**Lacerations**

A. History and initial evaluation  
Where and when the injury occurred  
Mechanism of injury – Is there possibility of an underlying injury, retained FB, or bite?  
Size and location of the wound  
Sensory function and vascular integrity  
Tetanus status  
Contributory past medical history: allergies, bleeding diathesis, medications, etc

B. Objectives  
Restore function  
Produce optimum cosmesis  
Avoid infection  
Hemostasis  
Improve healing time  
If possible have a painless wound repair

C. ED Assessment  
Examine wound adequately – You must see the bottom of the wound to  
Most times anesthesia is required before adequate inspection can occur  
Achieve hemostasis with direct pressure, and or, vasoconstrictors  
Decide how you the wound should be closed, or whether you will close it at all  
If the wound is dirty, contaminated, or may have a retained foreign body decide to how you will approach the laceration. You may need to obtain radiographs(to rule out fractures or foreign bodies), or other studies.

**Timing**  
Ideal closure of a wound is within 12-18 hrs (some wounds have been closed at 24-72 hrs. after they have occurred).  
If the location or type of injury has a low risk of infection, it may be closed later than if it is an area that has a high risk  
Areas that are important cosmetically may be closed later if there is a low risk of infection.  
Generally, after 24 hours wounds should not be sutured.  
The extremities probably should not be sutured if over 16 hours because of the high infection rates

**Animal Bites**  
Dirty or Animal(Human) wounds: infected or infection-prone wounds such as human or animal bites should generally not undergo primary closure.

**Anesthesia**  
Topicals – LET(Lidocaine, Epinephrine, Tetracaine)  
Topicals are most effective when used in smaller lacerations(<7cm) on highly vascularized areas like the scalp and face.  
They have been shown to be as effective on the face and scalp as infiltration with lidocaine.  
They do not work well on extremity lacerations or areas that are not highly vascularized.
Application of topical anesthetics
Topicals are painless and effective if used appropriately. They require adequate penetration of the wound and may require two applications to be maximally effective.

**The major mistake is poor application technique!**
LET is best applied in or on a vehicle. Dribbling a little into the wound directly is not a problem but not as effective as leaving it in there on a vehicle.

**Methylcellulose Gel**
Methylcellulose gel comes as a powder, and when mixed with a liquid forms a gel. The LET gel can be placed both deep into and superficially on the wound, allowing excellent anesthesia. Tegaderm can cover the gel to apply some pressure and keep the gel in place.

**Cotton**
LET can also be applied onto gauze or cotton and placed on top of the wound. The best method is to place the LET onto a soaked Q-tip and place it into the wound, then soak a 2x2 gauze with LET and cover the top of the wound.

Tape, Band-aids, or Tegaderm can hold the Q-tip and gauze in place. CAUTION! LET applied to loose cotton has been noted to be a problem (as a retained FB) and is not recommended for applying LET!

**Best Application of LET:**
Coverage all the way into wound to get both deep and superficial anesthesia
Change LET after 10 minutes with second application
Apply pressure with the LET(Tegaderm/tape)
Leave the LET on for at least 20 minutes, or until the wound is blanched around the edges, for optimal anesthesia(leaving on up to an hour is no problem, the site will still be numb)

**Injection:** Local injection or Nerve blocks(blocks will be covered later)
Local injection of Lidocaine 1% solution (2% solution provides no additional benefit and increase risk of toxicity
Max. dose 4.5mg/kg may use larger doses if with epinephrine 6-7mg/kg)
Onset of action approx. 3-5 minutes.
Warning! Cannot use lidocaine with epinephrine on digits or end organs, such as ears, nose, penis, toes.

Pain of injection may be decreased by:
Using the smallest needle possible, preferably a 27 or 30 gage. Longer 27 gage needles keep from having to inject as many times as with a shorter needle. Injecting lengthwise also decreases the number of injections.
Buffering the lidocaine with bicarbonate at a 10:1 dilution(10ml lido:1ml bicarb)
Injecting slowly through the wound margin
Inject lidocaine 1cm. around the entire wound edge to achieve good anesthesia
If it is a clean wound, it can be infiltrated through the wound margin.
**Preparation of the wound**
Remember, before inspection and irrigation, anesthesia is required to decrease pain!

