

4 Basic methods and instruments

4.1 Appropriate surgical technology: the equipment you need

You may step into a beautifully organized theatre, or you may have to create it from scratch. To help you in this task we have listed everything you might need to do the procedures we describe, down to the last needle and cake of soap. To minimize the tediousness of long lists we have described the equipment in the text. We have included everything which you could reasonably have, but may not have at the moment. For example, many district hospitals do not have skin-grafting knives, pneumatic tourniquets, simple bone drills, Kirschner wire, or manometers for measuring the central venous pressure; but you could reasonably try to get them, so we have included them. Some of the special methods we describe do not need any extra equipment: *e.g.* the plastic bag method for laparostomy (11.10). Learn to recognize the instruments you use and to know them by their names. Remember the instruments may have different names in different countries! When you first arrive at a hospital check the theatre equipment and find out what is missing!

When you order equipment that is not listed here try to make sure that:

- (1) It will work reliably (good quality) without needing to be returned to the makers to be mended.
- (2) It will work well in your hands and is electrically compatible.
- (3) You can afford both its initial and its running costs.
- (4) Spares are available.
- (5) You can easily learn how to use it and teach other people to do the same.
- (6) It can be repaired locally if need be.

Think about whether it needs to be portable, and so how robust it needs to be. *Don't get persuaded by wily salesmen into buying things you don't really need!*

If you want to be well supplied, encourage and motivate your storeman. Look at what there is and how he has organized things. *Do not forget to visit your central medical stores*; you may find things you need, which the storeman there cannot identify, and you can make good use of. The equipment we list is the equipment he should stock.

You will certainly have to improvise. If you do not have the standard stainless steel instruments, *do not hesitate to use ordinary steel ones*, if you can buy, adapt, or make them. You will need to wipe these carefully with an oily rag after each operation. For example, you can use an ordinary steel carpenter's drill instead of a bone drill, and a sterile pair of ordinary pliers may be the best way to remove a plate.

You can save much on IV fluids by infusing water rectally: a patient will readily tolerate and absorb 500ml over 6hrs.

If you have no Kirschner wires you may be able to use sharpened bicycle spokes. *Do not store instruments of ordinary steel sterilized in packs or drums*: the interior of these is damp and they will rust rapidly.

STORES AND EQUIPMENT

SUPPLY CYCLES. If your supply period for a consumable item is 'x' months, try to keep 3 times the quantity of it you consume during this period in stock, so that one indent can go astray without causing disaster.

When you order equipment, try to include the catalogue number. Where possible write to the supplier and ask for a 'proforma invoice' giving the exact details and costs, etc. This will make ordering much easier. Obstetric equipment is discussed in 19.2.

The theatre. Theatre furniture and lighting, gowns, gloves and drapes (2.1, 2.3), drains and tubing (4.9). Miscellaneous smaller items of theatre equipment (4.11).

Preventing sepsis. Sterilizing equipment (2.4), antiseptics and disinfectants (2.5).

Preventing bleeding. Haemostats and arterial clamps (3.1), tourniquets (3.4).

Cutting and holding tissues. Scalpels and dissectors (4.2), scissors (4.3), forceps (4.4), retractors (4.5), suture materials (4.6), needles and their holders (4.7).

Instruments for bones (7.5), bowel (11.3), obstetrics (19.2), proctology (26.1), urology (27.1), eyes (28.1), ENT (29.1), tracheostomy (29.15), dentistry (31.1, 31.3), chest aspiration (36.1).

4.2 Scalpels and dissectors

A sharp scalpel cuts tissue with less trauma than any other instrument. There are 2 ways of holding one:

- (1) If you need force to make a big bold cut, grasp it with your index finger along the back (4-1).
- (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. Some blades have very specialized uses. Use the stab point of a #11 blade to open an abscess. Use #12 blades for removing sutures. Use a #15 blade for small incisions, and a #10 for larger ones; a #20-24 is best for a laparotomy incision. The smaller blades (sizes 10-19) fit onto the #5 Bard Parker handle, and the larger ones (sizes 20-36) onto the #4 handle. A guarded scalpel is useful for special situations, like tonsillar (6.7) and retropharyngeal abscesses (6.8). A fixed scalpel is especially useful for symphysiotomy (21.7). If you find the scalpel difficult to use at first, use sharp scissors, but as your experience grows you will find the scalpel easier and safer.

Beware cutting yourself or an assistant when using sharp instruments!

Make sure you have secured the blade tightly on the handle, because if you lose it in a body cavity it is difficult, and hazardous to find it again!

