Principles of Suturing Wounds and Basic Skills: Evidence Based Review

Pathophysiology of wound healing
The healing of every wound takes place in overlapping phases. Healing by first intention occurs when the skin edges are in contact, as when held by sutures. Immediate haemorrhage produces a fibrin-rich blood clot in the small gap and a mild acute inflammatory reaction is initiated.

Macrophages and granulation tissue soon invade the area – the former to remove debris including fibrin, the latter to begin the process of organisation. This continues rapidly until a relatively small scar is produced. Meanwhile, the squamous epithelium of the adjacent overlying epidermis migrates and proliferates until continuity is restored.

The wound healing process occurs over a period of months. The period between 7-10 days is most vulnerable to unwanted opening. The wound has only about 5% of normal tensile strength after two weeks. At two months, the wound has regained about 35% of normal tensile strength (Singer et al, 2002).

Assessment of the patient
This begins by taking a history from the patient, including knowledge of any potential host factors that maybe a risk for delayed healing. Healing may also be impaired in inherited and acquired connective tissue disorders, such as Marfan's syndrome. The tendency of the patient to form keloid should be ascertained, because this may result in a poor scar. Anatomical variation in regional blood flow and skin flora also plays a part in determining the likelihood of infection.

Finally, the patient's tetanus status should be assessed and any allergies to local anaesthetics, latex or antibiotics should be determined.

Assessment of the wound
Although most wounds are caused by shear forces, problematic wound mechanisms include animal or human bites, punctures, decubitus ulcer wounds and crush injuries with burst lacerations. Crush wounds are more susceptible to infection (De Souza et al, 2002).

This starts with a look, feel and move approach. It is important to examine the wound meticulously in all cases. This is usually best done in a controlled area such as a suture room in the emergency department (ED) with correct lighting and with control of bleeding. This will allow a search to identify foreign bodies and any injury to vital structures (such as nerves and tendons).

Wounds over joints and tendons should be put through a full range of motion to reduce risk of missed injury, as their position during the injury may differ from their position during the examination.

A detailed neurovascular examination based on your knowledge of anatomical structures around the wound should be performed and documented before anaesthesia and closure. Perfusion should be assessed by palpation of pulses and capillary refill distal to the injury.
Materials and equipment

If the ideal suture existed it would be biologically inert and cause no tissue reaction. It would be very strong but simply dissolve in body fluids and lose strength at the same rate that the tissue gains strength. It would be easy for the surgeon to handle and knot reliably, as well as being reasonably priced. It would neither cause nor promote complications. However, despite great improvements in suture materials, no single suture is ideal in all circumstances.

Regardless of its composition, suture material is a foreign body to human tissue and will elicit a foreign body reaction to some degree.

Suture materials can conveniently be divided into two broad groups: absorbable and non absorbable. Two major mechanisms of absorption result in the degradation of absorbable sutures. Sutures of biological origin, such as catgut, are gradually digested by tissue enzymes. Sutures manufactured from synthetic polymers are principally broken down by hydrolysis in tissue fluids and are the preferred material. Non-absorbable sutures, such as nylon, are made from a variety of non-biodegradable materials, and are ultimately encapsulated or walled off by fibroblasts.

The sizes and tensile strengths of all suture materials are standardised. Size denotes the diameter of the material - and the smaller the diameter, the less tensile strength it will have. Stated numerically, the higher the first number, the smaller the diameter of the suture.

Examples of suture size used are:

- trunk and lower limbs 3/0
- scalp 2/0, 3/0 or 4/0
- upper limbs 4/0
- most wounds 4/0
- face 5/0, 6/0

In children the gauge is usually reduced by one size.

Preparation and technique

In the ED, verbal and sometimes written informed consent must be taken. This should include the reason for the procedure, the principles involved (including use of anaesthetic) and complications expected.

Preparation of the suture equipment involves use of the aseptic technique. This is the method by which contamination of surgical wounds and other susceptible sites by pathogenic microorganisms is prevented. Asepsis is achieved by:

- good hand hygiene – hands are the common route of infection
- use of protective clothing
- use of sterile gloves and forceps, e.g. sterile drapes should be placed over the wound
- sterilisation of instruments, materials and fluids
- decontamination of the dressing trolley

A suture pack usually consists of sterilised instruments as shown in Figure 1.
Sterile water should be available for cleaning the wound; however, some recent studies have shown that ordinary tap water of drinking quality is as effective at irrigating and cleansing wounds as normal saline solution (Angeras et al., 1992; Riyat and Quinton, 1997; Moscati et al., 1998).

The wound is then isolated with sterile towels.

Several suturing techniques exist but interrupted sutures are generally used in the ED for the following reasons:

- they are technically easier to insert than continuous sutures and easier for the less experienced physician
- if a single suture is placed incorrectly, it is easy to replace without disrupting the remaining sutures
- alternate sutures can be removed, e.g. in facial wounds, where a good cosmetic effect is paramount, or in infected wounds, where it may be necessary to allow the drainage of pus
- suture removal is usually simple and less painful for the patient
- it is usually easier to achieve accurate alignment of the wound edges due to the process of inserting each suture individually
• the insertion technique is to begin at strategic points along the wound and working out towards the edges. Consequently, the alignment is usually good.

The technique of suturing begins by selecting the tissue forceps, needle and needle holder. Hold the needle holders in your dominant hand by placing the thumb and ring finger into the rings and the index finger on the hinge of the blades (Figure 3). This position permits good control of the instrument. Scissors should be held in a similar position.

