since it prolongs the trauma associated with wound closure. Instead, a more palatable method for pediatric use may be to allow wounds that are complicated by delayed presentation to heal by secondary intention. In this method, the wound is cleaned and dressed and then allowed to heal on its own. This method is a reasonable choice for small wounds. Quinn et al compared this approach with suturing in wounds less than 2 cm in diameter and found no significant differences in outcomes; however, healing by secondary intention might result in a less acceptable scar in patients with larger or complicated wounds.17

Sedation

Laceration repair has been reported to be the second most common indication for procedural sedation in children under 2 years of age.18 (See Figure 1.) Within the past 15 years, several reports in the literature have looked at the safety and efficacy of various pharmacologic means of providing pediatric sedation,19 and these studies were reviewed in the May 2006 issue of Pediatric Emergency Practice.20

With regard to wound repair alone, some repairs are better tolerated and yield better outcomes when the patient receives anxiolytic medication or a sedative. Although multiple factors must be considered when determining the need for this procedural adjunct, the factor most often cited is the child’s age, although this will not necessarily predict how the child will handle the procedure. Both the children and their parents will have different levels of anxiety depending on the circumstances in the ED, and the clinician must be able to discern these and treat appropriately and effectively. (See Clinical Pathways on pages 12 and 13.)

Non-pharmacologic methods of anxiolysis including distraction and hypnosis have been found effective and are supported in a recent Cochrane review.21 Child life specialists are especially helpful with this due to their training as well as their ability to focus on this rather than the technical side of the procedure as well.

For relatively short procedures in anxious children, oral midazolam is an effective agent. For longer or more complicated repairs (for instance lacerations around the face where the child’s anxiousness is heightened), sedation with a combination of midazolam and fentanyl is often necessary. The patient must be monitored closely for the development of respiratory depression.

Table 2. Risk Factors for Wound Repair Complications.16

<table>
<thead>
<tr>
<th>Complication</th>
<th>Risk Factors</th>
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<tbody>
<tr>
<td>Infection</td>
<td>Use of epinephrine</td>
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<tr>
<td></td>
<td>Wide wound</td>
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<td></td>
<td>Older patient</td>
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<tr>
<td></td>
<td>Trauma to surrounding skin</td>
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<tr>
<td></td>
<td>Incomplete approximation of skin</td>
</tr>
<tr>
<td>Poor cosmesis</td>
<td>Trauma to surrounding skin</td>
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<tr>
<td></td>
<td>Male gender</td>
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<tr>
<td></td>
<td>Traumatic cause</td>
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<tr>
<td></td>
<td>Extremity location</td>
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<tr>
<td></td>
<td>Incomplete approximation of skin</td>
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<tr>
<td></td>
<td>Use of electrocautery</td>
</tr>
<tr>
<td></td>
<td>Incomplete approximation of skin at 5-10 days</td>
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</tbody>
</table>

Figure 1. Indications For Procedural Sedation And Anesthesia (PSA) In Children Under Age 218

ety or movement will prohibit a safe and effective repair), a deeper level of anesthesia may be indicated. In this case, the child may need to be referred to a physician trained and credentialed in safe sedation of pediatric patients.

**Anesthesia**

Historically, intradermal anesthetics have been the treatment of choice for making wound repair more tolerable to the patient. Newer modalities have helped this become even better, especially with the pediatric population to whom even the slow infiltration of lidocaine may produce so much discomfort and anxiety that the child is then unnerved and not cooperative with the rest of the procedure. Injectable lidocaine is still indicated when time may be a limiting factor, and a few recent studies have looked at ways to minimize discomfort on injection. When using injectable lidocaine, buffering the solution with 1 cc of sodium bicarbonate per 10 cc of lidocaine makes the local infiltration less painful and has been shown not to change the rate of infection. Many studies have looked at ways to decrease the pain associated with infiltration of local anesthetic and have gleaned that slower infiltration through a smaller needle (ie 27-gauge) of a solution that has been buffered or warmed may make this more tolerable for the patient. It is also helpful to enter the subcutaneous space from the wounded edge of the skin rather than the intact layer.

This review would be incomplete without mention of safety concerns with these injections. Be careful in choosing lidocaine with or without epinephrine. The combination product is useful in decreasing bleeding at the injection site and increasing hemostasis due to the vaso-constrictive actions of epinephrine. Epinephrine should not be used in areas of the body with distal perfusion and thus should be avoided on ears, nose, fingers, toes, and genitals. Another safety concern is the maximal dose of lidocaine, which is summarized in Table 3.

Useful information for the clinician is provided in a thorough review of randomized controlled trials on topical anesthetics introduced in the early 80s. Tetracaine, adrenaline and cocaine (TAC) was the first product released and many studies showed it to have equal if not superior efficacy to intra-dermal lidocaine. Tetracaine, adrenaline, and cocaine was quickly replaced by newer agents that proved to be just as effective without the cost and risk associated with the cocaine-containing product. Lidocaine, adrenaline, and tetracaine gel (known as “LAT solution” or “LET gel”) is the most commonly studied of these formulations, and as of July 2010, 5 mL of LET costs only $1.87 as opposed to $19.82 for TAC. Lidocaine, adrenaline, and tetracaine gel has the advantage of cost, the lidocaine has a quick onset of action, and the tetracaine component affords longer anesthetic effects.

**Wound Cleansing**

Clinicians learn in medical school that one of the first steps in avoiding wound infection is to apply topical antiseptic to the surrounding area prior to intervention, yet the literature on this topic is scarce. The goal is to decrease the presence of bacterial organisms on the skin surface while not causing further damage to the wound and surrounding tissues. The 3 main types of topical antimicrobials used in this setting are agents in the iodine family (eg, povidone-iodine), alcohols, and chlorhexidine gluconate. In 2008, based on a review of the literature on antiseptic use in the preoperative setting, the National Institute for Health and Clinical Excellence (NICE) released guidelines on how to avoid postoperative infection. Although the authors found no evidence that any one agent was better than another, they concluded that minimizing microbial contamination of the wound should be the standard of care. A more recent randomized, controlled study in adult surgical patients found that cleaning the skin with chlorhexidine–alcohol preparations before surgery led to significantly fewer postoperative infections than did cleaning with povidone-iodine.

