



# RemoteMedics Online

## DipROM

Diploma in Remote and Offshore Medicine

Basic Surgical Skills and Emergency Procedures Manual

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## Forward

Welcome to the basic surgical skills course of the Diploma in Remote & Offshore Medicine. The purpose of the next couple of days is to introduce you to the concepts behind the surgical skills required to perform the emergency and first-aid procedures that you may require in the 'remote' setting.

The course will not teach you how to do a vascular anastomosis in a limb after major trauma, but it will teach you how to stop the patient bleeding to death before more experienced help arrives. You will also learn how to save limbs involved in major burns; treat life threatening respiratory problems etc.

You will learn the basics of instrument and tissue handling, what different types of suture material are available, how and when to use them and then put this knowledge to use in managing various emergencies.

The purpose of the manual is an aide memoir for future reference after you have completed the course. More detailed information is contained in the manual for those wishing to explore the topics further with guides for further reading. We intend to make this manual available on the DipROM website along with future updates. Please use the website to feed back to us what you think of the manual and the course so we can improve it for those who take it in the future.

**Jason Smith**  
**Consultant Surgeon**  
**DipROM Tutor**  
**March 2004**

## Surgical Instruments

### Equipment list for the course as follows:

#### Student instrument packs

- No 3 scalpel handle
- Dissecting forceps (x2)
- Kilner needle holder
- Scissors 6" Blunt/Sharp
- Scissors 6" Sharp/Sharp
- Kelly forceps
- Instrument case

#### Class kits

- Sinus forceps for chest drains
- Skin jigs
- Blowtorches for eschar
- Large sharps bins
- Yellow bags
- First aid kit
- Marker pens

#### Disposables

- #10 blades
- Sutures
- 14g cannulae
- Disposable apron
- Wipes
- Chest drains
- Oxygen tubing

#### Disposable teaching aids

- Skin pads
- Cut down pads
- Lamb legs
- Pig trachea
- Lamb ribs

## Care of Instruments

Proper care of surgical instruments begins with appropriate cleaning. Most professionals will recognize that new instruments feel different. Newer devices tend to be harder, with a stiffer feel to them. That's because as instruments age, they soften with use and cleaning. With proper care, these devices can last a lifetime. It's important to realise, however, that even the highest grade instruments will experience at least minimal wear and softening over time.

Enemies of surgical instruments include blood, tissue, and surgical residue. These are the primary causes of pitting, staining, and discolouring of instruments. Water and moisture also have damaging effects. Allowing any of these elements to dry or soak on your

instruments will cause undesirable stains. Other enemies include washing instruments with inappropriate solutions such as dish or laundry soap, bleach, disinfectants, and non-approved solutions. Cold soaking also causes damage.

To properly care for your instruments, it is important to use approved methods of cleaning, and to understand the causes of undesirable effects such as staining. Surgical instruments are manufactured from 300 and 400 series stainless steel. *While this material rarely rusts-- it does stain, despite its name.* Stains appear as an orange or brown discoloration.

## Surgical Residues

Blood, pus, and other secretions contain chloride ions which lead to corrosion, most often appearing as an orange-brown colour. If left on the instruments for any extended period of time (1-4 hours), the instrument will mark and stain, especially if these residues are allowed to dry. Therefore, always clean and dry every instrument thoroughly after use. Only sterilize a clean instrument. The most damaging procedure is to allow dried-on debris to become baked-on stains in the autoclave. The temperature of the autoclave (250°-270°) will cause chemical reactions that can make the stain permanent. Remember, an autoclave does not clean; it will only sterilize.

## Tap Water

Even tap water can stain an instrument. Tap water contains a high concentration of minerals which can be seen as a fine deposit on the instrument surface. Rinsing with distilled water eliminates such deposits. Water with high mineral counts left to sit on an instrument can cause unattractive stains. Therefore, it is important to dry your instruments immediately and thoroughly.

## Cleansers

The cleansers and cleaning agents you use could also be a cause of corrosion. Strong substances, as well as those containing a chemical make-up of acid or alkaline-based solutions can lead to pitting and staining. Wash instruments with a neutral pH soap (between pH7 - 8) for optimal results. Anything higher may damage the instrument and is not necessary. Do not use Betadine® Solution, dish soap, laundry soap, or surgeons hand scrub. These products will cause spotting and corrosion. Using an instrument cleaning brush is a good idea, especially for jaw serrations, teeth, and hinged areas.

The washing process should begin within 10 minutes after surgery, even if sterilization will take place much later. Washing instruments within a few minutes of surgery is your best defence against corrosion, pitting, and staining. Use only approved solutions. Non-approved solutions are any that do not specifically state on the label that uses include surgical instruments, stainless steel, and sterilization.

Approved solutions are specially designed for surgical instruments and the sterilization cycle. Their product labels will state this use.

## Sterilization

This is the complete destruction and removal of all micro-organisms, including spores and viruses. This is done in a number of ways:

1. Steam Sterilisation – high pressure steam eg 134°C (30lb/sq.in) for 3mins (Autoclave)
2. Hot air sterilisation – needs to be 160°C for 2-hours to kill everything
3. Ethylene Oxide – dangerous as it is highly flammable!
4. Low temp steam and formaldehyde – 73°C dry saturated steam and formaldehyde
5. Irradiation – usually by gamma irradiation

Obviously sterilisation needs to be done professionally and cannot be carried out by you!

## Scalpels

A sharp scalpel cuts tissue with less trauma than any other instrument. There are two ways of holding one: (1) If you need force to make a big bold cut, grasp it with your index finger along the back, (2) If you want to cut more gently, hold it like a pen. The size of a blade does not change the way you use it, but its shape does. A small blade allows you to make precise turns. Stab the point of a No.11 blade into an abscess and then sweep it upwards in an arc. Experienced surgeons do a lot of knife dissection beginners find other instruments safer for many purposes.



Holding a scalpel for large cuts



Holding scalpel for fine cuts

## Forceps

**Dissecting (thumb) forceps** can be short for working close to the surface, or longer for working more deeply. They can be plain, or toothed with an odd number of teeth on one jaw, and an even number on the other, either one into two teeth, or three teeth into four, etc. Toothed forceps hold tissue so firmly that only a little pressure is necessary; but they can easily puncture a hollow viscus or a blood

vessel. Strong, plain, straight forceps without teeth are even more useful for blunt dissection than they are for holding tissues.



Non-toothed DeBakey forceps

How to use forceps:

For skin closure use a fine-toothed forceps, such as an Adson forceps. The forceps should be held so one arm is an extension of thumb and the other is an extension of your index finger. The base of the forceps should rest on the dorsal surface of the web space between the thumb and index finger.



Correct way to hold dissecting forceps

Use only forceps with teeth. Use the arm with a single tooth to gently elevate the skin edge. Avoid crushing the skin edges with the forceps. This further traumatizes the wound edge and impedes healing.

The forceps allow you to create counter traction and control the position of the skin edge to facilitate passage of the needle perpendicularly through the skin.