**Irrigate, Irrigate, Irrigate.**
A clean wound should be irrigated with at least 50-100cc of normal saline per centimeter of wound length. The more the better.
Saline is the fluid of choice, although clean tap water has found to be as effective
Be sure to open up the wound and remove the overlying clot to get good access to the bottom of the laceration.
Irrigation of contaminated wounds should definitely be done under high pressure, using a 18 gage catheter or a broken needle, and the use of 100-200cc per centimeter

**Inspection** of the wound is critical. You must be able to visualize the bottom of the wound to insure there is no foreign body.
When in doubt, obtain a radiograph
Examination also allows you to see if other underlying structures are involved.

**Debridment** - Necrotic skin, discolored or free subcutaneous fat and fragments of tissue containing foreign body. Irregular lacerations can be trimmed to achieve a better cosmetic effect. Avoid increasing tissue damage when debriding.

**Hair removal** - Hair removal is generally not necessary or recommend.
Hair follicles are a source of infection and one should avoid traumatizing them.
If the hair needs to be removed, than clip it off rather than shave it
Shaving the hair should be avoided because it has been shown to increase the wound infection rates compared with hair clipping.
Avoid shaving the eyebrows! They may not grow back or grow back abnormally.

**Antisepsis** - “Disinfection of the skin around the wound should be initiated without contacting the wound itself.”
Betadine and chlorhexidine are both tissue toxic killing the living tissue, and can damage the wounds defenses and invite infection. DO NOT POUR OR PUT INTO WOUNDS!

**Suture Selection**

<table>
<thead>
<tr>
<th>Body Location</th>
<th>Suture size</th>
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<tbody>
<tr>
<td>Face</td>
<td>5-0 to 7-0</td>
</tr>
<tr>
<td>Scalp</td>
<td>4-0 - 5-0</td>
</tr>
<tr>
<td>Extremity</td>
<td>3-0 - 5-0</td>
</tr>
<tr>
<td>Mouth</td>
<td>4-0 - 5-0</td>
</tr>
</tbody>
</table>

Note: Larger suture is used over areas of tension and extremities, smaller sutures on the face.
Usually on the face we use 5.0 or 6.0 suture sizes.

Needles: cuticular, plastic or reverse cutting
3/8 circle reverse cutting is the most common
Suture selection (continued):

**Absorbable** sutures – Used for deep or subcutaneous areas, or for superficial lacerations where
the stitches will dissolve quickly without scarring
Chromic gut – especially in the mouth areas
Vicryl – Braided and good for closure of two layer wounds
Monocryl – Similar use as vicryl, but monofilament and less tissue reactivity
Plain gut – Use for superficial wound care closure on the scalp, face, and extremities without
tension
Rapid absorbing plain gut – Very fragile, but excellent for lacerations around the eyes,
eyebrows, and other delicate areas of the face

**Non-absorbable** suture – Used for superficial skin closure, especially over areas of high
tension, extremities, or in the face
Nylon sutures:
Ethilon – Excellent for all areas where non absorbable sutures are required. Easy to sew with
Prolene – Good for the extremities, is very stiff, and more difficult to sew with than Ethilon
Silk – Braided and soft, good around the mouth to avoid irritation, high tissue reactivity, vicryl is an alternate(but as a superficial stitch, needs to be removed like a non absorbable suture)

**Staples** - Staples are fast and effective but require removal that may be uncomfortable for the
child. They are easy to apply. They are excellent for long scalp lacerations and can be applied
rapidly to avoid blood loss.