**Irrigation**

Wound irrigation has been done for centuries and is considered basic first aid. Recent research has centered on the choice of fluid, the volume of irrigant, and the pressure with which it is instilled into the wound area. Normal saline has been the primary agent based on the assumption that a sterile isotonic solution is best for healing tissue. However, recent studies have challenged this assumption. In a Cochrane Database Review updated in 2008, Fernandez and Griffiths summarized 11 trials investigating irrigant fluids. Seven of these articles compared normal saline to tap water, 3 compared irrigation with water to no irrigation at all, and the final article looked at pro-

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**Table 3. Maximal Doses And Volumes Of Topical Anesthetics**

<table>
<thead>
<tr>
<th>Product</th>
<th>Maximum Dose</th>
<th>Maximum Volume</th>
</tr>
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<tbody>
<tr>
<td>1% lidocaine with epinephrine</td>
<td>7.0 mg/kg of body weight</td>
<td>0.70 mL/kg of body weight</td>
</tr>
<tr>
<td>1% lidocaine without epinephrine</td>
<td>4.5 mg/kg of body weight</td>
<td>0.45 mL/kg of body weight</td>
</tr>
<tr>
<td>LET gel (4% lidocaine)</td>
<td>—</td>
<td>0.18 mL/kg of body weight</td>
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caine spirit versus water in episiotomy wounds.\textsuperscript{31} No significant difference in wound healing or rate of infection was found between tap water and normal saline, with a relative risk of wound infection of 1.07 (95\% CI, 0.43-2.64). Because of the wide confidence interval, they concluded that water is possibly as good as sterile saline but that further research is required to confirm this.

Other irrigation fluids have also been studied, although not recently. Of the available agents, a 10\% solution of povidone-iodine is toxic to tissues and therefore should not be used. Although dilution to 1\% (betadine preparation) does not appear to be significantly toxic to tissues and it may be of use in contaminated wounds, its benefits also remain unclear. Hydrogen peroxide, a common household agent, is also a poor choice of irrigant because of its tissue toxicity and ineffectiveness in infection control.\textsuperscript{14}

As discussed in the March 2005 volume of \textit{Emergency Medicine Practice}, the volume and pressure of the fluid used for irrigation have been studied, although mostly in animal models. Since the late 1950s, the volume of irrigation fluid has been noted to be inversely proportional to its effectiveness in eradicating bacteria. Singer et al looked directly at the pressure generated by different irrigation techniques and found that using a 35-mL or 65-mL syringe with a 19-gauge needle provided effective high-pressure irrigation (> 25 pounds per square inch), although results in animal models have indicated no change in bacterial counts with high-pressure versus low-pressure irrigation;\textsuperscript{32} some researchers using animal models have theorized that high-pressure irrigation could, in fact, drive the bacteria deeper into the tissues.\textsuperscript{32,33}

**Closure Method**

Several wound and patient characteristics can be used to help determine the most appropriate closure method. (See Table 4.) The emergency clinician will want to select a method that is efficient and easy to perform and that will minimize both pain and scarring. Wound tension, location, and depth are also important factors to take into account. Other key considerations include the time required to perform the procedure (and therefore the time the child will need to remain still), cost, operator training, and level of pain.\textsuperscript{34}

**Tissue Adhesives**

Although the cyanoacrylates or tissue adhesives have been used since the 1970s, they are still the most current materials employed in wound repair. They have been particularly useful in the pediatric population, where a fear of needles and short attention spans are prevalent. A review of tissue adhesives was published by Farion et al in a Cochrane Review in 2001\textsuperscript{35} and then later in \textit{Academic Emergency Medicine} in 2003. The authors reviewed the literature and found 13 articles based on 8 randomized, controlled studies that compared tissue adhesives with more standard methods of wound closure (staples, sutures, or adhesive strips) and 1 study that compared 2 different tissue adhesives. The most common outcome evaluated in these studies was cosmesis, with results measured at 5 to 14 days, 1 to 3 months, or 9 to 12 months. No significant differences were seen when tissue adhesives were compared with more standard methods of wound closure. Models that compared pain levels (as described by the patient, the parent, or the physician) or time required for the procedure showed that tissue adhesives provided a significant advantage. Closing a wound with tissue adhesives saved an average of 5.7 minutes (95\% CI, 3.1-8.2), but the standard wound closure methods were less likely to result in dehiscence (risk difference 0.04). Rates of infection, discharge from the wound, and delayed healing were small in both groups, with no significant differences between them. In the 1 study comparing butylcyanocrylate (BCA) to octylcyanoacrylate (OCA), the outcome measures of cosmetic result, pain level, duration of the procedure, and rate of infection or dehiscence did not differ significantly.

In a Canadian study, Osmond et al compared the costs of nonabsorbable sutures, absorbable sutures, and tissue adhesives and found that tissue adhesives saved nearly $50 and absorbable sutures saved $38 (in Canadian dollars in 1995). They also noted that parents indicated a preference for tissue adhesives even if they had cost more than other methods.\textsuperscript{36}

Octylcyanoacrylate, the more commonly used molecule, is a monomer with longer chains than BCA and a stronger tensile strength clinically. In 2008, using an animal model, Singer et al compared the tensile strength and flexibility of various tissue adhesives on the day of application and then 2 days later.\textsuperscript{37} Octylcyanoacrylate was found to be more flexible and to have a higher bursting strength

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**Table 4. Factors Influencing Choice Of Closure Method**

<table>
<thead>
<tr>
<th>Provider Factors</th>
<th>Ease of use</th>
<th>Cost</th>
<th>Time</th>
<th>Ability to minimize pain and scarring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound Factors</td>
<td>Depth</td>
<td>Tension</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Patient Factors</td>
<td>Age</td>
<td>Anxiety level of patient and parents</td>
<td>Comorbidities</td>
<td></td>
</tr>
</tbody>
</table>

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on each day of analysis. This well-structured study shows the advantages of OCA over the other molecules available.\textsuperscript{37,38}

Another functional use of tissue adhesives is in patients with facial wounds. So-called “Langer lines,” which have been described for centuries, have been mapped to show the way healing skin will pull based on underlying tissue and muscle. A 1998 study looked at the difference in results in the repair of facial lacerations that paralleled Langer lines versus those that crossed these lines, and it showed that tissue adhesives were superior to suturing.\textsuperscript{39} Suturing in which the wounds crossed Langer lines led to notably poorer results than when the wounds ran parallel to these lines. On the other hand, wounds that were closed with tissue adhesives showed comparable results, regardless of the orientation of the wound.

**Suture Properties**

The suturing of wounds has been described as far back as 3500 BCE, with the earliest materials consisting of naturally occurring substances.\textsuperscript{40} In the modern era, there are many options available to the clinician and multiple factors to consider before choosing the material with which to approximate a wound. Hochberg et al performed a thorough review of suture choices, describing the qualities of the various suture materials as well as the materials available today.\textsuperscript{34} In order to decrease inflammation and infection rates, the emergency clinician should generally choose a synthetic material over a naturally occurring one, particularly for dermal sutures. Natural fibers are the most irritating to the already damaged tissue. Furthermore, synthetics absorb less fluid than natural substances and are therefore less likely to serve as a conduit for invading bacteria. Monofilament sutures also absorb less fluid than multifilament sutures, making them safer to use, especially with dermal sutures.

The location of the wound dictates the most appropriate cross-sectional diameter, or gauge, of the suture with the smallest-diameter sutures (highest gauge) being used on the thinnest, most delicate tissues to ensure minimal tension. The clearest example of this is the repair of facial wounds, for which a small-diameter suture is recommended. Facial wounds are generally under less tension, and the use of thin sutures will minimize scarring and trauma to this vulnerable tissue.