SCALPELS

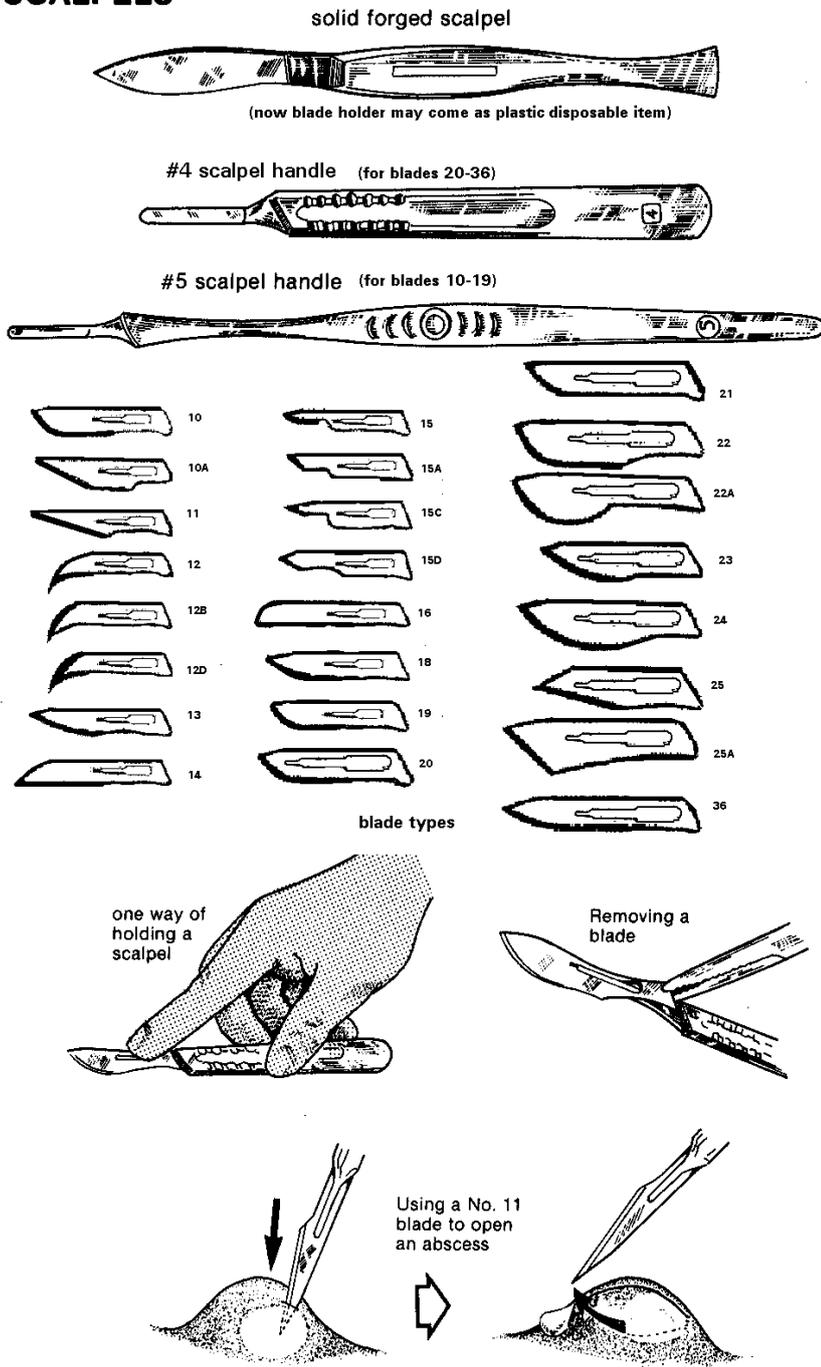


Fig. 4-1 SCALPELS AND HOW TO USE THEM.

The advantage of a solid forged scalpel is that you can resharpen it. It is useful for symphysiotomy (21.7). Take care when you remove a blade: *always use an instrument, hold the blade with the sharp side away from you and never your fingers or plastic forceps!* Dispose of sharps in special containers (5.3).

SCALPEL, solid forged, size #1, 30mm, and size #5, 40mm. If your disposable blades are exhausted, you can use a solid scalpel and re-sharpen it (4-3), whereas you cannot re-sharpen a disposable blade.

HANDLE, scalpel, Bard Parker, #4. Get good quality handles, because poor ones may not fit the blades.

HANDLE, scalpel, Swann Morton, #5.

BLADES, scalpel, disposable, Bard Parker or Swann Morton type, stainless steel.

OILSTONE, hard Arkansas pattern, 150x70x30mm.

Use this to sharpen scalpels and scissors. A very blunt instrument needs a carborundum stone first.

DISSECTOR, MacDonal. A blunt dissector is often safer than a scalpel. This is a blunt general purpose dissector, with 1 straight flat end and 1 round curved end, neither of which are likely to injure anything.

4.3 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 joint. Use only the extreme tips for cutting.

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 (4-9B). 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) *Do not use sharp-tipped scissors in dangerous places, or cut what you cannot see.*

(2) *Do not 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 *do not use them for anything else.* Use other scissors for cutting sutures and dressings.

(4) Carefully keep and pack very fine scissors, *e.g.* ophthalmic instruments, separately.

(5) Beware, when passing scissors to do so holding the closed tips, so that your assistant or scrub nurse can take them by the handle. Alternatively, place them on a special tray.

Note that it is not necessary or even desirable to have all these sorts of different scissors.

Make sure you look after your sharp instruments carefully. Buy good quality scissors, and *do not autoclave them mixed together with the other instruments.* The very best ones have tungsten carbide inserts, which make their cutting edges last much longer. These are 4 times more expensive, but justify their extra cost.

IN DANGEROUS PLACES BLUNT DISSECTION IS SAFER THAN SHARP DISSECTION WITH SCISSORS

SCISSORS

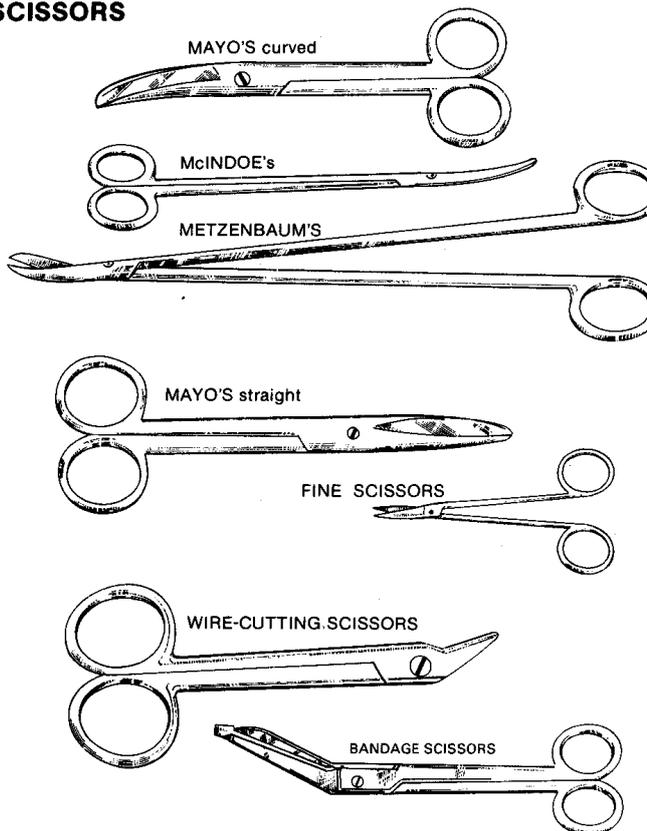


Fig. 4-2 SCISSORS.

Mayo's, McIndoe's, and Metzenbaum's scissors are intended for cutting tissues, so do not use them for anything else. Use other scissors for cutting sutures and dressings.

SCISSORS, operating, Mayo, straight, bevelled, 200mm. Use these for cutting sutures.

SCISSORS, operating, Mayo, curved, bevelled blades, 170mm. These tissue scissors are curved in the plane of the blades.

SCISSORS, operating, McIndoe's, curved, with rounded tapering blades, 180mm. These elegant tapering tissue scissors are curved perpendicular to the plane of the blades.

SCISSORS, operating, Metzenbaum, curved 275mm. These have long handles and quite narrow blades. Use them for dissecting at the bottom of a deep wound.

SCISSORS, Aufrecht's, light, curved, 140mm. This pair of scissors is for the set of instruments for hand surgery.

SCISSORS, straight with fine sharp points, Glasgow pattern, 100mm, stainless steel. Use these very fine scissors for cutting down on veins.

SCISSORS, suture cutting, 'assistant's scissors', rounded ends. Keep these in spirit with the other scissors. Your assistant needs a pair; so does the scrub nurse.

SCISSORS, suture wire cutting, 130mm. If you cut suture wire with ordinary scissors, it will ruin them.

SCISSORS, bandage, angular, Lister, 180mm. These have a blunt knob at the end of one blade which goes under the bandage to protect the patient. Insert them away from the wound; if they become soiled or wet, clean and sterilize them before you use them on someone else.