**Tissue (locking) forceps** have a ratchet which keeps them closed. Some have teeth (Allis') and some have none (Babcock's). The blades of Allis' forceps meet together, and inevitably injure the tissues a little, whereas Babcock's have bowed jaws with a gap between them. This makes them gentler but less secure. When you use Allis' forceps for retracting a skin flap, apply them to the subcutaneous tissue or fascia, and not to the skin itself, which may be injured. Kocher's forceps are stronger, and even more traumatic; they are for clamping wide vascular pedicles, so that the vessels do not slip out.





Mosquito artery forceps

## Needle Holders

You will want a needle-holder to hold small needles and suture in a confined space. Use a holder with a short handle near the surface, and a long one deeper inside. Use big needles in big holders, and small needles in small holders. A large needle can break a fine needle-holder such as Derf's, so treat it with care. Needle-holders can have plain jaws, or tungsten carbide inserts which prevent the hard steel of the needles wearing them away. These cost twice as much, but last more than twice as long. Quality counts in needle-holders, so get good ones.

### How to use needle holders:

There are several techniques for holding the needle holder. The most common method is to place the thumb and ring finger slightly into the instrument's rings (a). This allows you to pronate (c) and supinate (d) and to open and close the jaws of the needle holder. Avoid inserting your fingers far into the rings of the instrument, since this will tie up your fingers and impede your mobility. Some surgeons do not put their fingers into the rings at all and simply grasp the rings and body of the needle holder in the palm of their hand (b).



a – common way of using needle holder



b – alternative way



c – pronation



d – supination

(note the way the needle turns through an arc)



## Scissors

The tips of a pair of surgical dissecting scissors are usually rounded; scissors in which both tips are pointed are only used for very fine dissection. Look after your scissors carefully. Use straight scissors near the surface and curved ones deeper inside. Hold them with your index finger resting on the blades. Use the tips for cutting.



Correct way to hold scissors

You can also use scissors for blunt dissection by pushing their blades into tissues and then opening them. This will open the tissues along their natural planes, and push important structures, such as nerves and blood vessels, out of the way. This is the "push and spread" technique. If there is something nearby which it would be dangerous to cut, blunt dissection is always safer. But remember that even blunt dissection can injure veins, and that venous bleeding can be very difficult to control.

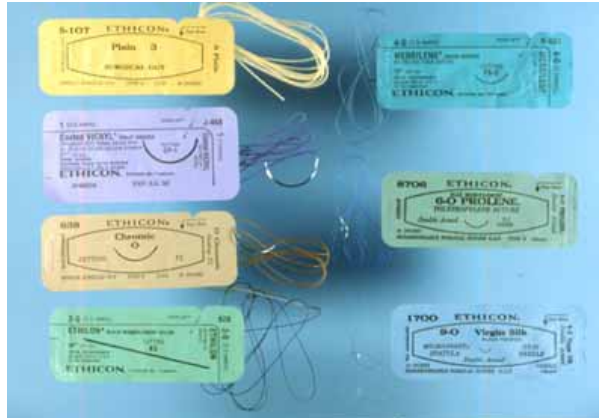
### Remember:

1. Don't use sharp-tipped scissors in dangerous places, or cut what you cannot see.
2. Don't use scissors which are longer than the haemostats you have, or you may find yourself cutting a vessel which you cannot reach to clamp.
3. Mayo's, McIndoe's, and Metzenbaum's scissors are intended for cutting tissues, so don't use them for anything else. Use other scissors for cutting sutures and dressings.

## Suture materials

### The purpose of a suture

To hold a wound together in good apposition until such time as the natural healing process is sufficiently well established to make the support from the suture material unnecessary and redundant.



a selection of different suture materials and needle sizes



Proper suturing technique is needed to ensure good results in surgery. The postoperative appearance of a beautifully designed closure or flap can be compromised if an incorrect suture technique is chosen or if the execution is poor. Conversely, meticulous suturing technique cannot fully compensate for improper surgical technique. Poor incision placement with respect to relaxed skin-tension lines, excessive removal of tissue, or inadequate undermining may limit the surgeon's options in wound closure and suture placement. Gentle handling of the tissue is also important to optimize wound healing

### Choice of a suture

Choice of suture depends on:

- Properties of suture material
- Absorption rate
- Handling characteristics and knotting properties
- Size of suture
- Type of needle

### Natural suture materials

Absorbable

- Catgut - Plain or chromic

Non-Absorbable

- Silk
- Linen
- Stainless Steel Wire

## Synthetic suture materials

### Absorbable

- Polyglycolic Acid (Dexon)
- Polyglactin (Vicryl)
- Polydioxone (PDS)
- Polyglyconate (Maxon)
- Non-Absorbable
- Polyamide (Nylon)
- Polyester (Dacron)
- Polypropylene (Prolene)

### Silk

Strong and handles well but induces strong tissue reaction  
Capillarity encourages infection causing suture sinuses and abscesses

### Vicryl

Tensile strength:

- 65% @ 14 days
- 40% @ 21 days
- 10% @ 35 days

Absorption complete by 70 days

### Polydioxone

Tensile strength:

- 70% @ 14 days
- 50% @ 28 days
- 14% @ 56 days

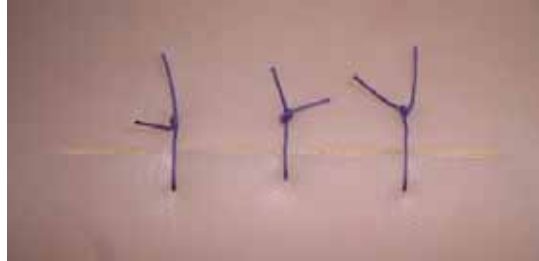
Absorption complete by 180 days

## Common errors of suture use

1. Too many throws. Increases foreign body size. Causes stitch abscesses
2. Intra-cuticular rather than subcuticular sutures causing hypertrophic scars
3. Holding monofilament sutures with instruments reduces tensile strength by over 50%
4. Holding butt of needle causes needle and suture breakage

## Suture Methods

The choice of suture technique depends on the type and anatomic location of the wound, the thickness of the skin, the degree of tension, and the desired cosmetic result. The proper placement of sutures enhances the precise approximation of the wound edges, which helps minimize and redistribute skin tension.



Interrupted sutures closing a wound  
The suture on the far right is too loose



Continuous closure of a wound

Wound eversion is essential to maximize the likelihood of good epidermal approximation. Eversion is desirable to combat the risk of scar depression secondary to tissue contraction during healing. Usually, inversion is not desirable, and it probably does not decrease the risk of hypertrophic scarring in an individual with a propensity for hypertrophic scars. The elimination of dead space, the restoration of natural anatomic contours, and the minimization of suture marks are also important to optimize the cosmetic and functional results.

"Over-and-over" sutures are the most common ones (as in the diagrams above), and can be continuous or interrupted. Each interrupted suture needs its own knot; each knot can act as a nidus for infection; and each takes time to tie. So continuous sutures are quicker, but they are also less reliable, because, if the knot on a continuous suture unties, or the suture breaks, the whole wound may open up, whereas the loss of a single interrupted suture matters little. Furthermore a continuous suture makes the wound edges more ischaemic. A beginner usually finds interrupted sutures easier. If you wish, you can lock a continuous skin suture to make it more secure; you can lock every stitch or every few stitches.