To minimize scar formation, it is important to consider the tensile strength of the suture material. This refers to both the inherent strength of the material and how long it will retain that strength in order to hold the wound edges together until the tissue itself has repaired the defect. Lacerations that are under greater pressure (eg, owing to missing tissue or proximity to a joint) will require closure with a stronger suture material. Some materials degrade while in the tissue and thus lose their initial strength. This process of suture degradation differs from the expected process of suture absorption by the surrounding tissue, although absorbable sutures degrade more rapidly than their nonabsorbable counterparts.

Another important property of suture materials is knot security, which is the ability of the material to hold a knot and thus decrease the rate of dehiscence. A minimum of 3 throws with 3-mm ends is generally recommended regardless of the “memory” of the suture material.

**Choice Of Suture Type**

For wounds requiring deep sutures, those involving mucous membranes, and some facial wounds in children, absorbable sutures are the most appropriate. Polyglactin 910 is the most commonly used suture material for these purposes. It is a synthetic, braided fiber that retains up to 40% of its tensile strength after 3 weeks and is completely degraded by 3 months. Polyglactin 910 also comes in a newer formulation, which is a similar fiber that has been partially hydrolyzed and irradiated so that it will be absorbed faster; it is completely degraded by 2 weeks but loses more than half its tensile strength at 5 days. These sutures can thus be used as absorbable dermal sutures in areas of the head and neck where short-term suture strength is desirable. In a 1997 article, Niessen et al compared 2 absorbable synthetic materials, Vicryl Rapide\textsuperscript{TM} and Monocryl\textsuperscript{TM}, and found that the latter yielded better results, with less inflammation and hypertrophic scarring and overall smaller scars. Since this study involved 53 women undergoing breast-reduction surgery, it may not be generalizable to patients with wounds due to trauma.\textsuperscript{41}

Natural fibers used for suturing include plain, chromic, and fast-absorbing gut. Each of these is made from collagen fibers derived from the intestines of sheep or cows, but they have been processed differently, yielding distinctive uses. Plain (or untreated) gut retains its tensile strength for 7 days and is absorbed by 2 weeks. In contrast, chromic gut remains strong for up to 2 weeks. Fast-absorbing gut does just as its name implies and is really only strong for 5 to 7 days.

When it comes to nonabsorbable sutures, silk is the only naturally available option; unfortunately, silk increases the risk of inflammation and infection owing to its absorption of fluids in the surrounding tissue. The most commonly used nonabsorbable materials used in wound management are nylon and polypropylene. Each of these is a synthetic monofilament with similar tensile strengths and causes a minimal inflammatory response. Since polypropylene is more plastic, it reacts better to
swelling and edema without losing its strength. It also exhibits minimal friction, which makes it useful in creating running sutures that will later be removed, although its smoothness requires more throws to keep the knot from slipping. Table 5 on page 10 summarizes suture choices based on the location and depth of the wound.

Proper Closure Method

For small wounds without tension, multiple closure methods may be appropriate. In a 2004 randomized, prospective trial, Holger and colleagues compared the cosmetic results of facial lacerations closed with tissue adhesive, nylon, or fast-absorbing catgut and found no statistically significant difference among the suture choices in the appearance of scar at 9 to 12 months. Another study published the same year by Karounis et al confirmed these results. In their study, 95 patients were randomly assigned to either absorbable (fast-absorbing plain gut) or absorbable sutures (nylon) for wound closure. Each patient was seen within 10 days and then at 4 to 5 months after the wound had been repaired. At the later date, a single plastic surgeon graded each scar based on the wound evaluation score (WES). No difference was noted in the appearance of the wound at the initial follow-up nor in the rates of infection or dehiscence; however, at the long-term follow-up, the average visual analogue scale (VAS) for reporting pain level was 79 (95% CI, 73-85) for those patients with absorbable sutures and 66 (95% CI, 55-76) for those with nonabsorbable sutures. (The VAS for pain has a range of 0 to 100, with higher numbers representing greater pain levels.) The authors found no statistical difference in the rate of dehiscence, but it is notable that the nonabsorbable sutures had a dehiscence rate of 11% in contrast to 2% in the absorbable group (P = 0.07). They concluded that absorbable sutures may actually have some benefits when compared with nonabsorbable sutures, but the 2 are at least equal in terms of outcomes.

The literature includes a number of studies regarding the outcomes with the use of absorbable versus nonabsorbable sutures. In children, absorbable sutures are preferable in that they save the child an anxiety-producing follow-up visit to the doctor for their removal. In a Canadian study, absorbable sutures also proved to be more cost effective. The preference of absorbable sutures has been challenged by the belief that absorbable sutures are more likely to cause an inflammatory response and increase scarring. The 2 studies described above are included in a 2007 meta-analysis of 7 studies on this topic, which showed no significant difference between nonabsorbable and absorbable sutures with respect to cosmetic outcome. Absorbable sutures were favored in studies that examined long-term cosmetic outcome, infection, wound dehiscence, and redness at the wound site. Nonabsorbable sutures appeared to be favored with respect to patients’ satisfaction with the cosmetic result. When traumatic and surgical wounds were included in the analysis, the incidence of infection, extent of scar hypertrophy, and degree of swelling were the same for the 2 types of sutures. Short of conducting a large randomized, controlled trial to confirm these results, this meta-analysis concluded that the 2 groups were comparable in all results.

In a randomized, controlled trial, Luck et al used a visual analogue scale to compare cosmetic outcomes at 3 months after wound closure using nylon versus rapidly absorbed catgut. Although only 47 patients completed the study, no significant difference in cosmetic appearance was evident as rated by parents or observers. In 2 cases, the wounds were closed with fast-absorbing catgut and the wound dehisced, but one of these patients was not seen at the 3-month follow-up and was therefore not included in the analysis. Also, a parental survey at 3 months seemed to indicate better parental satisfaction with the results in the absorbable suture group, although the difference was not significant.

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By this method, the needle is introduced in the same way as with the simple interrupted suture technique, but a second pass through both edges of the wound is carried out. The needle enters the skin just a few millimeters closer to the wound edge than it last exited and then crosses the wound a second time, so the needle will exit the wound closer to the edge than is done for the primary entry. The knot is then tied on that side. Although the vertical mattress technique can be useful for true approximation and wound edge eversion, it should be noted that if these sutures are not removed within 5 to 7 days, “hatch-mark” scarring may result.47

In contrast, horizontal mattress sutures are useful for wounds that continue to bleed or are under a great deal of tension. These sutures must be applied gently to maintain perfusion of the tissue edges and thus allow appropriate healing.

Running, or continuous, sutures can be used and are often time-saving, since they obviate the time spent on tying knots with multiple throws each. Unfortunately, in cases when the suture material breaks or the provider sees that the wound is not lying appropriately, the entire repair must be aborted and restarted. Therefore, in traumatic wounds, interrupted sutures are generally the best choice. No studies could be found that compared suturing techniques with regard to outcome results.

