



LIMB WOUNDS

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SCENARIO

A 4-year-old boy presents to you with a dilemma. He is conscious and alert with an isolated foot injury.

Perhaps in an effort to control the subcutaneous infection, all the skin from the lower calf and the foot has been excised.

The wound is relatively clean, but at the point of the heel, the calcaneus can be seen.



(ICRC)

KEY POINT

- » All wounds in disaster and conflict situations must be assumed to be contaminated and treated as such. These wounds are at high risk for fatal infections including gas gangrene or tetanus (ACS class 3 and 4).
- » No wound sustained in a disaster or conflict should be sutured primarily. They should be left open and undergo delayed primary closure on day 2-5.



TYPE 1

- Wounds that can be managed at an EMT type 1 facility include:
- Superficial wounds with no nerve, tendon, bone or joint involvement.
- Wounds that can be washed out under local anaesthesia.



TYPE 2

- Wounds requiring debridement require a minimum of type 2 facility to allow for surgical care with anaesthesia.



TYPE 3

- Complex wounds requiring frequent dressing changes may require a type 3 facility to allow for advanced nursing care.

EMT TYPE 1 WOUND MANAGEMENT

Initial care of a wound requires simple washing to minimize contamination and a light dressing for protection of the wound from environmental hazards. Any wound that has been sutured primarily should have the sutures removed if there is any suspicion of infection. Feel for crepitus and fluctuance in the soft tissues. In some patients infection may present with purulence in the absence of swelling or erythema.

- » **If pus is present in the wound, the patient must be transferred to a type 2 EMT for surgical debridement.**
- » Irrigate copiously with between 3 and 12 L of fluid. While isotonic fluid is ideal, drinking water can be used if needed to preserve resources.
- » Wipe the wound surface gently with gauze within the patient's tolerance .
- » Wound cleaning may be facilitated by providing analgesia or local anesthetic, however this should always be within the appropriate scope of care for your level of EMT.
- » **Do not primarily suture any wound.**
(Some exceptions can be made for simple wounds of the face, scalp and perineum).
- » **Antibiotics cannot replace cleaning and surgical debridement of wounds.**
- » Dress the wounds with a bulky absorbent dressing.
- » Following sudden onset disasters, the injured survivors predominately present with wounds sustained during the event, or in the hours or days that follow, as they move around in debris.
- » In hot climates and in the absence of any immediate medical care, contaminated wounds progress quickly to wound infection and tissue necrosis.
- » This is seen clinically as cellulitis, subcutaneous infections, and possibly necrotizing fasciitis with necrotic muscle and gangrene.
- » Wounds from tsunamis typically involve wound infections, while earthquakes tend to create wounds with crush injuries. Both types can result in necrotic tissue that requires debridement.



Figure 2. Initial irrigation and cleaning of a wound prior to any surgical treatment.

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EMT TYPE 2

WHEN TO REFER FROM EMT TYPE 1 TO EMT TYPE 2 FACILITY:

- » Complex wounds that penetrate fascia
- » Contaminated wounds due to requirements for sharp excision and anaesthesia
- » Impaired sensation distal to the wound
- » Bleeding vessel within the wound not controlled by 10 minutes of pressure
- » Infected wounds with obviously necrotic tissue requiring debridement
- » Palpable crepitus in the soft tissues or other signs of deep infection such as increased pain or fever
- » Suspicion of fracture
- » Not possible to administer adequate anesthetic to properly clean the injury

WOUND SURGERY

- » Formal wound surgery (as opposed to wound cleaning) must **not** be performed in an EMT type 1 facility.
- » The goal of wound care surgery is to provide the optimal outcome as early as possible. Surgery will prevent deterioration and allow transfer if available, acknowledging that this may be delayed. **Antibiotics for wounds are an adjunct to surgery and wound cleaning not an alternative.**
- » Wound debridement must be performed in a designated room where safe sedation and anaesthesia can be provided. Surgery must be provided under adequate analgesia and sedation, or anaesthesia as required ensuring that the patient does not suffer pain during the procedure.
- » ***Surgery in disaster and conflicts should still be undertaken with the same precautions as an elective operation in a high resource hospital.***



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Figure 3. Massive lower leg wound following full surgical debridement.