Locked continuous suture (blanket stitch)

## Basic suturing skills

Vertical mattress sutures take a superficial bite to bring the skin edges together, and a deeper one to close the deeper tissues; so they are useful for deeper wounds, but they leave scars: they are always interrupted. Horizontal mattress sutures may be interrupted or continuous, superficial or buried, and are merely alternatives to 'over-and-over' sutures without any special merit, except that they are better at everting the skin edges.



Vertical mattress suture

Unless you have a very brave patient or you are in an extreme situation it may be wise to consider giving some local anaesthetic before beginning suturing! See below for details.

The ideal skin suture should form a rectangle, penetrating the epidermis and dermis perpendicular to the skin surface, then turning at a right angle to traverse the depth of the wound parallel to the skin surface, and then turning again to emerge from the opposite skin edge perpendicular to the skin surface.

The distance between the skin edge and the emerging suture should be the same on both sides of the wound. The exact distance of the suture from the wound edge will vary depending on the type of wound being closed, its anatomical position, type of suture material being used etc – a general rule for 'most' skin wounds is 3-5mm from the wound edge on both sides. When tied, a suture placed in this fashion will form a rectangle and will provide optimal approximation of the wound edges.

Getting the suture path to follow the rectangular course described above may seem counterintuitive, since the needle is curved. However, a rectangular path can be achieved by taking advantage of the needle's curvature and rotating the needle in such a way that the body of the needle stays perpendicular to the skin. Think of the skin as the tangent to the arc formed by the needle; in this case, the tangent is stationary and the arc rotates.

A final but important tip is that suturing at all times should be towards the operator and never away. In other words place you needle in the far skin edge first and move towards yourself. Equally, suturing should be done forehand whenever possible and not backhand. On occasion it may be necessary to perform these techniques, however aim for the correct method at all times and this will improve your technique in the long run.

## Local Anaesthesia

Local anaesthetic agents can be defined as drugs which are used clinically to produce reversible loss of sensation in a circumscribed area of the body. Local anaesthetic agents act by reducing membrane permeability to sodium. They act on small unmyelinated C fibres before large A fibres. The effects they have are to reduce pain and temperature sensation before touch and power

Local anaesthetics are often given with a vasoconstrictor such as adrenaline (epinephrine) in order to reduce blood loss, to prolong the duration of action of the anaesthetic, and to increase the maximum dose of anaesthetic that can be given. Some very important points to consider when using adrenaline:

- Never ever use adrenaline around end arteries (eg fingers, toes penis) irreversible ischaemic necrosis can occur if you do
- Adrenaline 1:1000 contains 1 gram of adrenaline per 1000mls solution i.e. 1mg/ml.
- To prepare a 1 in 200,000 solution the 1:1000 must be diluted 200 times. This is achieved by taking 0.1ml (= 0.1mg) and adding 19.9 mls of local anaesthetic solution.

**Always remember to calculate the maximum dose of anaesthetic you can use before you use it and then use less than this**

### Upper dose limits for commonly used local anaesthetics

	Plain Solution mg/kg	With Adrenaline mg/kg
Prilocaine	6	9
Lignocaine	3	7
Bupivacaine	2	2

### Common local anaesthetics – Lignocaine (Lidocaine)

- Has a duration of action of about one hour
- With addition of adrenaline duration of action can be increased to 2 hours
- Main toxicity is on central nervous and cardiovascular systems
- Plain lignocaine should be used for local anaesthesia in digits and appendages
- Adrenaline containing solutions can cause tissue ischaemia.

## Techniques of anaesthesia

An anaesthetic block can be obtained around a wound in a number of ways. The simplest method is by direct infiltration into the edges of the wound. In most cases this will suffice for wound closure and can be accomplished simply by injecting the anaesthetic solution into the surrounding tissue through the open wound.

For removing a foreign body it may be better to produce a “field block”. In this method a zone of anaesthetised tissue is produced around the affected area by sequential injection usually in a diamond shape.

The technique is simple, depending mainly on the size of the field to be blocked. Choose an appropriate length needle to accomplish the task in as few injection phases as possible. The metal part of a green cannula is often useful for this technique as it is longer than a conventional needle. Begin by injecting a small bleb of local anaesthetic under the skin and advance your needle along its length under the skin. Check you are not in a vein by pulling back slightly on the plunger of the syringe and then inject the anaesthetic whilst withdrawing the needle. When completed withdraw the needle, wait for about 1 minute for the anaesthetic to work and then insert the needle again this time at the distal point of your last injection. By doing this the patient will only feel one injection. Repeat the procedure until you have formed a diamond shaped zone of anaesthetised tissue around the foreign body. Wait a couple of minutes for the anaesthetic to work before attempting removal of the object!

More advanced techniques using regional nerve blocks should only be done by those trained in the procedure.

**ALWAYS REMEMBER TO WORK OUT THE SAFE DOSE BEFORE GIVING THE ANAESTHETIC**

## Suturing Skills

### Mounting your needle



Correct mounting of a needle

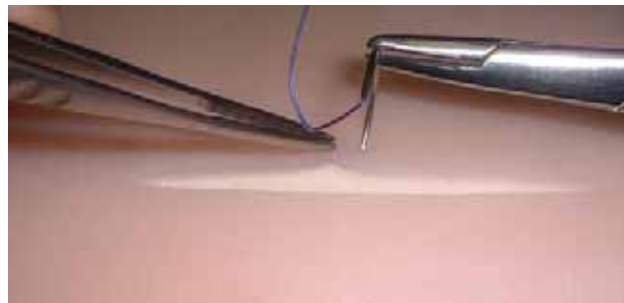
The tip of the needle holder should grasp the needle about 2/3 of the way back from the point. The needle holder and needle should be roughly perpendicular. You grasp the needle with the tips of the



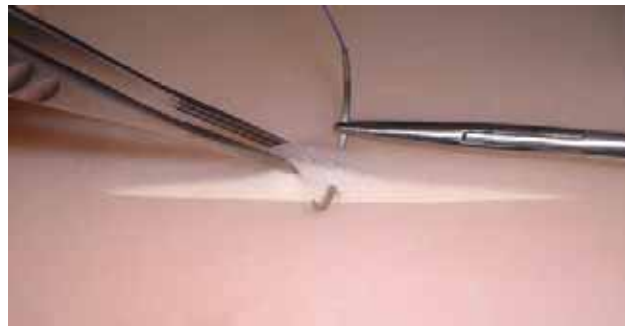
needle holder not midway or close to the hinge. This facilitates accurate movement and placement of the needle. This is the reason why you should use a needle holder appropriate to the size of the needle. Fine needle holders can easily be broken by grasping large needles in this way.

### Simple interrupted sutures

The far skin edge is elevated with the forceps in the left hand, while the right hand is pronated to “cock” the needle in preparation for taking the first “bite”. The tip of the needle should penetrate the skin perpendicularly about 5-10 mm from the wound edge, and the needle should be rotated all the way through the epidermis and dermis by supinating the right hand to rotate the needle through its arc.