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### Special Circumstances

#### Specialist Consult

Although many lacerations can be managed successfully by the emergency clinician, certain wounds will require consultation with a specialist. (See Table 6.)

Children with facial trauma often benefit from plastic surgery or otolaryngology services. For example, injuries to the external ear may require a complicated repair to restore the normal contours and prevent chondritis, which can be aggressive.47 Otolaryngologic consultation should also be considered for children with oropharyngeal trauma. Case reports document the risk of internal carotid artery damage and thrombosis, with subsequent neurologic deficits following seemingly minor soft palate injuries.48 These complications are rare, and a recent study by Soose et al failed to identify clinical factors that might predict which children are at greater risk.49 The emergency clinician should therefore consider an ear, nose, and throat (ENT) consult and/or computed tomography (CT) angiography in such cases.

Cosmetic concerns in children with facial wounds also influence the decision to consult. Plastic surgeons are frequently consulted for these cases, especially for lacerations in certain

### Table 6. Reasons To Consult With A Specialist

<table>
<thead>
<tr>
<th>Site of Wound</th>
<th>Findings of Concern</th>
<th>Specialist Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>Complicated external ear injuries</td>
<td>Plastic surgeon</td>
</tr>
<tr>
<td></td>
<td>Soft palate injuries</td>
<td>Otolaryngologist</td>
</tr>
<tr>
<td></td>
<td>Cosmetic concerns</td>
<td>Ophthalmologist</td>
</tr>
<tr>
<td>Hand</td>
<td>Deep injuries</td>
<td>Orthopedic surgeon</td>
</tr>
<tr>
<td></td>
<td>Neurovascular compromise</td>
<td>Plastic surgeon</td>
</tr>
<tr>
<td></td>
<td>Bite wound</td>
<td>Hand specialist</td>
</tr>
<tr>
<td>Genitals</td>
<td>Possible abuse</td>
<td>Gynecologist</td>
</tr>
<tr>
<td></td>
<td>Females:</td>
<td>Urologist</td>
</tr>
<tr>
<td></td>
<td>Extensive injury</td>
<td>Child Abuse Team</td>
</tr>
<tr>
<td></td>
<td>Hymen involvement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Males:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extensive injury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laceration or avulsion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urethral involvement</td>
<td></td>
</tr>
<tr>
<td>Over a joint</td>
<td>Potential joint space involvement</td>
<td>Orthopedic surgeon</td>
</tr>
<tr>
<td>Multiple locations</td>
<td>Need for general anesthesia</td>
<td>Anesthesiologist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trauma surgeon</td>
</tr>
</tbody>
</table>
Clinical Pathway For Treating Pediatric Wounds

Wound risk factors:
- Infected? (Class I)
- Obvious contamination? (Class I)
- Sustained > 18 hr ago? (Class II)

Closure by secondary intention or
Delayed primary closure

NO

Wound < 6 hr old? (Class I)

YES

• Imaging, if indicated, for foreign bodies
• Consult specialist, if indicated

Primary closure preparation

NO

• Clean, viable tissue?
• Well-vascularized area?
• No comorbidities that might lead to poor wound healing? (Class II)

YES

Primary closure preparation

NO

• Anesthesia — topical or injectable (Class I)
• Cleanse: chlorhexidine–alcohol preparation (Class II)
• Irrigation: tap water or saline (Class II)
• Choose closure method: suture, cyanoacrylate, staples

YES

Sedation needed?

Refer to “Clinical Pathway: Pediatric Pain And Anxiety In The ED” (See page 13)

Class Of Evidence Definitions

Each action in the clinical pathways section of Pediatric 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
- Non-randomized or retrospective studies: historic, cohort, or case control studies
- Less robust RCTs
- 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


This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient’s individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

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Clinical Pathway: Pediatric Pain And Anxiety In The ED

Invasive ED procedure that produces pain, anxiety, or both

Can the procedure be completed with local anesthesia alone?  
YES  Topical anesthesia, local anesthesia, or both (Class II)

NO  

Will the addition of child life or other behavioral technique be enough to complete the procedure?  
YES  Local anesthesia along with child life or other behavioral technique (Class I)

NO  

Will inhaled nitrous oxide be a helpful adjunct, and is this child cooperative?  
YES  Inhaled nitrous oxide by demand mask (Class II)

NO  

Will PO midazolam be a helpful adjunct?  
YES  Oral or intranasal midazolam (Class II)

NO  

Is there any reason that the patient is not an appropriate candidate to be sedated in the ED to complete the procedure?  
YES  Consultation or transfer to a facility with pediatric anesthesia and surgical services (Class II)

NO  

Choose appropriate drug regimen (Class II)
Administer sedation in the ED under appropriate, close monitoring (Class II)
Disposition when appropriately back to baseline mental status (Class III)

This clinical pathway is intended to supplement, rather than substitute for, professional judgement and may be changed depending upon patient's individual needs. Failure to comply with this pathway does not represent a breach of the standard care.

1. “I didn’t notice the smaller wound which became infected.”
Providers must resist the temptation of focusing on the obvious. Thorough examination of trunk and extremities for minor or hidden injury must be part of the patient assessment. Recognition of such “covert” injuries prevents increased complication risk such as infection or scar formation after secondary-intention closure.

2. “He wouldn’t hold still for long, so I cleaned the best I could and used liberal antibiotics to prevent infection.”
Cleansing, irrigation, and debridement are more effective at prevention of infectious complications than antibiotic use alone. Short cuts put patients at risk of complications and increase provider liability.

3. “The patient’s father said he removed the glass from the wound.”
Evaluation of traumatic injury demands a detailed examination of the entirety of the wound’s length, width, and depth. If foreign material caused the laceration or wound, suspicion should be high that there may be retained debris in the wound. When in doubt, or if history suggests, obtain ultrasound, CT, or magnetic resonance imaging (MRI) if necessary before completing a primary closure.

4. “I never knew she had something that would cause poor wound healing.”
Past medical history can reveal any of a long list of conditions which can lead to poor healing on their own or as a result of medication use. Chronic corticosteroid or other immunosuppressive therapies are not uncommon in children, especially those with neoplastic or autoimmune disease. After the patient is assessed for hemostasis, take the time to get a thorough history.

5. “I use topical antibiotics on all primary closures, including staples and tissue adhesives.”
Topical antibiotics are excellent at reducing post-closure infection risk. However, they should not be placed over cyanoacrylate adhesives, as they may dissolve the adhesive and lead to wound dehiscence.

6. “The sutures took so long to place with the kid thrashing about.”
Poor outcomes, including extending ED time and costs, can occur when the child is not properly prepped with appropriate anesthesia and sedation, if needed. Emergency clinicians should be experienced in first-line sedation for children and should not hesitate to consult with anesthesia colleagues if a child needs a deeper level of sedation than the clinician is comfortable administering.

7. “I’ve repaired many facial lacerations, so I disagreed when the parents wanted a plastic surgeon.”
Wounds on the face, although low risk for infection due to excellent vascularity, are often the reason for litigation due to scarring or less-than-acceptable outcomes. Parental requests for specialist services should always be taken seriously, even when the emergency clinician feels comfortable with their abilities.