**Tissue Adhesives:** Dermabond (2-Octyl Cyanoacrylate)
Excellent superficial wound closure technique - Quick, easy, safe, no removal
Helps provide an antimicrobial barrier, sealing out infection
Best for small wounds under no tension, or for wounds where a layer of deep sutures have been
placed. Think of it as a superficial skin closure technique. This means that you still will
require anesthesia, a suture tray, irrigation, and sterile gloves.
Contraindications
Do not use tissue adhesives with dirty wounds – will seal the bacteria in leading to an infection
Animal bites – NEVER!
Suspected retained FB (Dirt, wood, metal, etc.)
Active skin infections – Impetigo, abscesses, etc
Do not use over areas of high tension without subcutaneous sutures, splinting, or other
immobilization techniques
Do not use in areas that are exposed to moisture repeatedly
Do not use with a history of cyanoacrylate or formaldehyde allergy
Wound preparation:
Anesthesia - Apply LET to wound. This allows for excellent inspection and irrigation without
pain. Also the epinephrine will give hemostasis which will facilitate the Dermabond
application. The wound should be dry before using Dermabond
INSPECT, IRRIGATE, and DEBRIDE! Most failures with Dermabond have less to do with
Dermabond and more to do with the lack of adequate wound preparation.
Dermabond application
To use the ampoule, crush the inner vial and express the glue to the end of the applicator tip. Release and let the pressure equilibrate in the vial. Approximate the edges of the wound with your fingers, forceps. Press the vial gently and lightly paint the glue onto the wound. Apply at least 3 layers allowing the glue to dry between layers. The glue dries with an *exothermic reaction* that can cause minor stinging or burning. Advise the parent and child of this. Waving or blowing on the glue to help it dry faster does not help speed the process, and makes you look ignorant. Optimal application may require two people, one to hold the wound together, and the other to apply the glue. Be careful to never let the glue get into the wound, it will delay healing and increase scarring. If this happens, let the glue dry and peel the glue out, and then redo the laceration. Be sure to achieve hemostasis before applying the glue. Bleeding in the area will cause the glue to discolor and bead up - looks ugly, and decreases effectiveness of the wound. Use of the Dermabond ampoule involves a learning curve in order to have the right pressure to get the proper flow of glue. Studies indicate a rapid attainment of efficiency with Dermabond. Placing petroleum ointment on surrounding areas will prevent TA from sticking to them. May choose to use it as a barrier to keep the glue from running. **Use with care around the eyes!** Runoff is a significant problem in this area. The entire area of TA may be peeled off if needed. It comes off slowly as a sheet. Petroleum ointment may help loosen the glue.

**Tape closure** (Steri-strips)
Unless a very small cut over an area of no tension, steri-strips and butterfly bandages are not the method of choice for wound closure. They may be used as adjuncts for other wound closure techniques. If using, use with an agent that promotes adhesion, like mastisol or benzoin.

**Preparation of the patient**
Decide whether the child needs immobilization, sedation, or a combination of both. Be sure the wound is adequately anesthetized prior to starting. Arrange on the stretcher for the most ease in completing the procedure. Usually placing the patient’s head at the foot of the bed allows easier access for the person suturing. Have a papoose, a sheet, towels, chucks, and gauze ready as needed. If the patient is immobilized, so your best to avoid any delays which may increase agitation and decrease your success.
Getting yourself and staff ready

Get everything that you need ready before you start:
gloves
suture kit
suture material
anesthetic
syringe and needles
irrigating solution
antibiotic ointment and dressings

Use disposable gloves and quickly cleanse the wound and areas around it and remove any obvious foreign body that can be easily taken out.

Prior to injecting anesthesia document the sensation and function distal to the wound.

After wound anesthesia, inspection and preparation, we are ready to suture. Discard disposable gloves, injection needles and remove wet, or bloody material around the work site.

Get help. Someone to hold the child still, papoose, direct light source to suture site, open suture packets, etc…..

Now you can put on your sterile gloves.

Suturing, the procedure

Basic rules to remember:
Do not hesitate to cut out and replace any suture you are not completely satisfied with!
If the patient is unable to be sutured consider sedation, or reassess the need to suture at all.
The patient will have the scar for the rest of their life, so take your time and do a good job.
Take pride in your work. Practice will lead to success. This is not an easy skill to learn, it will take time. Suturing moving targets who are crying is a difficult task, but very doable.

Placing the sutures:
It is better to use smaller sutures placed closer together than larger sutures farther apart.
Wound edges should only be approximated to accommodate edema; tissue should not be strangulated.

For optimal cosmetic result, wound edges should be everted when closed.

Bites should be about 4-5 mm from wound edges.
Sutures should be spaced about 5 to 7 mm apart, enough to approximate the wound edges but not so tight to cause ischemic skin edges.

Loose but snug approximation of wounds produce stronger wound margins because proliferative activity can occur in the wound clefts, and proper wound edge alignment is encouraged. Too tight is not good.
The actual procedure of suturing:
Make sure to use a needle holder, not the hemostat. The needle holder is flat and not curved.

1. Arming the needle:

Place the needle holder 1/3 of the way from where the suture begins, just below the swag, where the needle is hollow, and joins the suture material.