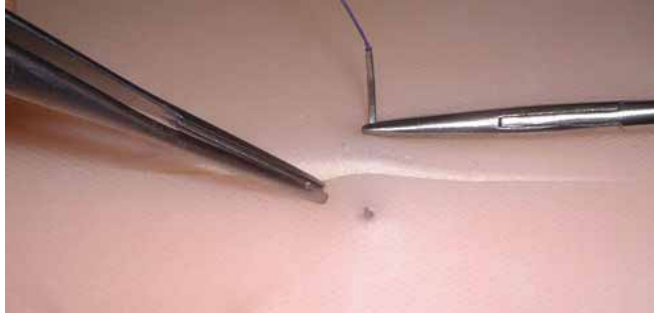
The tip of the needle should now be seen protruding into the wound from the subcutaneous tissue. At this point, it is important to maintain the position of the skin edge using the forceps. A common error here is to release the forceps from the skin edge, but this allows the skin to retract, and the needle may move and retract beneath the skin edge.



The next step is important for accurate suture placement. The key is to maintain the position of the skin edge while releasing the needle from the needle holder. This will maintain the position of the needle tip. After the needle is released from the needle holder, the right hand should be fully pronated before regrasping the needle. The “bite” can then be completed by supinating the right hand in order to complete the rotation of the needle through the skin.

If it is necessary to reposition the needle in the needle holder before taking the second “bite,” the needle should be grasped with the forceps, not with your fingers.

The forceps then elevate the near skin edge in preparation for the second “bite.” Once again, the right hand is cocked by pronating it, and the needle is passed upward through the near skin edge by supinating the right wrist in order to keep the body of the needle perpendicular to the tissue it is passing through at all times. The needle should emerge about 4-5 mm from the wound edge (equidistant on both sides of the wound). At this point you can tie you knot – see the next section on knot tying methods.



## Suture Removal

In general and especially in the remote circumstance, sutures can be left in the skin for quite a long period of time. If you use an inert monofilament material for skin closure as recommended such as nylon or prolene then the suture material will cause little skin reaction in the absence of infection. As such the sutures can be left in for a number of weeks if circumstances dictate. However if sutures are left in for longer than recommended then marking and pitting of the skin becomes more pronounced and the final cosmetic result is less than desired. In order to get the best cosmetic result from your surgery the following guide should be followed:

Face	3-4 days
Scalp	5-7 days
Trunk	7-10 days
Arm or leg	7-10 days
Foot	10-14 days

## Surgical knot tying

Knot tying for surgery is nowhere near as complex as it is for mariners, although some surgical trainees appear to make it so! There are very few knots you will need to learn for this course; the basic square knot, the surgeons knot, hand tying and instrument tying.

Before tying any knots it is important to remember the some information about the properties of the materials you are using. Multifilament sutures are generally easier to handle and to tie than monofilament sutures; however, all the synthetic materials require a specific knotting technique. With multifilament sutures, the nature of the material and the braided or twisted construction provide a high coefficient of friction and the knots remain as they are laid down. In

monofilament sutures, on the other hand, the coefficient of friction is relatively low; resulting in a greater tendency for the knot to loosen after it has been tied. In addition, monofilament synthetic polymeric materials possess the property of memory. *Memory* is the tendency not to lie flat, but to return to a given shape set by the material's extrusion process or the suture's packaging.

## General Principles of Knot Tying

Certain general principles govern the tying of all knots and apply to all suture materials.

- The completed knot must be firm, and so tied that slipping is virtually impossible. The simplest knot for the material is the most desirable.
- The knot must be as small as possible to prevent an excessive amount of tissue reaction when absorbable sutures are used, or to minimize foreign body reaction to nonabsorbable sutures. Ends should be cut as short as possible.
- In tying any knot, friction between strands ("sawing") must be avoided as this can weaken the integrity of the suture.
- Care should be taken to avoid damage to the suture material when handling. Avoid the crushing or crimping application of surgical instruments, such as needle holders and forceps, to the strand except when grasping the free end of the suture during an instrument tie.
- Excessive tension applied by the surgeon will cause breaking of the suture and may cut tissue. Practice in avoiding excessive tension leads to successful use of finer gauge materials.
- Sutures used for approximation should not be tied too tightly, because this may contribute to tissue strangulation.
- After the first loop is tied, it is necessary to maintain traction on one end of the strand to avoid loosening of the throw if being tied under any tension.
- Final tension on final throw should be as nearly horizontal as possible.
- The surgeon should not hesitate to change stance or position in relation to the patient in order to place a knot securely and flat.
- Extra ties do not add to the strength of a properly tied knot. They only contribute to its bulk. With some synthetic materials, knot security requires the standard surgical technique of flat and square ties with additional throws if indicated by surgical circumstance and the experience of the surgeon.

## The basic surgical knot: square knot



### Hand tie technique

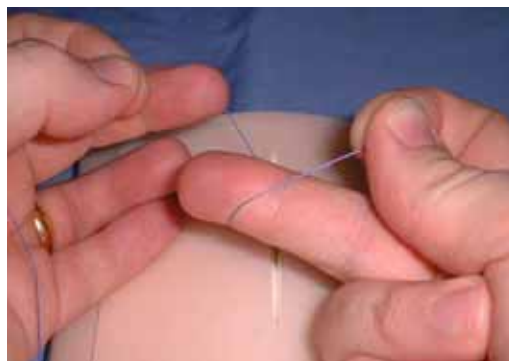
#### Step 1

Grasp the sutures as shown in the picture below; threads should be held between the tips of your index finger and thumb. The lower thread should be in your right hand and the right hand is below the left hand. The lower thread is grasped at its end.



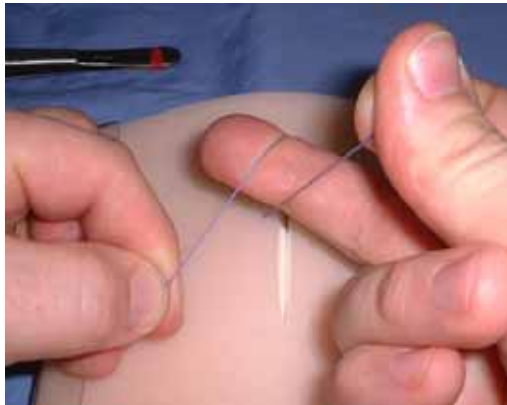
#### Step 2

Supinate your right hand so that the thread grasped by it comes to lie across the tip of the little or middle finger (depends on access and suture tension).



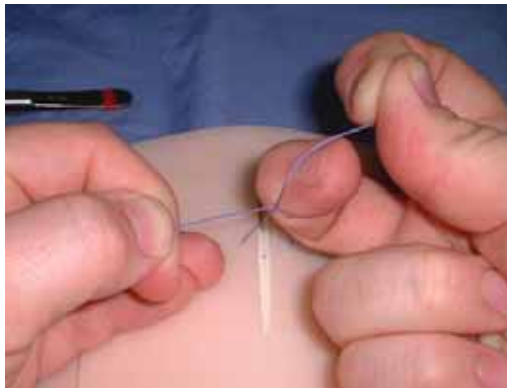
### Step 3

Pass your left hand across the top of the right hand so the thread in your left hand comes to lie across the distal joint of your middle finger.