8. “His fingers were swollen from the injury and he didn’t want to bend them.”
This is not an unreasonable response for failure to assess flexor and extensor tendon integrity; however, it is not an acceptable excuse. Ability to assess function and strength against resistance, without the patient having to move the fingers very much, can lead to suspicions of tendon damage.
locations, such as the vermillion border of the lip, where scarring could produce obvious deformity and potentially impair function. Furthermore, there is some evidence that the injection of botulinum toxin into the facial muscles underlying the laceration may inhibit scarring, so consultation with a specialist may make such an intervention available to the patient.50

Hand lacerations constitute a significant number of ED visits and raise concern over loss of function. In a retrospective review of all children with hand injuries who presented to an ED, 27% of all injuries involved a laceration — a rate second only to that of contusions or hematoma as the most frequent diagnosis. Of these lacerations, 72% required primary closure.51 In a study at the Yale–New Haven Hospital Emergency Service, 6.1% of hand lacerations had deep-structure injuries, of which 36.4% involved damage to tendons.52 Flexor tendon injuries must involve a workup for neurovascular injury, while intra-articular damage must be assessed in the case of extensor tendon injuries.53 For this reason and because of the potential for loss of function, a suspected tendon injury should prompt consultation with a hand specialist. Similarly, any laceration with potential nerve involvement or associated with neurologic findings on examination warrants a referral.54 Nail bed injury may also require specialized care. Finally, one study revealed that 16% of pediatric hand injuries seen in the ED required consultation with a specialist.51

Genital wounds may or may not require a specialist consult. In a retrospective review by Spitzer et al of unintentional female genital trauma over 3.5 years at The Hospital for Sick Children in Toronto, straddle injury was the most common mechanism; however, these injuries were less likely to require consultation.55 Out of all patients in their cohort, only 49% required gynecologic consultation and only 19% underwent operative management. Factors that were significantly associated with gynecologic consultation and the need for surgery included older age, interhospital transfer, shorter time to presentation, laceration-type injury, hymenal injury, and larger size of injury. This study examined only accidental trauma; wounds relating to sexual trauma were not included. However, the possibility of abuse must be considered by the emergency clinician who encounters a child with genital trauma. Separate histories should be obtained from both the child and the caregiver to help in distinguishing accidental genital trauma from abuse, and concern is warranted when the child is not forthcoming with details about the injury.56

The literature on pediatric male genital injuries is sparse. Based on reports of adult male injuries, the American Association for the Surgery of Trauma (AAST) has created an injury scale for solid organs including the male genitals; this scale was validated in a retrospective review by Mohr et al in which adult male patients with external genital injuries could be stratified on the basis of their injury score into those who required operative treatment and those who could be managed with nonoperative treatment.57 The AAST scale is based on the type, size, and location of each wound. Some data are available to help differentiate accidental from nonaccidental trauma in male children; a small retrospective study by Kadish et al demonstrated that scrotal trauma was more frequently accidental while rectal lesions were more suggestive of abuse.58 As with female patients, a careful history and examination are paramount in deciding whether to pursue an abuse work-up.

Wounds that appear to overlie a joint space also deserve special consideration. Consultation is reasonable if there is any concern that the wound has penetrated the joint capsule because of the risk of joint sepsis. For injuries to a large joint, the consultant may wish to perform the methylene blue test, in which dye is injected to detect extravasation as a sign of joint involvement.

In some cases, lacerations may be numerous enough to merit operative management under general anesthesia, even if none of the individual wounds is complicated. This is especially true for children who are not likely to tolerate a long procedure or those who have medical conditions that might complicate conscious sedation.

**Bite Wounds**

Bite wounds are relatively frequent and are associated with additional issues largely related to infection. (For a full review of this subject, please see the September 2009 issue of Pediatric Emergency Medicine Practice.) Dogs are responsible for 85% to 90% of mammalian bite wounds, followed by cats (5%-10%), humans (2%-3%), and rodents (2%-3%); however, the incidence of infection is highest in cat bites (up to 50% of cases), followed by human bites (in about 18%), and finally dog bites (5%-10%).59

The initial management of bite wounds, as for any type of traumatic laceration that carries the risk of infection, includes aggressive irrigation and debridement as needed. Most bite wounds can be closed primarily without increasing the risk of infection if the wound is less than 8 hours old.60 Wounds that should not be closed include puncture wounds, cat or human bites, minor hand or foot wounds, wounds in immunocompromised patients, and wounds that already appear to be clinically infected.59

Dog bites are more common in children than in adults, are typically inflicted by a dog with which the child is familiar, and are commonly
provoked. Such wounds may include abrasions, lacerations, and puncture wounds. In addition to staphylococcal and streptococcal species that may be found in any skin wound, the microbiology in a bite wound may include Pasteurella multocida, Pasteurella canis, and Capnocytophaga canimorsus. Cat bites are more likely to be puncture wounds, with an incidence of Pasteurella multocida up to 10 times higher than in dog bite wounds, resulting in an overall higher rate of infection.

Human bites in young children are typically located on the face, arms, or trunk; child abuse should be suspected if the bite mark has an intercanine distance greater than 3 cm. A human bite from a young child is much less likely to become infected than a bite wound inflicted by an adult.

In adolescents, the hand is involved in 75% of human bites. The wound may be occlusional, in which the teeth are closed over the patient’s skin, or a clenched-fist injury, in which the patient hit the teeth of an adversary with his fist. The latter results in the highest incidence of infection, often following a seemingly minor wound, because relaxation of the hand from the clenched-fist position inoculates the bacteria into deeper, less vascular fascial layers. These injuries require careful exploration for tendinitis or deep compartment infection. Infected human bite wounds are typically polymicrobial and may include anaerobes, especially bacteroides or peptostreptococcus species, or Eikenella corrodens, which can cause significant morbidity. An additional concern with human bites is the potential for spread of systemic illnesses, such as HIV infection, syphilis, or hepatitis B.

Except for uncomplicated dog bites to the head or neck, prophylactic antibiotics should be prescribed for patients with a mammalian bite wound. The typical choice is amoxicillin–clavulanic acid, administered at a dose of 30 to 50 mg of amoxicillin per kg of body weight per day in 2 doses; a broad-spectrum cephalosporin or trimethoprim–sulfamethoxazole plus clindamycin may be used for patients allergic to penicillin. The duration of therapy is typically 7 to 10 days.

The final concern with bite wounds is the potential for rabies infection if the animal is wild or its vaccination status is unknown. If the animal has an owner, currently appears healthy, and can be observed for 10 to 14 days with no signs of a change in its condition, rabies prophylaxis is not indicated. Postexposure prophylaxis recommendations have recently been published and include human rabies immunoglobulin at 20 IU/kg (half given intramuscularly, half infiltrated locally around the wound) plus 4 doses of human diploid cell vaccine administered intramuscularly. Patients who are immunocompromised require 5 doses of vaccine, while those who have previously been immunized, with documented titers, require only 2 doses.