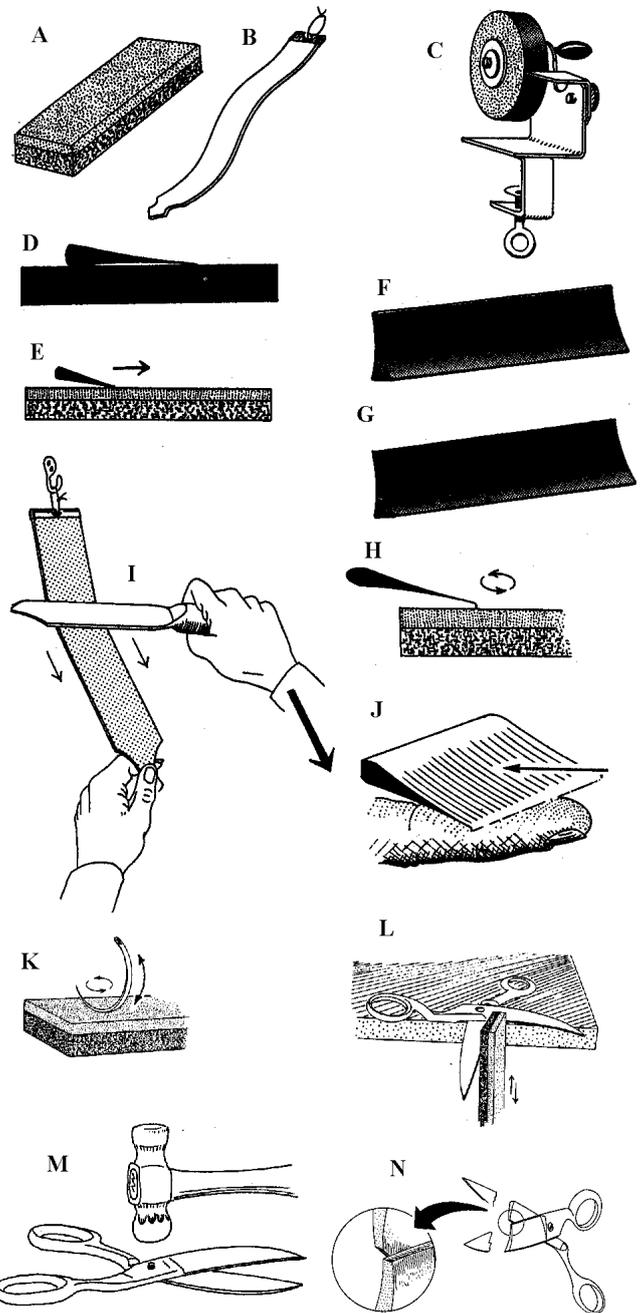


Fig 4-3 CARING FOR YOUR EQUIPMENT.

A,C, grindstones. B, strop. D, if your razor is hollow-ground, lay it flat, so that both edges rest on the stone and push it forwards. E, if it is ground on the flat, lift its heel slightly and push it forwards. F, light reflecting from the blunt edge of a razor. G, no reflecting light from a sharp razor. H, removing a burr. I, stropping a knife by pulling it towards you. J, feeling if there is a burr on a blade by drawing it backwards across your finger (*make sure you do this when the blade is sterilized*). K, sharpen a cutting needle by rotating it in 2 planes on a stone. L, sharpen a pair of scissors against a grindstone. M, tighten the rivet of a pair of scissors with a light hammer. N, the cutting edges of scissors should look like this.

4.4 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 1 into 2 teeth, or 3 teeth into 4, 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.

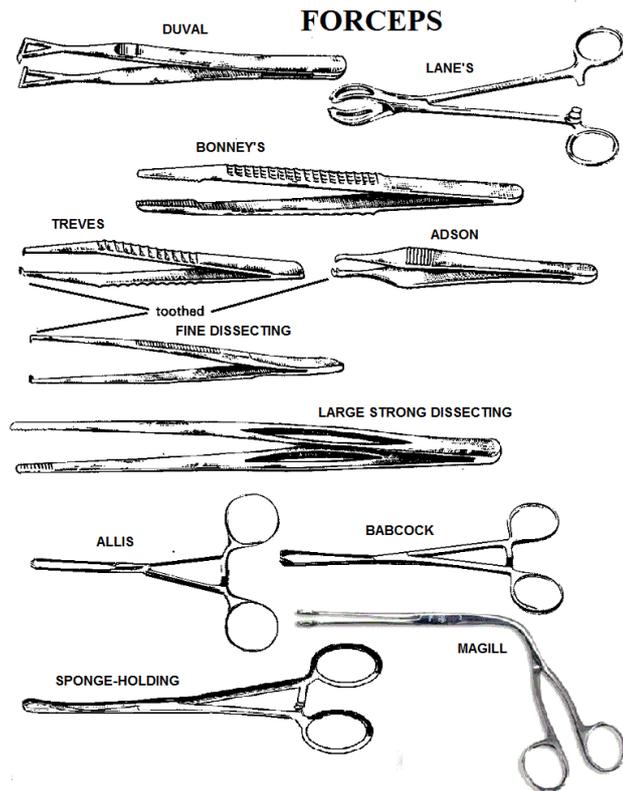


Fig. 4-4 FORCEPS.

Dissecting forceps are also called thumb forceps, and can be plain or toothed. Use forceps according to the size of tissue you are handling: Lane's tissue forceps have teeth and are useful for holding a large piece of tissue you are going to excise; Bonney's for the abdominal wall; Treves or Adson's for skin; Duval's have a groove to hold tissue with minimal trauma to it; Babcock's have bars on each blade that come together gently without damaging the tissues, and so are useful for holding bowel or ureter which you don't want to damage; Sponge-holding forceps for gauze swabs, or to retract the gallbladder (15.8). Magill's are specifically for guiding an endotracheal tube, but also for extracting foreign bodies from the throat (30.1).

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, have a toothed end, and are even more traumatic; they are for clamping fascia or wide vascular pedicles, so that the vessels do not slip out (3.1).

FORCEPS, dissecting, thumb, blunt, non-toothed, Bonney's, 180mm. These are strong dissecting forceps without teeth.

FORCEPS, dissecting, thumb, toothed, Treves', 1x2 teeth, 130mm. These are the standard toothed dissecting forceps.

FORCEPS, dissecting, thumb, fine, Adson's, (a) plain, (b) 1x2 teeth, 120mm. These have broad handles and fine points and are particularly useful for the eye.

FORCEPS, dissecting, thumb, Duval's, 150mm, with non-traumatic teeth on triangular jaws. These are thumb forceps for general use.

FORCEPS, dissecting, thumb, toothed, 180mm. These are long fine dissecting forceps.

FORCEPS, dissecting, thumb, Maingot's, 280mm. These are large toothed forceps with fenestrated sides that are easy to hold.

FORCEPS, dissecting, McIndoe's, plain, 150mm. These are for the hand set.