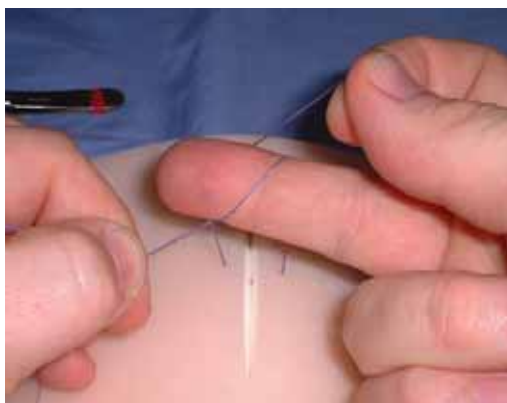
### Step 4

Flex the joint of your middle finger of the right hand so that its tip passes below the thread held between the index finger and thumb of the right hand.



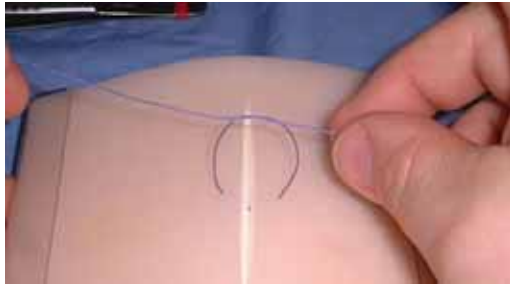
### Step 5

Now flip the thread held in your right hand underneath the thread held in your left hand by extending the flexed middle finger and then releasing the thread held between the thumb and index finger of the right hand.



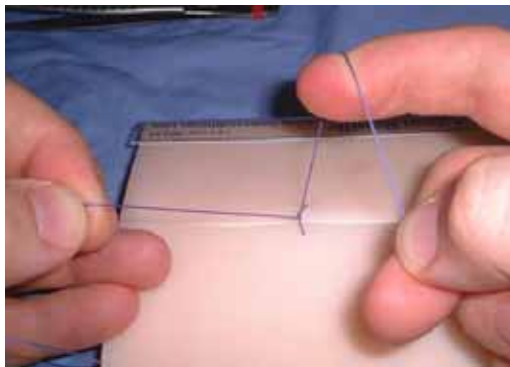
### Step 6

You should still have control the released thread, which can now be pulled to the correct tension forming a flat knot overt the wound.



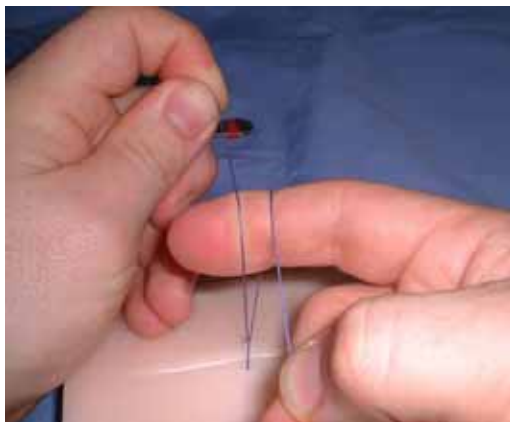
### Step 7

Now with your right hand grasp the thread between your thumb and middle finger with the thread coming to lie across the distal joint of your index finger.



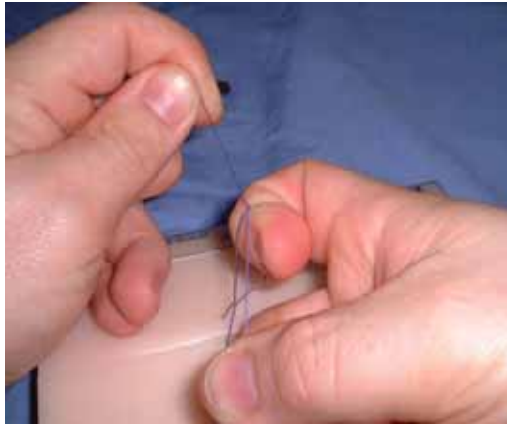
### Step 8

Bring the thread held in your left hand so that it too comes to lie across the same joint of the index finger in your right hand.



### Step 9

Flex the joint of the index finger of your right hand so that it begins to wrap around the thread held in your left hand and the tip of the index finger begins to move under the thread held in your right hand.



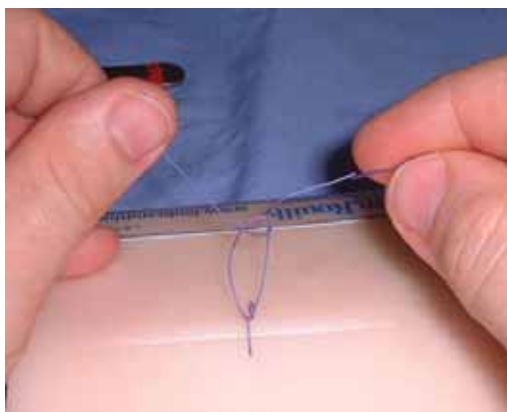
### Step 10

Flick the thread held in the right hand under the thread held in the left hand by extending the index finger again and releasing the thread held in the right hand.



### Step 12

Now take control of the loose thread again and complete the knot.





This is the basic surgical square knot and you have tied it using a one handed technique – note how the thread grasped in your left hand is never released. For added security you can throw a further knot by repeating steps 1-7.

## Instrument tie technique

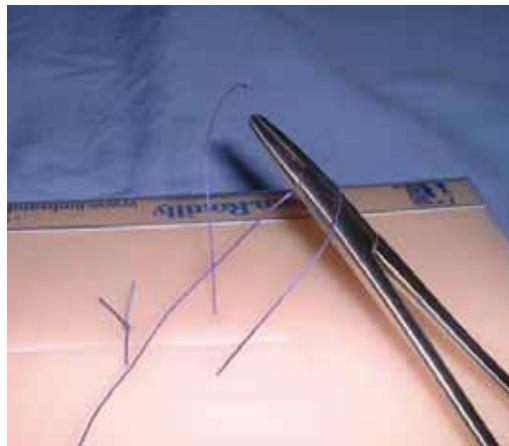
The exact same knot can be formed using your needle holders as detailed below:

### Step 1

The instrument tie is performed with a needle holder held in the surgeon's right hand. The left hand holds the end with the needle on between the tips of the thumb and index finger. The needle holder is positioned perpendicular to and above the fixed suture end. By keeping the length of the free suture end relatively short (approx 2cm), it is easy to form suture loops as well as to save suture material.

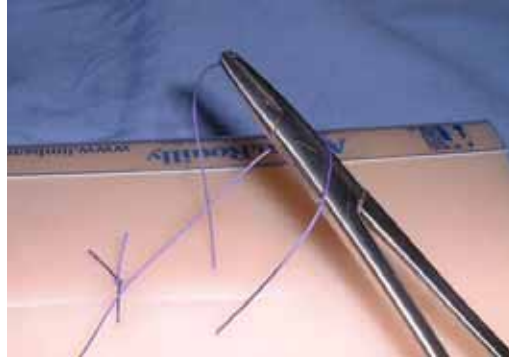
### Step 2

The fixed suture end held by the left hand is wrapped over and around the needle holder jaws to form the first suture loop.