Medical Conditions Requiring Special Consideration

Physiologically, wound healing requires a functioning immune system. Therefore, patients who are immunocompromised, whether from disease or medication, require special consideration. The emergency clinician must be careful when observing a wound for infection, since many of the clinical signs may be absent in an immunosuppressed host. Because of their decreased ability to fight infection, such patients are candidates for prophylactic antibiotics along with inpatient management and observation. Furthermore, wound healing is slower in immunocompromised patients, so they should be prepared for a more prolonged course. In a study by Karpelowsky et al of HIV-infected children undergoing surgery, 51% experienced wound complications, such as tissue breakdown or sepsis. One potential factor contributing to these complications is the generally poor nutritional status of immunocompromised patients. Assessment of nutrition and potential supplementation including zinc and vitamin C should be considered.

There is a dearth of literature on the repair of wounds in patients with bleeding disorders. One case report describes the formation of a false aneurysm following a puncture wound in the hand of a hemophiliac, which emphasizes the importance of adequate factor VIII replacement and a careful evaluation for bleeding in these patients.

Controversies/Cutting Edge

Emergency clinicians are frequently asked about measures that can be taken to reduce scarring. Appropriate overall wound care, which includes cleaning, closure, a moist environment for healing, and steps to prevent infection, is necessary to minimize scar formation. Beyond that, several topical treatments have been marketed for this purpose, one of which is a topical extract of onion gel with the active ingredient allium cepa; however, the majority of studies do not support the marketers’ claims. Jackson et al performed a pilot study comparing topical onion gel extract to a topical petrolatum-based emollient and found that only the emollient produced a statistically significant reduction in scar erythema; the topical onion gel extract did not improve scar erythema or reduce pruritus. Similarly, a randomized, double-blind, split-scar study demonstrated no difference in scar appearance or patient symptoms between the half of the scar treated with onion gel extract and that treated with a petrolatum-based emollient. In those studies that did show a benefit, treatment with onion gel was compared with no treatment. It is therefore reasonable to recommend regular
application of any emollient beginning at the
time of suture removal to promote wound heal-
ing and minimize scar formation.

Anecdotal data attest to the role of topical vita-
mom E in reducing the appearance of scars. However,
in a double-blind, split-scar study, Baumann and
Spencer reported no improvement in scar appear-
ance or symptomatology after 12 weeks of treatment
with emollient versus emollient mixed with vitamin
E. Furthermore, 33% of patients developed a contact
dermatitis in response to the vitamin E application,
so the study authors discouraged its use. 72

Research on the molecular mechanisms
involved in scarring has led to promising future
interventions. The observation that embryonic
tissues do not form scars prompted an investiga-
tion into the growth factors present in tissues at
various ages. One drug has been developed to
optimize levels of growth factors to match those in
embryonic tissues and is currently being studied
in clinical trials. 73 Another study reported results
in which basic fibroblast growth factor was in-
jected locally into postsurgical wound margins. 74
Those patients that received the growth factor
had a lower incidence of hypertrophic scars or
scar widening, with no serious side effects. While
these treatments are not yet used routinely, they
may represent the next generation of therapies to
reduce scar formation.

Disposition

The majority of uncomplicated lacerations in chil-
dren can be managed in the ED, after which the
patient can be discharged for follow-up with the
general pediatrician. Potential criteria for inpatient
admission include any systemic signs of infection,
involvement of joints or tendons, immunocompro-
mised status, a wound requiring reconstructive sur-
gery, or any infected wound that has not responded
to oral therapy. 75 Ultimately, the decision will also
depend on the overall health of the child as well
as the reliability of the family to return to the ED
quickly if complications arise.

Antibiotic Prophylaxis

The decision to prescribe topical or systemic anti-
biotics for prophylaxis needs to be made prior to
discharge. In general, infection rates are low for
wounds that are not grossly contaminated and that
have been appropriately cleaned, irrigated, and de-
brided before being repaired. Various studies docu-
ment the infection rates in pediatric wounds to be
between 1.3% and 3.0%. 76,77 The emergency clinician
should consider the various factors associated with
an increased incidence of wound infection, as listed
in Table 7.

Reviews of antibiotic prophylaxis in simple
lacerations of the hand found no conclusive ben-
efit of such therapy when the wound was properly
prepared prior to repair. 78,80 Similar results were
reported in a review of intraoral wounds. 81 Al-
though a small placebo-controlled, randomized
trial demonstrated a trend toward a decreased
infection rate with oral antibiotic prophylaxis, a
second randomized trial actually showed in-
creased rates of infection. The authors of this
review raised several concerns about the design
of the second study, but the issue remains that
no conclusive data exist for or against the use of
prophylactic antibiotics in children. 81

Furthermore, topical and systemic antibiotics
may be equally effective. 82 In a study of wounds
that had become secondarily infected, 2 random-
ized, double-blind studies demonstrated that
topical mupirocin applied 3 times daily was as ef-
effective in clearing the infection as oral cephalaxin
given 4 times daily. Topical antibiotics exhibit im-
proved delivery to the skin and are not absorbed
systemically, thus avoiding many of the adverse
effects of oral antibiotic therapy, including the
development of resistant organisms. In addition,
the emollient component of the topical formula-
tion aids in wound healing as discussed later in
this paper. 83 It is generally reasonable to manage
patients who have uncomplicated lacerations with
topical antimiicrobials for wound care.

Available options for topical antibiotics include
bacitracin, mupirocin, and triple antibiotic ointment
(TAO), yet relatively few data are available that
directly compare these agents. Triple antibiotic oint-
ment contains bacitracin, neomycin, and polymyxin
B in a petrolatum base, and in a recent study it de-
omnstrated activity against many methicillin-resistant
Staphylococcus aureus (MRSA), community-acquired
MRSA (CA-MRSA), mupirocin-resistant gram-posi-
tive strains and all coagulase-negative staphyloccoci,
Pseudomonas aeruginosa, and Enterobacter isolates. 84

Table 7. Risk Factors For Wound Infection 78

<table>
<thead>
<tr>
<th>Host Factors</th>
<th>Very young age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td>Chronic renal failure</td>
</tr>
<tr>
<td>Obesity</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>Immunosuppressed</td>
<td></td>
</tr>
<tr>
<td>Wound Factors</td>
<td>High bacterial content</td>
</tr>
<tr>
<td>Soil contamination</td>
<td>Crush injury</td>
</tr>
<tr>
<td>Stellate laceration</td>
<td>Sterile site (ie joint)</td>
</tr>
<tr>
<td>Bite injury</td>
<td></td>
</tr>
<tr>
<td>Treatment Factors</td>
<td>Use of epinephrine-containing solution</td>
</tr>
<tr>
<td>Greater number of sutures</td>
<td></td>
</tr>
<tr>
<td>Less experienced physician</td>
<td></td>
</tr>
</tbody>
</table>
In a small randomized, prospective study comparing TAO and mupirocin, patients treated with mupirocin had a higher rate of infection, but the difference did not achieve statistical significance. There is some concern about sensitizing patients to TAO, specifically to the neomycin component, so this product should not be taken for longer than 1 week at a time. Overall, however, TAO is cheaper than either bacitracin or mupirocin and has equal clinical efficacy; its use is appropriate for most patients unless there are significant concerns about pre-existing sensitivity to neomycin.