FORCEPS, dissecting, ophthalmic, Silcock's, 100mm. This is a fine pair of forceps for operating on the eye or the hand.

FORCEPS, tissue, locking, Allis, box joint, 150mm, 5x6 teeth.

FORCEPS, tissue, locking, Babcock's, box joint, 160mm. These have a bar on each blade that comes together gently without damaging the tissues. Use them to hold bowel.

FORCEPS, tissue, Lane's, 15cm. These have curved jaws, teeth and a ratchet.

FORCEPS, sinus, Lister, box joint 150mm. You can use these for many other purposes besides exploring sinuses. Use them for packing the nose, or putting a drain into an abscess cavity.

FORCEPS, cholecystectomy, curved jaws with longitudinal serrations, Lahey's, box joint, 200mm. These forceps are useful for other purposes besides dissecting out the cystic duct. If you put them into the tissues and separate them, you can use their rounded ends to define arteries, veins and ducts.

FORCEPS, intestinal, Dennis Browne, 180mm. Use these to pick up the bowel during an abdominal operation, or a hernia repair.

FORCEPS, Moynihan, box joint, 220mm. Use this massive pair of crushing forceps for wide vascular pedicles, such as those which contain the uterine vessels at hysterectomy.

FORCEPS, Desjardin's, screw joint. Use these for removing stones from the bile duct.

FORCEPS (clamps), hysterectomy, curved, box joint, 1 into 2 teeth, 23cm, Hunter or Maingot. Hysterectomy is difficult without several long curved clamps for big vessels, preferably with longitudinal serrations and teeth at their tips.

FORCEPS Magill's. Use these in endotracheal intubation and for removing foreign bodies in the throat (30.1).

N.B. It not necessary nor even desirable to have all these sorts of different forceps.

4.5 Retractors & hooks

You will need a retractor to hold tissues out of the way of where you want to operate. There are 2 kinds. One has to be held by an assistant, the other holds itself.

Self-retaining retractors should never stretch a wound and cause ischaemia: make a bigger incision if the field is inadequate! Strong retraction causes trauma, especially to the edges of the wound. So avoid it by approaching deep areas through larger incisions. Avoid sharp, pointed retractors.

Any blacksmith should be able to make you the simpler retractors from ordinary steel.

If you need an assistant to hold a retractor for a considerable length of time, engage him in the operation lest his concentration wanders at a critical moment!

RETRACTORS

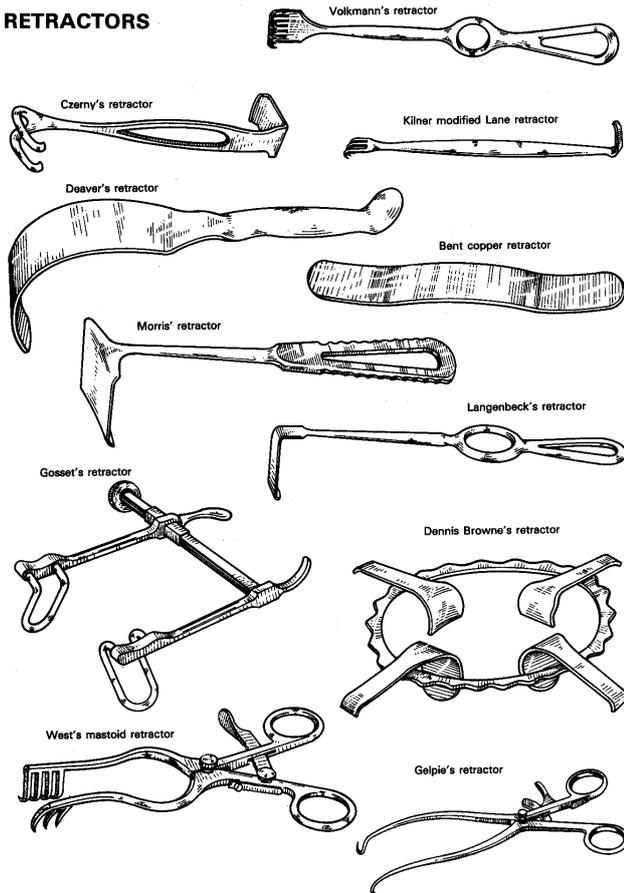


Fig. 4-5 RETRACTORS.

You cannot operate on a patient if the surrounding tissues get in your way. These retractors will help to give you a clear field. Some have to be held, others hold themselves.

RETRACTOR, Volkmann's rake, sharp, 4 prong, 220mm. These have sharp teeth like a cat's paw. Take care that they do not injure anything important.

RETRACTOR, Langenbeck, 13x44mm. These are fairly small narrow deep retractors.

RETRACTOR, Czerny, double ended. These have a flat blade at one end and 2 deep prongs at the other. They are thus more versatile than Langenbeck's retractors.

RETRACTOR, Lane's modified by Kilner, double ended, 150mm. This is a light general-purpose retractor with short shallow hooks at one end and a tongue at the other.

RETRACTOR, Gelpie, 170mm. A pair of these are very useful as general purpose retractors.

RETRACTOR, Morris, double ended. This is a double ended abdominal retractor. Some surgeons prefer single-ended ones which are easier to hold.

RETRACTOR, Deaver's, plain handles, set of five sizes. These inexpensive general purpose abdominal retractors nest together, and so are easy to store.

RETRACTOR, malleable copper, set of 4 sizes. These are strips of copper that you can bend into any shape to suit your needs.

RETRACTOR, Meydering, 178mm. These are for hand surgery and are used as a pair.

RETRACTOR, self-retaining, West's, straight, sharp-pronged. This is a small self retaining general-purpose retractor.

RETRACTOR, abdominal, self-retaining, 2-blade, adult, Gosset's. The 3 blades of this large abdominal retractor can be arranged so that they support one another, and do not have to be held.

RETRACTOR, universal, Dennis-Browne, with (a) 1 frame 300x240mm, (b) 3 hook-on retractors 50x65mm, (c) ditto 80x90mm, (d) ditto 98x50mm, (e) ditto 105x35mm. This is a useful but expensive retractor. It has a notched ring and hooked prongs (4-5).

HOOKS, tendon, Harlow-Wood, 114mm. These are for the hand set (4.12).

4.6 Suture materials

If you bring soft tissues together and hold them there for 5-10days (depending on their blood supply) they will join. Most surgery depends on this. The easiest way to hold tissue is to suture it. You can use:

- (1) Absorbable sutures which are absorbed by the tissues so that you need not remove them.
- (2) Non-absorbable ones which you leave indefinitely if they are deep, or remove if they are on the skin.