2. Using the needle properly
   Let the needle do the work!
   Use the curve of the needle to guide where the suture will go.
   Do not use excessive force, or try to jam the needle through the skin. Never bend the needle.
   A bent needle is the result of poor technique, positioning, or a bad choice of needle selection.

3. Handling the tissue properly
   Do not increase trauma to wound or you will increase the risk of infection or scarring.
   Avoid grasping or pinching the skin with the forceps (a common mistake). There is rarely a need to do this!
   The edge of the forceps may used to lift or expose the areas to be sutured. Avoid puncturing the skin if at all possible except to place the stitch.

4. Gripping the needle holder

Many people prefer the thenar grip because it allows enough rotation at the wrist to drive the needle all the way through.

5. Entering the skin. Must be at a 90 degree angle to the skin in order to have a nice circular stitch that is even all the way around.
6. The simple interrupted suture
Most commonly used method of closing traumatic lacerations.
Appropriate for closing almost all wounds that are under minimal or low tension
Should be the mainstay of your suture technique

Drive the needle in the skin at 90 degrees

Roll the needle holder with your wrist through the tissue

Finish the arc of the needle, and the grasp the needle just below the tip, so not to dull it

Have more tissue at depth than at the surface
**Tying the knot**

Wrap the suture around the needle holder twice and then grasp the loose end of the suture, pulling it tight. Lacerations under a lot of tension may require you to wrap the suture around the needle holder three times on the first throw to keep the tension in the knot. After the first throw, then you will only need to wrap the suture once around the needle holder. It is extremely important that your knot be square and lie flat, otherwise they may come undone.

Generally the amount of knots or throws will correspond to the size of the suture. So, for example 6.0 size suture should have at least 6 knots. As a rule no less than 4 throws should be ever used. Avoid excessive tension which may break sutures and cut tissue. Practice will lead to successful use of finer gauge materials. Do not tie sutures used for tissue approximation too tightly, as this may contribute to tissue strangulation. *Approximate -- do not strangulate.*

**Suture removal**

<table>
<thead>
<tr>
<th>Wound location</th>
<th>Days to removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>2-5 days</td>
</tr>
<tr>
<td>Scalp</td>
<td>5-7 days</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>7-10 days</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>8-10 days</td>
</tr>
<tr>
<td>Extensor surface joint</td>
<td>10-14 days</td>
</tr>
</tbody>
</table>

**Post wound dressing care**

Dressing should provide:
- protection
- absorption
- compression
- immobilization

**1st layer**- non adherent sterile dressing

**2nd layer**- absorbent gauze

**3rd layer**- gauze wrap

**Antibiotic usage**

Dirty wounds are more likely to develop infection an may benefit from prophylactic antibiotics. Some recommend IV antibiotics for very contaminated wounds, or for areas such as the hands.
Most non bite wounds will be contaminated with staph or strep. We use had been using Keflex or a second generation cephalosporin, but with so much MRSA, clindamycin is a better choice. Erythromycin or Clindamycin if Penicillin allergic.

**Bites**
Very superficial bite wounds that do not involve full thickness of the skin may be managed with local wound care, irrigation and dressing.
Deeper bite wounds require a more broad spectrum antibiotic such as Augmentin for 3 – 7 days.

**#1 Dog bites** – Most frequent type of bite. Bacteriology is complex, but most common is *Pasturella Multocida, and Staph Aureus*

Cat bites – Very frequently get infected because it is a deep puncture wound. Most common infecting organism is *Pasturella Multocida*. Use Augmentin.

Human bites – Open wounds around the knuckles should always raise the suspicion of an injury involving the human mouth. Augmentin is a good choice.

**Tetanus status** should always be ascertained and immunization given in accordance to the Red Book recommendations. Usually if the child has had more than three doses of the tetanus toxoid than they will only need the Td(adult tetanus and diphtheria), every 10 years for a clean wound and every 5 years for a dirty wound. Other recommendations for children younger than 7 may include DTaP. Please check the Red Book for more precise information as needed.

**Discharge instructions**
Should be complete and include the following:
Dressing change and wound care, antibiotic ointment if indicated(Dermabond does not need ointment, and has a separate set of discharge instructions.)
Follow up care. If a wound check is needed to check for infection etc, when that needs to be done.
Explain signs of infection or complication
Whether or not the stitches dissolve
If they are non absorbable then the date of suture removal, and how many sutures were placed.