For wounds believed to be at high risk for infection, Table 8 lists names and dosing schedules for commonly used first-line systemic antibiotics.

Relatively novel compounds are also being reported for use in wound care. Honey, especially that made from plants of the Leptospermum species, has natural antimicrobial activity and is now FDA-approved for wound dressing. Studies have documented bactericidal activity against isolates, including MRSA, vancomycin-resistant enterococci, and Pseudomonas species. Should these findings be further confirmed in randomized, controlled trials, the use of honey may increase. A new antibiotic called retapamulin has also recently been licensed for use in superficial skin infections. It has a novel mechanism of action, is at low risk for cross-resistance with other antibiotics, and has demonstrated efficacy against streptococci and staphylococci (including staphylococci resistant to methicillin, mupirocin, and fusidic acid).

**Tetanus Prophylaxis**

The other issue that must be addressed prior to discharge is the status of tetanus prophylaxis. The history should include information about the patient’s tetanus immunization status, if known. Children may receive the tetanus and diphtheria vaccine (Td) and/or tetanus immune globulin (TIG) according to the Centers for Disease Control and Prevention Pink Book. (See Table 9.)

For children 4 to 6 years of age who have not yet received their preschool vaccines, the administration

**Table 8. Common Wound Infections And Suggested Systemic Treatment**

<table>
<thead>
<tr>
<th>Wound Type</th>
<th>Common Pathogens</th>
<th>Systemic Antibiotic</th>
<th>Recommended Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacerations, abrasions</td>
<td>Staphylococci, streptococci</td>
<td>Cephalexin or</td>
<td>25-50 mg/kg/day, every 6 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dicloxacillin or</td>
<td>50 mg/kg/day, every 6 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Erythromycin (if patient is sensitive to penicillin)</td>
<td>30-50 mg/kg/day, every 6-8 hours</td>
</tr>
<tr>
<td>Puncture wounds</td>
<td>Staphylococci, streptococci</td>
<td>As above</td>
<td>As above</td>
</tr>
<tr>
<td></td>
<td>Pseudomonas (osteochondritis)</td>
<td>Antipseudomonal agent (eg, ceftazidime) given intravenously</td>
<td>100-150 mg/kg/day, every 8 hours</td>
</tr>
<tr>
<td>Human bites</td>
<td>Staphylococci, streptococci, anaerobes</td>
<td>Amoxicillin-clavulanic acid or</td>
<td>30-50 mg/kg/day, twice a day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clindamycin and</td>
<td>10-30 mg/kg/day, every 8 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trimethoprim sulfamethoxazole (if patient is sensitive to penicillin)</td>
<td>8-10 mg/kg/day, twice a day</td>
</tr>
<tr>
<td>Animal bites</td>
<td>Staphylococci, streptococci, Pasteurella, Eikenella</td>
<td>Same as for human bites</td>
<td>Same as for human bites</td>
</tr>
</tbody>
</table>

**Table 9. Recommendations For Tetanus Prophylaxis**

<table>
<thead>
<tr>
<th>Vaccination history unknown or &lt; 3 doses</th>
<th>Give Td</th>
<th>Give TIG</th>
<th>Give Td</th>
<th>Give TIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Minor Wounds</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>All Other Wounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccination history ≥ 3 doses</td>
<td>Only if last dose received ≥10 years ago</td>
<td>No</td>
<td>Only if last dose received ≥ 5 years ago</td>
<td>No</td>
</tr>
</tbody>
</table>

Td = tetanus and diphtheria vaccine; TIG = tetanus immune globulin

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of the diphtheria–tetanus–acellular pertussis (DTaP) vaccine is recommended.

Although immunization status is relatively easy to determine in young children, it may become more difficult in older teenagers. New bedside testing has demonstrated good reliability and reproducibility for predicting tetanus immunity in adults with unknown status who present to the ED. Such real-time testing may eventually help obviate prophylaxis for teenagers whose vaccination status is unknown.

Summary

Accidents happen — they always have and they always will. Children, being at various developmental stages, curious, and unaware of real dangers, represent ideal candidates for self-inflicted and accidental traumas. Consequently, emergency and primary care physicians around the globe will never be in short supply of patients needing their clinical skills and experience. Patterns of injuries in children are consistent over time, and the paradigm for evaluation and adequate treatment of pediatric wounds has remained essentially unchanged. Of primary importance is the ability to recognize those wounds which pose the greatest risk for complications or poor outcomes, thereby increasing patient satisfaction and reducing liability to medical providers and their employers.

Case Conclusions

The autistic child with multiple forearm lacerations was initially very anxious about letting medical personnel examine his injuries. Topical LET gel was applied to his wounds while his parents comforted him and he participated when appropriate. After an informative discussion with his parents, you administered oral midazolam. High-pressure irrigation and cleansing was performed, and a tissue adhesive was chosen for all but the 2 largest lacerations on his right arm. These were infiltrated with buffered lidocaine for complete anesthesia and primarily closed using interrupted 4-0 nylon sutures. After returning to baseline mental status, he was discharged home with follow-up instructions to his primary care provider to remove the sutures after 1 week.

The 5-year-old required only topical anesthesia for cleansing and further evaluation of her wound. The laceration appeared to be clean and not deep, and it was felt that simple interrupted suturing with 6-0 nylon would lead to a good result. However, since the parents were extremely anxious about their only daughter having potential facial scarring from this wound, they requested consultation with a plastic surgeon, who subsequently performed the appropriate procedure. A child life specialist was also called in and assisted in relieving both the patient’s and the parents’ anxiety during the visit.

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, such as the type of study and the number of patients in the study, will be included in bold type following the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, will be noted by an asterisk (*) next to the number of the reference.

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CDC.gov/NCHS Accessed 12/11/09. (Multicenter Survey Data)
41. Niessen FB, Spauwen PH, Kon M. The role of suture material in hypertrophic scar formation: monocryl vs vicryl rapideTM. Ann Plast Surg 1997;39(3):254-60. (Prospective, comparative; 81 patients)
2. A 1-year-old boy presents with a 2-cm facial wound that runs perpendicular to Langer’s lines. The most appropriate next step is:
   a. Closure with tissue adhesive
   b. Irrigation with water
   c. Assess for risk of intracranial injury
   d. Application of topical anesthetic
   e. Discharge home with wound care instructions

3. You repair a facial wound on a 6-year-old girl without previous medical problems. Her mother is worried about scar formation. The best advice you can give her about minimizing the appearance of the scar is:
   a. Vitamin E is encouraged to promote healing with minimal inflammation.
   b. Onion gel extracts are very useful in decreasing the red hue of the scar.
   c. A clean wound with adequate moisture yields the best appearing wound.
   d. Sun-exposure allows the surrounding tissue to match the color of the scar.
   e. Young children rarely develop scars.