Absorbable sutures used to be solely plain catgut (from the submucosa of the bowel of sheep, *not cats!*) which usually holds its strength for about 10days. Catgut can be treated with chromic acid which slows its absorption by phagocytosis and makes it keep its strength for 20days, but this remains unpredictable. Sepsis speeds the dissolution of catgut, especially plain catgut, so that it may dissolve in 2-3days. Catgut is soft and holds knots well, but not so well as a non-absorbable multifilament, such as linen or cotton. If a suture material does not hold knots too well, its knots need longer ends (>5mm). While catgut is being absorbed it makes a good culture medium and may promote sepsis. So *do not use more than is necessary, do not leave the ends of ligatures unnecessarily long and avoid thick #2 or #3 catgut*. Plain catgut does not hold its strength for very long, so never use it for tying larger vessels or suturing the bowel. One problem with catgut is that it may be of poor quality, and does not preserve for long, and so give way early and perhaps disastrously. This is another reason for using monofilament where you can.

If necessary, you can use almost any suture material almost anywhere, especially on the skin. But, always use absorbable for:

- (1) The urinary and the biliary tracts because non-absorbable sutures can act as the focus around which a stone can form.
- (2) The mucosa of the stomach, where a non-absorbable suture may be the site of an ulcer later.
- (3) The mucosa of the uterus (less important).
- (4) Sutures close under the skin, where non-absorbable sutures may work their way to the surface.
- (5) The scrotal skin, where sutures easily "disappear" and cause intense itching.

There are long-lasting absorbable sutures which are more reliable, but they are expensive. It might be useful to have limited stocks for special purposes, e.g. bowel anastomosis, where suture breakdown is a disaster, and the extra cost readily justified. Various synthetic materials are used, with different absorption times:

Polyglycolic Acid	('Dexon', 'Polysorb')	30-60 days
Polyglactin	('Vicryl', 'Visyn')	60-90 days
Lactomer 9-1	('Clinisorb')	60-90 days
Poliglecaprone 25	('Monocryl')	90-120 days
Glycomer 631	('Biosyn')	90-120 days
Polydioxanone	('PDS')	120-180 days

NB. Vicryl rapide has a much shorter absorption (10-15 days) and Vicryl plus (preserved in triclosan antiseptic) longer.

Non-absorbable sutures can be polyamide ('Nylon'), polypropylene ('Prolene', 'Surgilene', 'Surgipro'), polyethylene ('Curlene'), polyester ('Dacron', 'Mersilene', 'Surgidac'), which may be coated with polybutylate ('Ethibond') or silicone ('Ticron'), linen, cotton, silk, or stainless steel wire. The first three come as a single (mono)filament, or as multiple filaments which are braided or twisted together. Monofilament is the most useful general purpose suture. Although non-absorbable sutures remain as permanent foreign bodies, monofilament nylon, polyethylene, and steel are less likely to promote infection than catgut, or multifilament cotton, linen, or silk.

Unfortunately, a single thicker filament makes less reliable knots than a many finer ones braided or twisted together, except for steel wire, which is always used as a single filament, and which knots superbly but is difficult to work with. So, always tie monofilament with a surgeon's knot (4.8). Silk, linen or cotton knot well, and you can cut these sutures 2mm from the knot.

Apart from the indications for absorbable sutures given above, you can use monofilament for almost anything, but silk, cotton, or linen threads, are better than monofilament for tying larger vessels. However, *never hold monofilament with artery forceps or a needle holder* because you will seriously weaken it at that point. Braided silk may cause troublesome stitch abscesses. *Do not use it immediately under the skin*, because it may work its way through to the surface, long after healing is complete. If it does become infected, you may have to remove it piece by piece. Even monofilament can come to the surface, so keep it well buried, and use absorbable close under the skin.

The strength of sutures is measured in 2 systems. In the old system the finest ones are measured in 'zeros' and the thicker ones are numbered. From finest to thickest the sequence is, with doubling of diameters each time, 6/0, 5/0, 4/0, 3/0, 2/0, 0, 1, 2, 3, 4. Although attempts are being made to replace the old system by a metric one from 0-8, most surgeons still use the old one.

Use the thinnest sutures you can: they need only be as strong as the tissues they are holding together. You can do most operations with sutures between 3/0 and 1. Only very occasionally will you need sutures which are thicker or thinner than this, except for fine work such as nerve or tendon repairs, and for eye and plastic surgery. If you do need a thicker suture, you can double up a thinner one.

The cost of sutures can significantly increase the cost of an operation. In the industrial world they are now sold in individual disposable packs, which are expensive to make and waste much suture material each time a pack is opened. (If the outer wrapping is opened in error, the suture is still sterile and *should not be discarded!*) The suture is combined with an atraumatic needle and this means that sutures for one operation may cost US\$20. But if you buy monofilament in rolls, and use ordinary needles, the suture materials for a single operation cost almost nothing. Monofilament suture material in packets is 20,000% more expensive than in reels, and with needles swaged on is 30,000% more!

INEXPENSIVE SUTURES

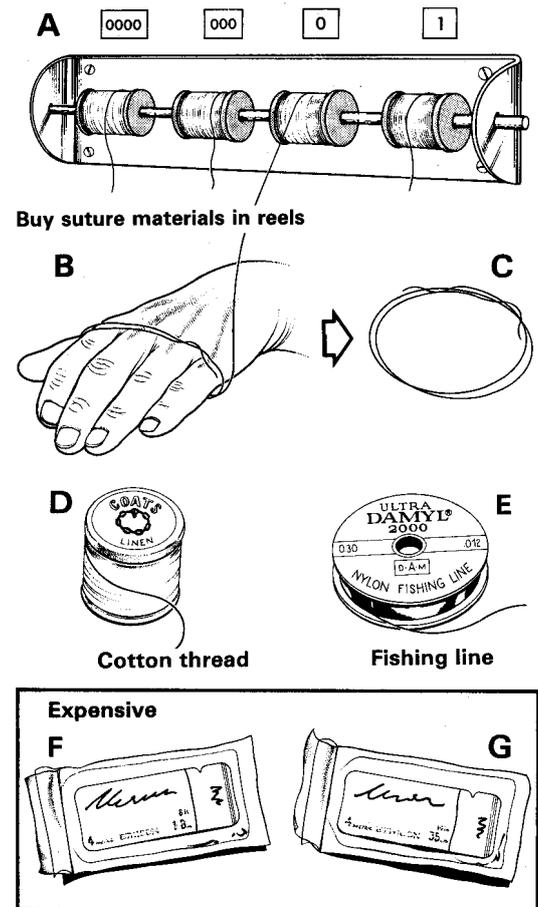


Fig. 4-6 BUY MONOFILAMENT IN REELS.

Hang them from a wall bracket (A), cut lengths of suture material about a metre long and twist them into loose coils (B,C), or wind them round the empty spools used for disposable sutures. If funds are scarce, avoid the expensive proprietary sutures F,G; you can also use cotton or linen thread, or colourless fishing line. Match this against surgical monofilament nylon strength for strength. A good strength for abdominal sutures is 12-20lb breaking strength.