TECHNIQUE FOR INITIAL WOUND EXCISION AND DEBRIDEMENT

- » Remove all dead, contaminated and infected tissue but leave all viable tissue to assist with reconstruction for maximum function.
- » **WOUND EXTENSION:** Every wound must be extended proximally and distally to adequately explore and examine the tissues for necrosis, contamination, and damage of vital structures. Extensions should be in the long axis of the limb, and not transverse, except when crossing a flexion crease. If they are required along the whole length of either the forearm or lower leg, they should be placed to join the lines of election for fasciotomies.
- » Be methodical in excising the wound. Progressively explore and debride in layers from superficial to deep.
- » Sharp dissection using a scalpel or sharp scissors should be used to remove any contaminated tissues. Electrocautery can be used for excision of tissue, but keep in mind that it can leave some dead tissue in the wound.
- » Techniques of excision that minimize bleeding provide an advantage. Carefully consider the use of a surgical tourniquet during debridement; this causes further tissue ischemia and can impair assessment of viable tissues but this must be balanced with the need for a clear view of the wound and prevention of blood loss.



Figure 4.
Recommended incisions for fasciotomy and wound extension (BOA/BAPRAS)

KEY POINT

- » Scraping the surface of damaged muscle with a sharp gynecological ring curette to remove surface necrosis or infection is efficient and effective without stimulating further bleeding.

WOUND DEBRIDEMENT BY LAYERS

Skin is very forgiving and generally has a very good blood supply. Leaving some doubtful skin is not going to result in rapid sepsis, so excise the edges—a maximum of 1–2 mm, or wider where the tissue is contused and ragged. This margin should only be exceeded in the event of **obvious** skin necrosis.

Be very conservative on the face and upper limbs. All viable skin should be left intact at this stage, increasing the subsequent reconstruction options.

Subcutaneous fat that is undamaged and viable should be left, but be generous with the excision of necrotic and contaminated fat.

Fascia that is shiny and clean is left, but excise anything impregnated with dirt or that appears ragged or dull. If the fascia is already grey and thickened with a fur like covering then it needs to be excised as **this is likely necrotizing fasciitis**. Wound extensions are required to excise the affected fascia over the compartment. These extensions may well convert a small puncture wound to a linear wound over the full length of the fascial compartment.

Muscle is unforgiving. All dead and doubtful muscle must be excised. **The timing of second surgery in a disaster or in conflict is never assured; so do not risk leaving doubtful muscle in a wound.** The next wound review is more than likely five days away.

PITFALL

- **Muscle can fail to contract when pinched if the patient is under the influence of a depolarizing paralytic.**
- **Acutely after blast injury, capillary circulation is impaired for several hours, but often returns.**

KEY POINT

VIALBLE MUSCLE IS:

COLOUR: is pink

CONTRACTS: when pinched with forceps

CONSISTENCY: is firm

CAPACITY: to bleed when cut

WOUND SURGERY

- » **BONE** – Remove only the contaminated periosteum taking care to preserve as much as possible. This layer is thick in children but thin in adults.
Articular fragments with a soft tissue attachment should be preserved, but loose bone fragments must be removed.
- » **NERVES** – Do not trim or tag the ends of nerves as it risks further damage. Perineural repairs should only be attempted at the time of definitive operation, when the risk of infection is lower.
- » **TENDONS** – Ragged ends may be sharply trimmed.
- » **BLEEDING** – All wound bleeding must be controlled to prevent formation of haematomas that can precipitate infection. Electrocautery is acceptable if available. Alternatives include suture ligation, clip and wait, or clip and twist.
- » **WASHING** – Pulse lavage is not recommended. Low pressure washout with isotonic fluid is preferred. In the absence of isotonic fluids clean water can be used.

WOUND COVERAGE EXCEPTIONS

- » Wounds in the face, head, neck, perineum and possibly hand may be considered for primary closure.
- » Wounds involving nerves, brain/dura, or vessels (picture right) should not be left without soft tissue coverage.