![Figure 3: Ideal way to hold the needle holder](image)

The needle should be grasped in the holders on its flattened area approximately one-third of its length away from the suture material (Figure 4).

![Figure 4: Holding of needle with needle holder](image)

To facilitate eversion (turning outwards), support the wound edge with the tissue forceps and insert the needle 5 mm from the edge perpendicular to the skin surface (Figure 5). This creates good apposition without excessive tension. As the wound heals, it causes slight inversion with contraction; this will result in a flat scar. Where skin edges curl under during suturing they tend to invert further, leading to poor healing and a less satisfactory cosmetic result.
Ensuring that the needle remains at right angles to the wound, follow the natural curve of the needle by rotating the wrist and move through each side of the wound separately. Do not be tempted to traverse both wound edges with one bite of the needle.

![Figure 5: Suturing at right angles to the wound](image)

When the needle emerges from the wound (Figure 5), pull the suture through the tissues until a short tail remains at the initial skin entry site. Then enter the opposite side of the wound at the same depth as the first bite. Again, follow the natural curve of the needle by rotating your wrist so that the needle emerges at the same distance from the wound edge as the first bite and at right angles (Figure 6).

![Figure 6: Needle emerging after second bite](image)

To tie the suture, keep the needle holders parallel to the skin and grasp the needle end of the suture. Then make two clockwise loops around the needle holder, followed by a single anti-clockwise throw.
Note that each successive throw is looped around the forceps in the opposite direction to the last and that all the knots should be seated on the same side of the wound. The suture can then be cut free from the knot, leaving tail lengths of approximately 5 mm, before beginning the next insertion.
Finally, dispose of all sharps in the appropriate and safe manner.

**Local anaesthesia**
Consider general principles such as safety and maximum doses (3 mg/kg plain lidocaine or 7 mg/kg of lidocaine with epinephrine). Contraindications to anaesthetic use include allergies, refusal or poor cooperation by the patient, and giving nerve blocks when a bleeding disorder exists. You should have an idea of which anaesthetics are available in your ED and what their safe doses are. Anaesthesia should only be used when needed, e.g. during exploration or suturing of a wound.

Consider using the following nerve blocks for regional anaesthesia:
- ring blocks – plain lidocaine for digits
- supraorbital blocks
- median, ulnar or radial blocks – wrist blocks
- greater auricular nerve block for the ear
- dental blocks, such as infra-orbital or mental nerve block
- ankle blocks for plantar lacerations

**Management**
Patients should be instructed to keep their wounds clean. Most wounds should be covered with a protective, nonadherent dressing for at least 24-48 hours to ensure sufficient epithelialisation to protect them from gross contamination (Schauerhamer et al, 1971). After this period, patients may wash their wounds but should not scrub or soak them.

The routine use of prophylactic antibiotics is not recommended (Cummings and Del Beccaro, 1995). Antibiotic use should be tailored to the individual on the basis of:
- degree of bacterial contamination
- presence of infection-potentiating factors, such as soil
- mechanism of injury
- host factors

In general, decontamination is far more important than the use of antibiotics. Antibiotics should be reserved for most human, dog and cat bites, as well as for some intraoral lacerations, open fractures and exposed joints or tendons (Steele et al; 1989; Cummings, 1994).

Trott (1997) also found that the use of adhesive tapes was associated with decreased infection rates. Wound adhesives are also associated with less microbial growth than sutures, partly because they lack invasive matter.

Antibiotic selection should be based on the suspected microorganism. Over 90% of wound infections are caused by *Staphylococcus aureus* or streptococcal bacteria. Soil contamination may result in infection with clostridium and gram-negative organisms.

Tetanus prophylaxis must be considered for tetanus-prone wounds (Department of Health, 2006) and also in relation to the immunisation status of the patient (see Table 1).
### Immunisation status

<table>
<thead>
<tr>
<th>Clean wound Vaccine</th>
<th>Tetanus-prone wound Vaccine</th>
<th>Human tetanus immunoglobulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully immunised, i.e. has received a total of five doses of vaccine at appropriate intervals</td>
<td>None required</td>
<td>None required</td>
</tr>
<tr>
<td>Primary immunisation complete, boosters incomplete but up to date</td>
<td>None required (unless next dose due soon and convenient to give now)</td>
<td>None required (unless next dose due soon and convenient to give now)</td>
</tr>
<tr>
<td>Primary immunisation incomplete or boosters not up to date</td>
<td>A reinforcing dose of vaccine and further doses as required to complete the recommended schedule (to ensure future immunity)</td>
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</tr>
<tr>
<td>Not immunised or immunisation status not known or uncertain</td>
<td>An immediate dose of vaccine followed, if records confirm the need, by completion of a full five-dose course to ensure future immunity</td>
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Table 1: Immunisation recommendations for clean and tetanus-prone wounds (Department of Health, 2006)

### Pitfalls

Consider the following points when suturing a wound:

- tie sutures just tight enough for the edges to meet
- handle the skin edges with toothed forceps only
- if an irregular wound, start with a few initial strategic sutures to match up the obvious points
- if the edges meet under considerable tension, consider undermining the skin edges
- if one suture doesn’t look right it can affect the whole wound/scar - consider taking it out and redoing it
- if you encounter difficulties, request senior help within the ED or from a specialist

**Remember**: some areas or wounds are not suitable for suturing, such as pretibial lacerations (consider adhesive strip “sutures”) or bite wounds (may require delayed closure).