Dr JAMES MUKOLAGE was horrified to find in the village a woman with an abdominal wound from which bowel was protruding. He was only recently qualified and had not operated on one of these cases before. He had few facilities, but he managed to find some local anaesthetic solution and some linen thread in the shops. A few instruments from the local health centre were boiled up; he washed the wound thoroughly, and anaesthetized the tissues round it with lidocaine. Fortunately, her bowel had only a minor cut in it which was easily repaired. When he had returned her bowel to her abdomen he was able to close it with linen thread. She survived. LESSON: Improvisation can save lives.

MONOFILAMENT IS THE MOST USEFUL GENERAL PURPOSE SUTURE MATERIAL

Never let the lack of suture materials be the reason for not doing an urgent operation. Either use ordinary nylon fishing line, which is exactly the same material as that used for surgical sutures. Thread this through a hollow sterile needle of correct size, snap off the plastic Luer lock, and crimp the metal of the needle tight onto the thread to secure it. Bend the needle to whatever shape you want and use it with a needle holder.

Here are comparative suture sizes related to fishing wire breaking strengths:

<i>Non-absorbable suture size, U.S.P. (and metric)</i>	<i>Diameter limits (mm)</i>	<i>Fishing line size by breaking strength (in pounds) and approximate diameter</i>	<i>Uses</i>	<i>Improvised syringe needle gauge and inner diameter (mm)</i>
6-0 (0.7)	0.070 - 0.099	N/A	Face, blood vessels	30g (0.140) or 31g (0.114)
5-0 (1)	0.100 - 0.149	1 lb (0.12-0.14 mm)	Face, neck, blood vessels	28g (0.191) or 29g (0.165)
4-0 (1.5)	0.150 - 0.199	2-4 lb (0.15-0.20 mm)	Neck, hands, limbs, tendons, blood vessels	26g (0.241) or 27g (0.216)
3-0 (2)	0.200 - 0.249	6 lb (0.22-0.26 mm)	Limbs, trunk, bowel, blood vessels	23g (0.318); 24g (0.292) or 25g (0.267)
2-0 (3)	0.300 - 0.339	8-10 lb (0.30-0.33 mm)	Trunk, fascia, viscera, blood vessels	22g (0.394)
0 (3.5)	0.350 - 0.399	12-14 lb (0.32-0.39 mm)	Abdominal wall closure, fascia, muscle, drain and line sites, bone	20g (0.584) or 22g (0.394)
1 (4)	0.400 - 0.499	15-20 lb (0.40-0.48 mm)		20g (0.584)
2 (5)	0.500 - 0.599	25-30 lb (0.50-0.58 mm)		18g (0.838)
3, 4 (6)	0.600 - 0.699	N/A		18g (0.838)
5 (7)	0.700 - 0.799	50 lb (0.70-0.77 mm)		18g (0.838)

N.B. The thickness of fishing line is not necessarily proportional to its breaking strength!

Or, if necessary, you can use ordinary linen or cotton thread almost anywhere, especially as ties. You can likewise buy this cheaply on a reel, and re-sterilize it.

Use 4/0 monofilament as your basic suture material for fine skin sutures.

SUTURES, catgut, plain, 3/0, in boxes of 12. Plain catgut is soft. Use it for suturing the mouth, tongue, and lip.

SUTURES, absorbable, strengths 3/0, 2/0, 0, 1 and 2.

SUTURES, absorbable long-lasting, atraumatic, (a) 2/0 on half circle 30mm needles. (b) 2/0 on 5/8 circle 30mm needles. (c) 4/0 on 16mm curved needle. These sutures have needles swaged on to them. Use them for the bowel, the gall-bladder, and the stomach, held in a needle-holder. The smaller needles (c) are for children.

SUTURES, prolene, atraumatic, (a) 4/0 on 16mm half circle, round-bodied needles, (b) 8/0 on 3mm 3/8 circle atraumatic needles.

SUTURES, linen, # 1. Use linen for tying vessels. It holds knots well and is stronger than cotton.

SUTURES, nylon or virgin silk, 8/0. These are for suturing the cornea.

WIRE, monofilament, soft stainless steel, (a) 5/0, (b) 0.35mm, (c) 1.0mm.. Surgical wire must be soft and malleable because springy wire is difficult to work with. Autoclave the whole reel.

(a) Fine 5/0 wire is cheap, and is excellent for the skin, if you can use it efficiently.

(b) 0.35mm wire is for wiring the teeth and for hemicerclage.

(c) Tension 1.0mm wire in a stirrup and use it for exerting traction.

These wires and the equipment to use them are essential. One of the advantages of wire is that, unlike more massive pieces of metal, it does not promote infection, so that you can if necessary put it though infected tissues. You can wire tissues in the presence of sepsis; for example, when you repair a burst abdomen (11.14).

Fasten wire by passing its ends through any convenient tube, such as that from a ball pen, and then grasping the ends and twisting them. Finally, cut the twisted ends of the wire short. This will prevent it from coiling up in an inconvenient way.

WALL BRACKET, stainless steel, to hold rolls of monofilament (4-6).

Fix this to the wall, and pull lengths of monofilament from it. If you cannot get one of these brackets, make it.

REELS, stainless steel, egg shaped ('eggs'), for holding suture material. Wind monofilament into these, autoclave them and cut off the length of suture material you require.

CRIMPING PLIERS, for bending needles.

4.7 Needles & their holders

Needles can be round-bodied, taper-pointed, or they can have cutting edges. They can be thin or thick, large or small; straight, J-shaped, or curved into $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, or $\frac{5}{8}$ of a circle. Curved needles are for working in confined spaces. Use a $\frac{3}{8}$ circle needle in a shallow space, and a $\frac{5}{8}$ needle in a deep one.

The narrower and deeper the space the smaller and more curved the needle has to be. If necessary, you can try to bend a half-curved needle into a $\frac{5}{8}$ circle. To economize on commercially-produced sutures, you can use fishing wire (4.6).

A needle can have an eye, or the suture material can be fixed to it to form an atraumatic needle. These are expensive, but they make smaller, neater holes, because the suture material is not doubled through the extra thickness of the eye. Use atraumatic needles to suture bowel, the urinary tract, blood vessels, nerves, the cornea and the face, especially the eyelids. These commercially available sutures are much easier to use. It is worthwhile trying to get them through donations. Though they have commercial expiry dates, their reliability lasts at least 12-24 months past this date.

Always use a cutting needle for the skin, either a straight, half-curved or a large curved one held in your hand, or a smaller curved one held in a needle holder. Use a cutting needle for tough fascia. Mayo's needle is a hybrid: it has a trocar point and a curved round shank. Use it for big wide vascular pedicles and tough tissues, such as ligaments. Use round-bodied or taperpoint needles for most other tissues, because of the danger of needle stick injuries. Re-sharpen cutting needles on a stone (4-3).

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. Hold the needle at the middle of its curvature at the very tip of the needle holder, and follow the curvature of the needle when you draw the suture through the tissues.