PITFALL

WOUND COVERAGE

Wounds sustained in conflict or disaster should be considered contaminated and almost never closed primarily, and then only if wound debridement is complete.



Figure 5. Exposed vascular repair in an open leg wound.

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DRESSINGS

- » The simplest dressings are **dry** gauze, or absorptive layers of cotton or wool held in place by elastic bandages. Dressings treated with iodoforn, chlorhexidine or sodium hypochlorite are not required and have been reported to damage host cells and inhibit healing.
- » Bandages should be applied in a traditional figure of eight pattern without tension. This avoids a circumferential bandage becoming a tourniquet when the limb swells.
- » Non-adhesive dressing layers such as petroleum jelly impregnated gauze may be laid next to the wound if the next dressing change is planned in a ward area.

SPECIAL TOPIC: NEGATIVE PRESSURE WOUND DRESSINGS

- » Although there is no published evidence that negative pressure dressings improve healing in acute wounds, their use is of practical benefit. Exudate soaking through dressings is eliminated, patient comfort is improved, and dressing change frequency is reduced.
- » Negative pressure dressings should only be placed on wounds that have been adequately debrided.
- » Foam should be of open cell type and placed only in the wound. Gauze can be safely allowed to overlap on to normal skin.
- » Staff should only use negative pressure dressings if they have experience in the technique.
- » For large wounds and stump dressings it may be necessary to hold the gauze in place with circumferentially wrapped adhesive tape. This should be carefully laid on and not tightly wrapped. Adherence can be improved with tincture of benzoin and application of a 2 cm strip of dressing around the wound edges to create a “window.”

NEGATIVE PRESSURE DRESSINGS IN AUSTERE SETTINGS

A negative pressure wound set up can be created with gauze and perforated tubing. (Figure 6)

- Loosely pack the wound with gauze and place a tube with several holes overlying the gauze. This can run through the dressing as shown or simply exit on one side of the dressing.
- Cover the gauze and tubing with more loose gauze.
- Cover with clear adhesive tape and connect to suction. The dressing should shrink down and become hard if the seal is effective. In the absence of a formal proprietary pump, improvised solutions such as wall suction, vacuum bottles or a vacuum created by using a syringe with the plunger held out with sticks, may be effective.



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DELAYED PRIMARY CLOSURE

- » Delayed primary closure, including skin grafting or repeat wound debridement, should be planned. “Look and see” as a planned procedure is a poor approach.
- » The timing of this next intervention is not strictly fixed. Experience suggests that the window for closure is between day 2 and day 5. An early return to the operating room is indicated if there are clinical signs of infection: fever, tachycardia, pain and malodor—the “bad smell”—for re-debridement.

HEALING BY SECONDARY INTENTION

- » If there is no plan to close the wound, in other words to allow the wound to heal by secondary intention, then dressing changes in a treatment area or ward are possible, as long as acceptable analgesia is achieved.
- » ***It is safer to allow a wound to heal by secondary intention if there is any doubt as to the adequacy of debridement or the presence of infection.***
- » Healing by secondary intention may occur in less than two weeks for wounds less than 2.5 cm in diameter. If healing is expected in less than two weeks, equivalent to the time for a graft to take and the donor site to heal, then skin grafting is not indicated.

ANTBIOTICS

- » Antibiotics are an adjunct to surgery and good wound care. See Open Fractures chapter for ICRC antibiotic guidelines. For wounds sustained in conflict and disaster settings then 3 days of broad spectrum antibiotics are advised. ***An open draining wound is more important than antibiotics.***

NUTRITION

- » The nutritional state of the patient pre-disaster may have been suboptimal to begin with and injury and surgery create a high catabolic state. Good nutrition is essential for wound healing. Appropriate foods rich in calories are required. Treatment for parasitic infection may also be appropriate, as well as iron supplements.
- » Comorbidities such as anaemia and diabetes need to be considered and addressed as soon as possible to facilitate healing.

SUGGESTED RESOURCES

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EMT Website: <https://extranet.who.int/emt/page/home>
 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>