4. Systemic antibiotics are indicated in which of the following patients:
   a. 4-year-old male with nail bed laceration due to a crush injury of his index finger
   b. 13-year-old female with a 3-cm laceration to the sole of her foot obtained while walking barefoot in a stream
   c. 12-year-old male status post renal transplant with laceration to forehead after hitting head on a shelf during a fall
   d. 2-year-old male with a laceration over the right knee obtained in a car accident
   e. All of the above

5. Which of the following is NOT an acceptable adjunct to anesthesia for wound repair in the emergency department:
   a. Topical anesthesia
   b. General sedation
   c. Oral midazolam
   d. Local lidocaine infiltration
   e. Inhaled nitrous oxide

6. A 6-year-old boy is brought to you after falling from a swing and hitting his forehead on the ground. You note a 2-cm long gaping laceration over his right supraorbital ridge, involving the eyebrow. The wound appears clean. Of the following, the most appropriate next step in management after hemostasis is attained is to:
   a. Allow the wound to heal by secondary intention.
   b. Cleanse the wound with saline by using a 19-gauge catheter and 35-mL syringe.
9. Which of the following factors is NOT associated with an increased risk for wound infection?
   a. Use of epinephrine
   b. Incomplete approximation of skin
   c. Trauma to surrounding skin
   d. Male gender
   e. Wide wound

10. A fluid shown to be likely to be as effective as saline for wound irrigation is:
   a. 10% povidone-iodine
   b. Benzalkonium chloride
   c. Dilute hydrogen peroxide
   d. Potable tap water
   e. Benzyl alcohol

11. Which of the following is a true statement regarding the use of tissue adhesive over suturing when appropriate?
   a. Tissue adhesives have demonstrated better cosmesis.
   b. Suturing is more time-effective than using tissue adhesives.
   c. Suturing is more cost-effective than using tissue adhesives.
   d. Tissue adhesives are equal to suturing for high-tension wounds.
   e. Use of tissues adhesives provide less patient anxiety during wound closure.

12. Which of the following wounds should not be closed primarily?
   a. Cat bite wounds
   b. Human bite wounds
   c. Puncture wounds
   d. Infected wounds
   e. All of the above

7. An 8-year-old girl is brought to the hospital after being struck by a car. Examination reveals normal vital signs, and the girl is alert and interactive. She has several lacerations involving the right parietal area, middle of the upper lip, left distal forearm, and left middle metacarpal-phalangeal joint. Findings on the remainder of the physical examination are normal. Of the following, the most appropriate statement regarding wound management is that:
   a. Administration of prophylactic antibiotics is the most effective means of preventing secondary infection.
   b. Application of tissue adhesive is an acceptable alternative to suturing the laceration over the metacarpal-phalangeal joint.
   c. Laceration of the lip involving the vermilion border should be managed by an adhesive wound closure tape.
   d. Pulsating hematoma in the distal forearm warrants urgent exploration.
   e. Scalp laceration should be allowed to heal by secondary intention if it is more than 4 hours old.

8. Wounds account for nearly _____ % of all emergency department visits for children under the age of 15.
   a. 5
   b. 10
   c. 20
   d. 40
   e. 60
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Management Of Wounds In The Pediatric Emergency Department
Sagerman PJ, McBride AS, Halvorson EE. September 2010; Volume 7, Number 9

Rare is the emergency department shift — urban, suburban, or rural — that does not include a visit from a pediatric patient with an open wound. Once the jurisdiction of the primary care providers (ie, the pediatric or family practice office), management of even minor wounds is becoming less common in that setting as concerns over time, reimbursement, and liability are sending more children to urgent care clinics and EDs for initial evaluation of their injuries.1 In this issue of Pediatric Emergency Medicine Practice, we will focus on the evaluation and management of the patient with an injury-related open wound using the best available evidence from the literature.

### Evidence-Based Practice Recommendations

**Key Points** | **Comments**
--- | ---
Thorough medical histories should be obtained in every child prior to planning the specific management of any wound, to ascertain if any confounding conditions exist which may complicate wound closure or healing. | During the history, be sure to elicit mechanism of injury, timing of injury, tetanus status, time of most recent oral intake, environment in which injury occurred, allergies or reactions to previous wound repairs, medical problems that will affect the procedure (eg, autism, attention deficit–hyperactivity disorder), and medical problems that may impair healing ability (diabetes, immunocompromised state, steroid use, obesity.)

Closure by secondary intention for small wounds is not associated with poorer outcomes than primary closure. | In closure by secondary intention, the wound is cleaned and dressed and then allowed to heal on its own. This method is a reasonable choice for small wounds. Quinn et al compared this approach with suturing in wounds less than 2 cm in diameter and found no significant differences in outcomes; however, healing by secondary intention might result in a less acceptable scar in patients with larger or complicated wounds.17

Proper cleaning, irrigation, and debridement are the most important steps in prevention of infectious complications of most pediatric wounds. | Apply topical antiseptic to the surrounding area prior to intervention to decrease the presence of bacterial organisms on the skin surface while not causing further damage to the wound and surrounding tissues. The 3 main types of topical antimicrobials used in this setting are agents in the iodine family (eg, povidone-iodine), alcohols, and chlorhexidine gluconate.25 A recent randomized, controlled study in adult surgical patients found that cleaning the skin with chlorhexidine–alcohol preparations before surgery led to significantly fewer postoperative infections than did cleaning with povidone-iodine.26

Tissue adhesives are time- and cost-saving and preferred by parents when used for appropriate wounds. | Although the cyanoacrylates or tissue adhesives have been used since the 1970s, they are still the most current materials employed in wound repair. They have been particularly useful in the pediatric population, where a fear of needles and short attention spans are prevalent.

Laceration repair is the second most common indication for procedural sedation in children.18 Consultations with specialists are extremely important in wounds occurring in high-risk locations. | Although many lacerations can be managed successfully by the emergency clinician, certain wounds will require consultation with a specialist. (See Table 6, page 11.) Children with facial trauma often benefit from plastic surgery or otolaryngology services. For example, injuries to the external ear may require a complicated repair to restore the normal contours and prevent chondritis, which can be aggressive.47 Otolaryngologic consultation should also be considered for children with oropharyngeal trauma.

Child-life specialists can be valuable alternatives or adjuncts to pharmaceutical sedation. | When the clinician is confronted with a fearful child with active bleeding and an anxious parent, it is easy to overlook pertinent facts that will affect the repair and the long-term outcome. It is important to allay fears and anxiety while at the same time obtaining a thorough history and carefully evaluating the injury. Often talking calmly to family members about their child’s history and how the injury occurred will engender trust and decrease anxiety.
REFERENCES


These references are excerpted from the original manuscript. For additional references and information on this topic, see the full text article at ebmedicine.net.

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