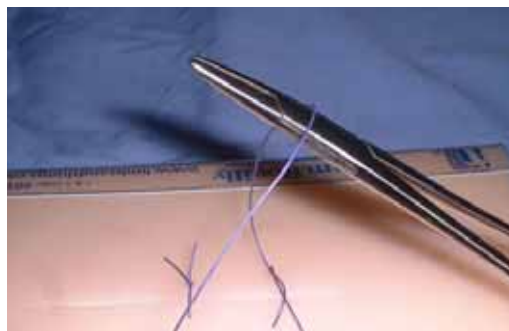
### Step 3

The tips of the needle holder jaws are opened and grasp the suture free suture end and pull it through the first suture loop. The resulting first throw will have the same effect as steps 1-7 for the hand tie technique



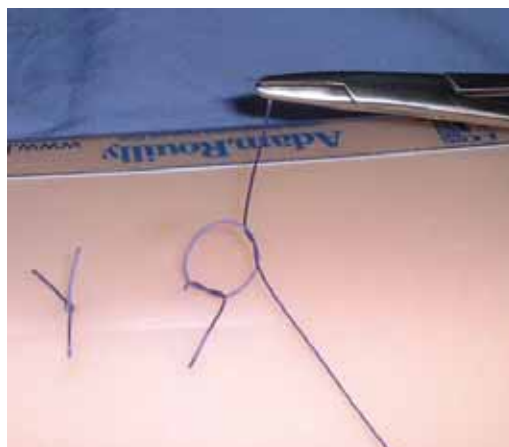
### Step 4

Release the end of the suture from the needle holder. Wrap the fixed end of the suture held in your left hand back around the jaws of the needle holder in an *opposite* direction to that in step 2.



### Step 5

Grasp the tip of the free end of the suture with the jaws of the needle holder as before and complete the knot.



This completes the square knot using an instrument tie method. For added security a third throw can be completed by repeating steps 1-3 above.

## The surgeons knot



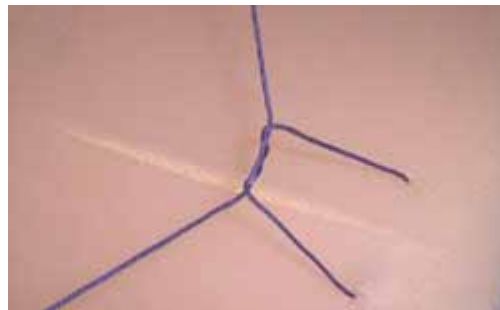
The only difference between a surgeons knot and a square knot is that the first throw has 2 loops. For the hand tie method proceed as follows:

### Step 1

Proceed with steps 1-7 as detailed in the hand tie technique for square knots. Before pulling the first throw down you need to position the thread in your right hand again between index finger and thumb.

### Step 2

Now in a manoeuvre analogous to steps 4-6 of the square knot method put a second throw on the suture as shown.



At this point you will have 2 throws on your first knot. The remainder of the knot can be completed as per the square knot method.

For instrument tying of the knot simply wrap the suture material around the jaws of the needle holder twice in step 2 of the instrument tying method.

As for the square knot a third knot can be formed for security as per the first knot.

## Surgical Techniques

### Venous Cutdown

Now you have some basic surgical skills knowledge we can apply it directly to some useful emergency surgical procedures.

Gaining intravenous access is a common procedure but may be difficult in hypovolaemic patients or those with difficult veins. When direct cannulation of a vein cannot be performed or is taking too long, a venous cutdown or intraosseous infusion (only in children under 5yrs of age) are alternative methods of access to the circulation.

Venous cut down is an emergency procedure that is potentially life saving. It might often need to be performed by the inexperienced in severely ill trauma patients. It is one of the few modern surgical procedures in which speed is a crucial factor due to the presence of hypovolaemic shock and the need to get fluids into the circulatory system as soon as possible.

This procedure exposes the vein surgically and then a cannula is inserted into the vein under direct vision. If no cannulae are available or very rapid infusion is required the sterile end of the drip tubing may be used in adults after cutting off the Luer (cannula) connection. The procedure must be performed under sterile conditions to avoid sepsis developing which will not only shorten the life of the infusion but may have serious consequences for the patient. During the procedure 2 ligatures (sutures) are placed around the vein. The distal ligature is used to tie off the vein distally and the proximal ligature holds the cannula in the vein. While the vein is incised the ligatures help to hold it.

If the need arises to perform a venous cutdown the veins will probably not be visible. Therefore the cutdown needs to be performed over a site where a large vein is known to occur. The best site to perform this is over the long saphenous vein in the leg. The long saphenous vein is best as it is large in diameter, almost always in the same position and there are relatively few structures surrounding it that can be damaged. Alternatives are the cephalic vein in the arm or the external jugular in the neck. These should only be used under extreme circumstances when both long saphenous veins have been attempted or are inappropriate to use (such as in major limb trauma).

### Technique

The long saphenous vein courses up the medial aspect of the leg and drains into the common femoral vein in the groin. The easiest place to find it approximately 2cm above and lateral to the medial malleolus.



### Step 1

If time permits infiltrate the skin with some local anaesthetic. Clean the skin and surrounding area with an antiseptic solution. Make a 2cm transverse incision through the skin perpendicular to the vein. Deepen the incision exposing the vein using artery forceps or scissors to spread the fat apart in the direction of the vein in order to expose a decent length of it.



### Step 2

Pass some suture material around both the proximal and distal ends of the vein. Tie off the distal end of the vein (furthest away from the heart) and place a loose tie around the proximal end of the vein.



### Step 3

Make a transverse incision in the vein using either scissors or a knife.



## Chest drain insertion

### Step 4

Advance the cannula (without the metal trocar inside) into the incision in the vein and tie the proximal suture around the cannula to secure it.



### Step 5

Close the skin with 2 interrupted mattress sutures either side of the vein and cover with a dressing. Attach the cannula to a giving set and infuse fluid rapidly.

The emergency insertion of a large bore chest drain for tension pneumothorax following trauma has been well described by the Advanced Trauma and Life Support (ATLS) course.

The indications for insertion in the emergency setting are as follows:

1. Large pneumothorax
2. Small pneumothorax prior to mechanical ventilation
3. Tension pneumothorax
4. Haemothorax

In an emergency the size of drain use does not matter. If a choice exists then smaller bore drains can be used for a pneumothorax as they are more comfortable and there is no evidence a larger size is better. For an acute Haemothorax the largest bore drain possible should be used.

### Technique of insertion

The ideal position is to have the patient at 45 degrees with the arm up and over their head in a slightly rotated position. In extremis this will be done with the patient flat. In all circumstances remember the primary survey rules from ATLS:

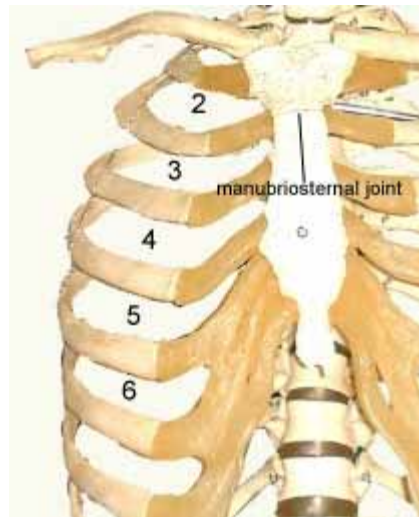
- A. Maintain a patent airway and supply high flow oxygen
- B. Ensure the patient is breathing
- C. Ensure there are at least 2 large bore cannulae inserted and fluid replacement has commenced

All of the above points **MUST** be performed before chest drain insertion or the chances of your patient decompensating and dying after chest drain insertion are greatly increased.