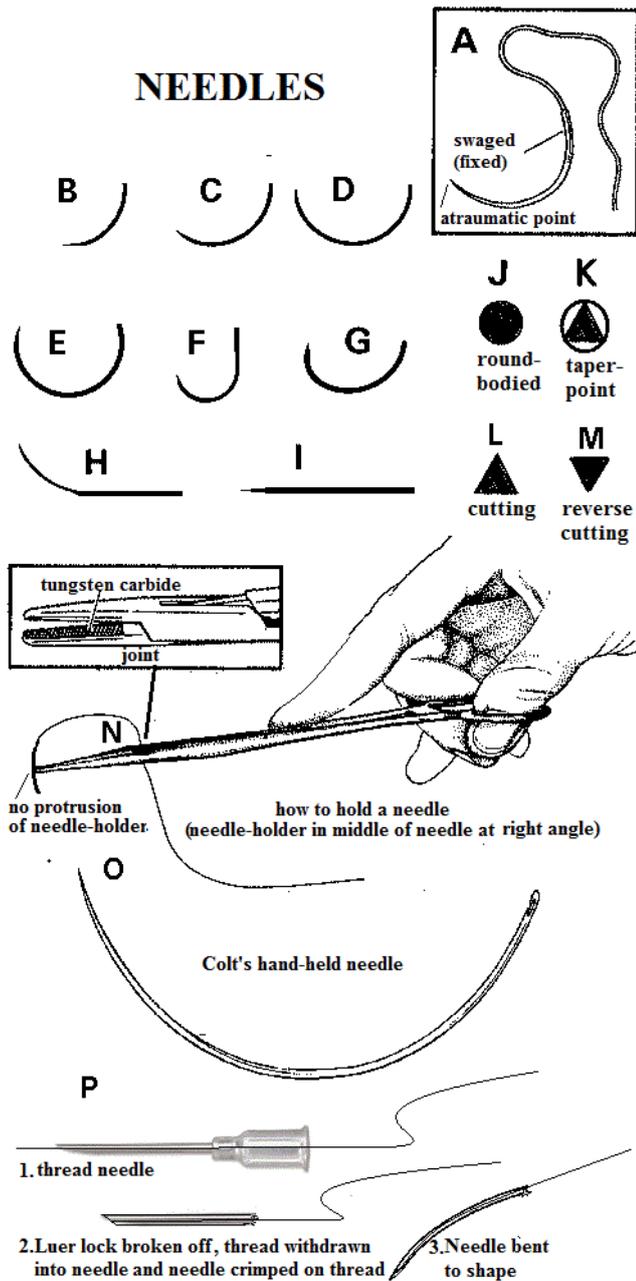


Fig. 4-7 NEEDLES.

A, Atraumatic suture with a needle swaged on to it especially for suturing bowel, vessels etc. B, $\frac{1}{4}$ circle, C, $\frac{3}{8}$ circle needles. D, $\frac{1}{2}$ circle needle for suturing soft tissues such as the broad ligament. E, $\frac{5}{8}$ circle needle for suturing deep in a wound. F, J-shaped needle for access into a small deep wound. G, compound curved needle. H, half-curved needle. I, straight needle, especially for subcuticular skin closure.

Needles can be round-bodied (J), taperpoint (K), cutting (L), or reverse cutting (M).

N, The best needle holders have tungsten carbide tips. Hold a needle where its cutting edge joins the shaft, with no part of the jaws protruding. O, Colt's large hand-held curved needle. P, Economize on sutures by using fishing line (4.6), thread this through an injection needle, break off the plastic Luer lock, withdraw the thread into the needle, and crimp it tightly onto the thread. Bend the needle to the shape you want.

Partly after Robert Remis.

NEEDLES, suture, Keith, triangular straight 64mm. This is the standard straight, hand held needle for stitching skin. It is easy to sharpen and 1 needle may last you a year.

NEEDLES, suture, $\frac{3}{8}$ circle, curved, triangular point, size 4, 12, & 18. These are the standard curved needles. Hold the largest ones in your hand and the smaller ones in a holder.

NEEDLES, suture, $\frac{1}{2}$ circle curved, triangular, size 2, 8, 14 & 20. Use these strong, triangular cutting needles for the scalp.

NEEDLES, suture, round bodied, $\frac{3}{8}$ circle curved, size 4, 10 & 18. Use these for suturing soft tissue such as the peritoneum and broad ligament.

NEEDLES, Moynihan, $\frac{5}{8}$ circle curved, round bodied, fine, size 1, 4, & 6.

NEEDLES, Mayo, intestinal, round-bodied, half circle curved with sharp perforating ends, 23mm, size 20. Use this small curved needle in a holder.

NEEDLES, suture, round bodied, $\frac{1}{2}$ circle curved, size 1, 4, 10, 15, & 20. Hold these in a holder and use them in the depths of a wound.

NEEDLES, suture, Moynihan, Lance point, $\frac{5}{8}$ circle, 115mm. Use these large curved needles for sewing up the abdomen (11.8).

NEEDLES, suture, curved, tension, Colt, 102mm. This is a very large curved needle used for tension sutures into the abdomen (11.8).

NEEDLES, straight triangular, cutting, 35mm. Hold these in your hand and use them for suturing tendons.

NEEDLES, suture, Jameson Evans, triangular, curved, 10mm. These small curved needles have flattened shafts, triangular points and lateral eyes. Use them for delicate sutures, such as repairing the eyelids.

NEEDLES, suture, Dennis Brown, round pointed, $\frac{5}{8}$ circle, 16mm. Hold these small curved needles in a needle holder, when you are working at the bottom of a narrow deep hole, such as the bottom of a burr hole.

NEEDLES, suture, $\frac{1}{2}$ circle, catgut, Mayo, size 1 & 3. These are strong needles for tough tissues. They have short cutting edges, so you can use them to repair an artery.

NEEDLE, Deschamps, angled to the right. This is the only needle (not illustrated) in this list which you can use to thread wire, to close the abdomen (11.8), or to wire the patella.

NEEDLE HOLDER, Boseman, 210mm, ratchet and box joint, tungsten carbide jaws. This is the standard needle holder for medium and large needles.

NEEDLE HOLDER, Mayo's, with ratchet & box joint, tungsten carbide jaws 185mm.

NEEDLE HOLDER, Mayo Dunhill, 160mm, ratchet & box joint, tungsten carbide jaws.

NEEDLE HOLDER, Mayo's with narrow serrated jaws, box joint, tungsten carbide jaws and ratchet, 185mm.

NEEDLE HOLDER, Derf, box joint and ratchet, tungsten carbide jaws, 115mm. This is an expensive fine needle holder for tiny needles.

4.8 Suture methods

SUTURING WOUNDS (GRADE 1.1)

There are 2 kinds of wound to suture:

- (1) Those caused by trauma.
 - (2) Those which you make yourself when you operate.
- You can suture both in much the same way. Here, we are mostly concerned with the skin; the special sutures for other structures are described elsewhere: arteries (3.2), and bowel (11.3).