Assuming the above has been performed the technique below describe chest drain insertion in a stable patient. Circumstances may dictate that not all steps can be performed.

### Step 1

With the patient appropriately positioned find the 5<sup>th</sup> intercostal space. This can be found by palpating the rib space next to the manubriosternal joint (2<sup>nd</sup> intercostals space) counting down to the 5<sup>th</sup> and then tracing the rib space out to the position chosen for insertion



### Step 2

Before proceeding further, confirm your diagnosis with a chest x-ray (except in the case of a tension pneumothorax, which is a clinical diagnosis). The chest tube is to be inserted into the 5<sup>th</sup> intercostal space midway between the anterior and mid-axillary lines. Once the position has been found mark it with a pen or your fingernail. Now place the index and middle fingers of your left hand in the 6<sup>th</sup> and 5<sup>th</sup> intercostals space respectively with your middle finger over your marked site.

### Step 3

Infiltrate a 3cm long area of skin between your fingers, lift up your middle finger and infiltrate some anaesthetic into the muscle of the 5<sup>th</sup> intercostal space.

### Step 4

Make a 2cm incision between your fingers directly down onto the 5<sup>th</sup> rib in the line of the rib.



### Step 5

Put a pair of Roberts or other similar forceps into the wound so the tips touch the rib. Slide the forceps ABOVE the rib into the muscle of the 5<sup>th</sup> intercostal space. If the patient is awake warn them they will feel a sharp brief sharp pain.

### Step 6

Push the tips of the forceps into the chest through the muscle layer and pleura, keep on top of the 5<sup>th</sup> rib so as not to damage the intercostal neurovascular bundle. Some controlled force will be required and a popping sound will be heard when entering the chest. Open the jaws of the forceps and withdraw them from the chest cavity in an opened position.

### Step 7

Put your index finger into the hole created and sweep it around the inside of the chest cavity. Remove the trocar from the chest drain and discard it. Clamp the chest drain with the Roberts forceps and advance the tip into the chest cavity through the hole directed towards the apex of the lung.

### Step 8

Connect the end of the chest drain to a suitable underwater seal and remove the Roberts forceps from the drain. Air and/or blood should then start to flow into the tube and into the underwater drain system. Secure the chest drain in place with a suture appropriate to closing a linear wound and apply a sturdy dressing.



## Escharotomy and burns Mx

## Burns Management

### Important points to note about chest drain management:

1. A bubbling chest tube should never be clamped.
2. Drainage of a large pleural effusion should be controlled to prevent the potential complication of re-expansion pulmonary oedema.
3. In cases of pneumothorax, clamping of the chest tube should usually be avoided.
4. If a chest tube for pneumothorax is clamped, this should be under the supervision of a physician or surgeon trained in the management of chest drains, the patient should be managed in a specialist ward with experienced nursing staff, and the patient should not leave the ward environment.
5. If a patient with a clamped drain becomes breathless or develops subcutaneous emphysema, the drain must be immediately unclamped and medical advice sought.
6. If a chest drain is clamped for the purposes of moving a patient it should be for the minimum time possible, removed as soon as the movement has finished, the chest tube checked for condition after the clamp has been removed, and ensure the whole system is functioning correctly afterwards

As a manual on surgical skills we will focus on the technique of escharotomy. Brief descriptions of the management of burns will be given for clarity.

### Treatment objectives in the emergency situation are:

- Prevention and treatment of shock
- Control of bacterial proliferation
- Conversion of an open wound to a closed one

### Burn definitions

**Partial thickness** - damage to epidermis but the dermis intact, therefore skin can regenerate. There is also so called DEEP partial, which has lost much of the dermis but there are epithelial pockets. With infection or inappropriate care it can become full thickness.

**Full thickness** - both epidermis and dermis are destroyed and will not regenerate the skin.

The clinical difference between partial and full thickness burns is that full thickness burns are not painful (except at the edges where they merge with normal skin) as all the nerve endings have been destroyed.

### First Degree:

- superficial, involving only epidermal damage (eg sunburn)
- erythematous and painful due to intact nerve endings
- heal in 5-10 days; pain resolves within 3 days
- no residual scarring



### Second Degree:

- partial thickness, involving the epidermis and dermis
- more superficial burns are moist and blister; deeper burns are white and dry, blanch with pressure, and have reduced pain
- heal in 10-14 days
- can develop into third degree burns with infection, edema, inflammation and ischemia
- treatment varies with degree of involvement - grafting is indicated for deep burns



### Third Degree:

- full-thickness, most severe of burns
- results in necrosis and avascular areas
- tough, waxy, brownish leathery surface with eschar, numb to touch
- grafting required
- usually have permanent impairment



### Fourth Degree:

- full-thickness as well as adjacent structures such as fat, fascia, muscle or bone
- reconstructive surgery is indicated
- severe disfigurement is common



## Assessing surface area of burns

The 'Rule of Nines' is a simple quick way of assessing the percentage of body surface area (BSA) burned:

- Face & Scalp 9%
- Back 18%
- Perineum 1%
- Arm each 9%
- Front 18%
- Upper arm each 9%
- Lower leg each 9%

It is important to note that the BSA in children varies with age. A Lund-Browder chart should be used for children under 10. As a rough guide the child's palm is approximately 1% of BSA.

The face, eyes, ears, feet, perineum and hands have the greatest risk of potential disability. Another important point in assessing burns is circumferential full thickness burns can lead to limb ischaemia or respiratory arrest and need to be recognized early in order to save limb and life.

## Burn Severity

### **Minor:**

partial thickness: < 15% BSA in adults, < 10% BSA in children

full thickness: < 2% BSA

### **Moderate:**

partial thickness: 15%-25% BSA in adults, 10%-20% BSA in children

full thickness: 2%-10% BSA

### **Major:**

partial thickness: > 25% BSA in adults, > 20% BSA in children

full thickness: > 10% BSA

burns of hands, face, eyes, ears, feet or perineum

associated injuries, such as inhalation injury, fractures, other trauma

poor risk patients with underlying disease or suspicion of child abuse

## Initial treatment involves the following:

1. Removing the patient from the offending agent and area.
2. Perform a brief primary and secondary survey and initiate stabilization procedures.
3. Inhalation injury should always be suspected - administer high-flow oxygen and assess the need for endotracheal intubation.
4. In cases involving chemical burns, brush off all dry chemicals and copiously irrigate the skin with water or saline.
5. During transport, large burns should be covered with dry sterile dressings, and small or moderate size burns should be protected with cool, wet dressings. Cool dressings relieve pain and decrease thermal injury if applied during the first 40 minutes after the burn.  
*NB - if wet bandages are placed on burns that are greater than 10% of the body surface area, they may produce hypothermia, especially in the very young or old patient.*
6. Large-bore intravenous access should be started at the scene and continued in the ambulance in patients with burns involving more than 20% of body surface area.

## Fluid resuscitation – general principles

There are many different formulae for the management of burns using various types of fluid ranging from normal saline, Hartman's solution, albumin and even blood. The exact type of fluid given initially is of little importance. Treatment should be directed as per the management of hypovolaemic shock. The various different regimens can be instituted in the burns unit after transfer.

### Remember the following:

- The greatest fluid loss occurs in the first 48-hours
- Denuded skin produces a 6-7 fold increase in evaporative losses

A simple formula to remember for continuing fluid replacement in the stable patient is:

$$\text{Total volume} = \text{weight} \times \%BSA \times 4$$

The fluid (usually Hartman's) is given as follows:

- first 8 hrs - give half of total
- next 16 hrs - give half of total
- next 24 hrs - give half of total

## Escharotomy

Escharotomy is indicated to relieve vascular compromise or ventilatory impairment. Vascular compromise to an extremity results from circumferential, full-thickness, inelastic eschar.



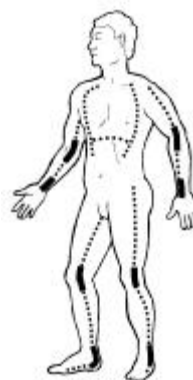
Underlying tissue oedema results in impaired venous outflow followed by impaired arterial inflow if not treated. All extremity burns at risk should be monitored with at least hourly vascular checks of pulse or Doppler signal. One must treat the condition immediately and not wait for loss of pulses because, by that time, neurovascular damage has already occurred. Decreasing Doppler signals or compartment pressures more than 40 mm Hg are indications for immediate escharotomy.

The chest wall and lungs are more compliant in children than in adults. Therefore, children may rapidly become exhausted by the oedema and restriction of a circumferential chest wall burn. Impaired ventilation, with progressive increase in ventilatory requirements, may indicate the need for chest wall escharotomy.

Escharotomy is performed in areas of full-thickness injury; therefore, analgesics / local anaesthesia are not needed.

## Technique

Escharotomy (with a scalpel or preferably using an electrocautery device to minimize bleeding) is performed longitudinally at the medial and/or lateral aspect of the extremity, beginning above the burn and extending to below the inferior aspect of the burn:





The incision is carried down to the subcutaneous fat, which bulges into the wound when adequately incised. Return of arterial pulse should be immediate. Chest wall escharotomy is performed with incisions along the anterior axillary lines bilaterally, extending onto the abdomen, with transverse bridging incisions across the chest



Adequate chest wall escharotomy improves compliance and ventilation.

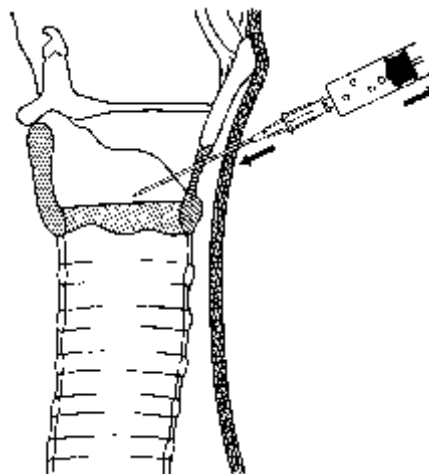
## Surgical Airways

The essential indication for a surgical airway is the need for an airway that can not readily be established with less invasive techniques, the usual first preference is for orotracheal intubation.

Situations in which a Surgical Airway should be considered as the primary method include major maxillo-facial Injury (eg compound mandibular fractures, Le Forte III midface fracture), oral burns, and fractured larynx.

## Needle Cricothyroidotomy

The simplest technique is needle cricothyroidotomy. This involves placing a 12 Gauge Cannula into the trachea via the cricothyroid membrane. This will allow adequate ventilation for up to 45 minutes, hypercapnea being the main limiting factor. This may buy enough time to obtain expert airway assistance and attend to other emergency procedures. (NB This is the preferred technique for children under the age of 12.)





The technique is easy to perform and can be done without removing the hard collar in trauma patients.

## Technique

1. A large diameter cannula is attached to a 2ml syringe with 0.5-1ml of saline in.
2. The cricothyroid membrane is palpated below the cricoid cartilage
3. The cannula is advanced through the skin and membrane at an angle of 45° to the skin in the midline aspirating during insertion until air bubbles are noticed in the syringe with free aspiration of air
4. The cannula is then advanced over the trocar, the syringe removed and reattached to the cannula and the plunger removed
5. The diameter of the 2ml syringe is ideal for the placement of green oxygen tubing which has been prepared by cutting a vent hole in the side
6. The tubing is attached to high flow oxygen and operated in a fashion that a finger occludes the vent hole for 1 second and is released for 4 seconds.

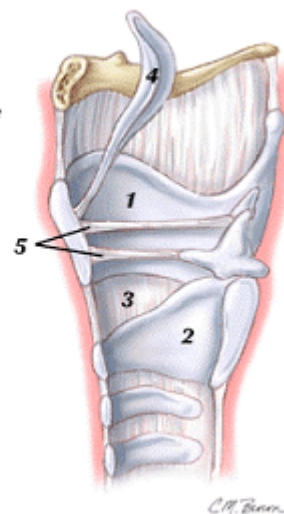
This system can oxygenate the patient for approximately 40 minutes before hypercapnia occurs and a more definitive surgical airway is obtained.

## Formal cricothyroidotomy

This is the classic surgical airway. It is safer and quicker than attempting formal tracheostomy.

### Larynx

1. Thyroid Cartilage
2. Cricoid Cartilage
3. Cricothyroid Membrane
4. Epiglottis
5. Vocal Cords



### Technique

1. The patients' cervical spine is immobilised in the neutral position.
2. A Right Handed Surgeon stands on the patient's right.
3. The area is prepared and draped in the usual way.
4. Local anaesthetic with adrenaline is used only in the conscious patient who has a patent airway. In an asphyxiated / dying patient there is insufficient time.
5. The thyroid cartilage is stabilised with the left hand as the right hand makes the incision. The first incision is a 2-3cm long transverse incision through the skin overlying the cricothyroid membrane.
6. The second pass of the scalpel is again transverse, through the cricothyroid membrane into the airway. Leave the blade in situ and twist through 45°
7. An artery forcep is placed into the airway to replace the blade, through the exposed gap, and opened so as to hold the incised edges apart.
8. The right hand then picks up the endotracheal tube or tracheostomy tube and inserts it into the airway, directed towards the chest. The best size ET tube for an adult cricothyroidotomy is a size 6.0.
9. After confirming adequate position, the tube should be secured and suctioned. A definitive airway will be required as soon as the patient is stable, fully assessed and appropriate interventions have been performed.

### Complications of surgical cricothyroidotomy

- Bleeding (often heavy)
- Placement of the tube anterior to the trachea (subcutaneously)\*
- Infection (late)
- Oesophageal perforation (v.rare)

This is a complex procedure that should be undertaken only by trained personnel and thus is rarely performed in the field. Although it can be performed in the field or at the bedside, it is best accomplished in an operating room by an experienced surgeon. Positioning of the patient is similar to that for emergency cricothyroidotomy. Emergency tracheostomy has a high rate of complications and as such we will not discuss the procedure further here.

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<http://www.surginet.org.uk>

Copies of this manual can be found on the following websites:

<http://www.remotemedics.co.uk>

<http://www.surginet.org.uk/wmuh/>