Remember, when you suture wounds, you are simply approximating tissue and skin edges. It is not your sutures which promote healing, but the body's own repair mechanisms. So, *do not tie your sutures too tight*; this causes ischaemia and ultimately tissue death, not healing. Place your sutures accurately and neatly to produce a scar as near invisible as possible. *Put the patient in as comfortable a position as possible so he does not fidget while you suture!*

SUTURING THE SKIN

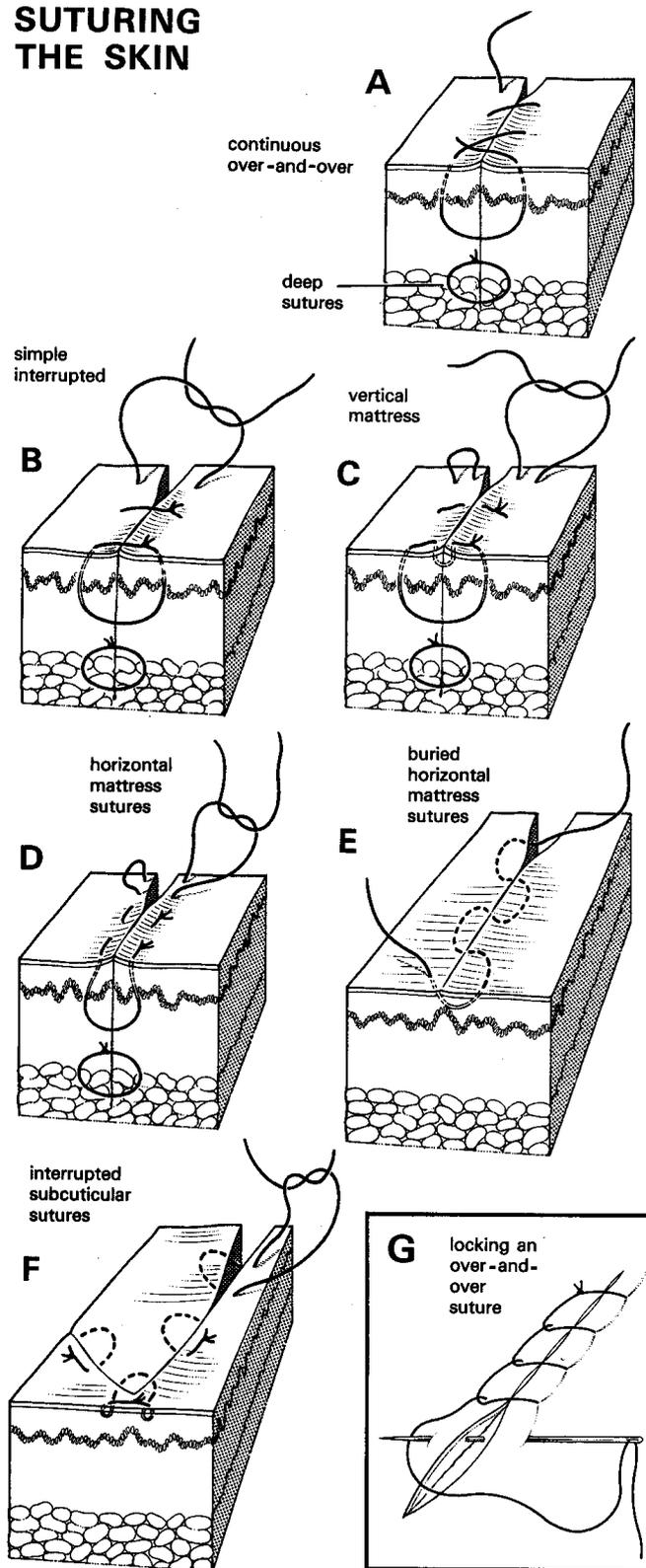


Fig. 4-8 SUTURE METHODS FOR THE SKIN.

A, continuous over-and-over suture. B, simple interrupted sutures. C, vertical mattress suture. D, horizontal mattress suture. E, buried horizontal mattress suture. F, interrupted subcuticular suture. G, continuous over-and-over suture which is being locked.

After Grabb MD, Smith JW, *Plastic Surgery*, Little Brown 3rd ed 1979 Figs 1-8, 1-9, with kind permission.

'Over-and-over' sutures are the most commonly used, and can be continuous (4-8A) or interrupted (4-8B). 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, or it cuts out, the whole wound may open up. The loss of a single interrupted suture, however, usually matters little. 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 (4-8G), or every few stitches.

Vertical mattress sutures (4-8C) 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 usually interrupted. **Horizontal mattress sutures** may be interrupted (4-8D) or continuous, superficial or buried (4-8E), and are merely alternatives to 'over-and-over' sutures without any special merit, except that they are better at everting the skin edges. *Do not bunch together the skin edges tightly: gentle approximation is all you require.*

A **subcuticular (or intradermal) suture** brings the skin edges together accurately, and is particularly useful in plastic surgery. By not puncturing the skin, it probably leads to less wound infections. It can be interrupted (4-8F) or continuous (4-8G). If it is continuous, anchor both ends using a knot internally, or leave the end long. *(Abandon the use of threaded beads because of the danger of needle-stick injury)*

The simple mattress suture (4-9G) is different from the figure of 8 suture (4-9H). Use this to stop bleeding from soft bulky tissue when there is no obvious vessel to tie. This can occur, for example, when you have closed the uterus after Caesarean section with the usual 2 layers of sutures and the wound is still bleeding at one end.

You may have donations of **skin staples** (4.10): they are quick and easy to insert to approximate skin edges, and leave little scarring, but need a special clip-remover to get them out easily.

KNOTS AND SUTURES

SUTURING. Hold a straight needle in your hand. Hold a curved one in a holder about half of its length from its end, with no part of the needle-holder protruding beyond the needle.

You will also have to hold the tissue you are sewing. Hold a hollow viscus, such as stomach or bowel, with plain forceps; hold skin or fascia with toothed ones. If the needle is curved, move the holder through an arc, so as to follow its curve.

In the skin, insert the needle a regular distance from the edge of the wound, and place sutures regularly. Include an equal amount of skin on each side of the wound.

Set knots down so that they lie square, and *do not tie them too tight*: just tight enough to bring the skin edges together. The skin will swell during the following day, and if the knots are already tight, they will become even tighter and impair the circulation, leading to necrosis.

CAUTION!

- (1) Do not insert the needle at different depths, because the edges of the wound will overlap.
- (2) Do not leave dead spaces, or they will fill with fluid which may become infected.
- (3) Suture towards you.
- (4) When you suture 2 tissues together, one of them may be mobile and the other fixed (because you are holding it). Suture from the mobile tissue towards the fixed.
- (5) Continue in the curve of the needle.

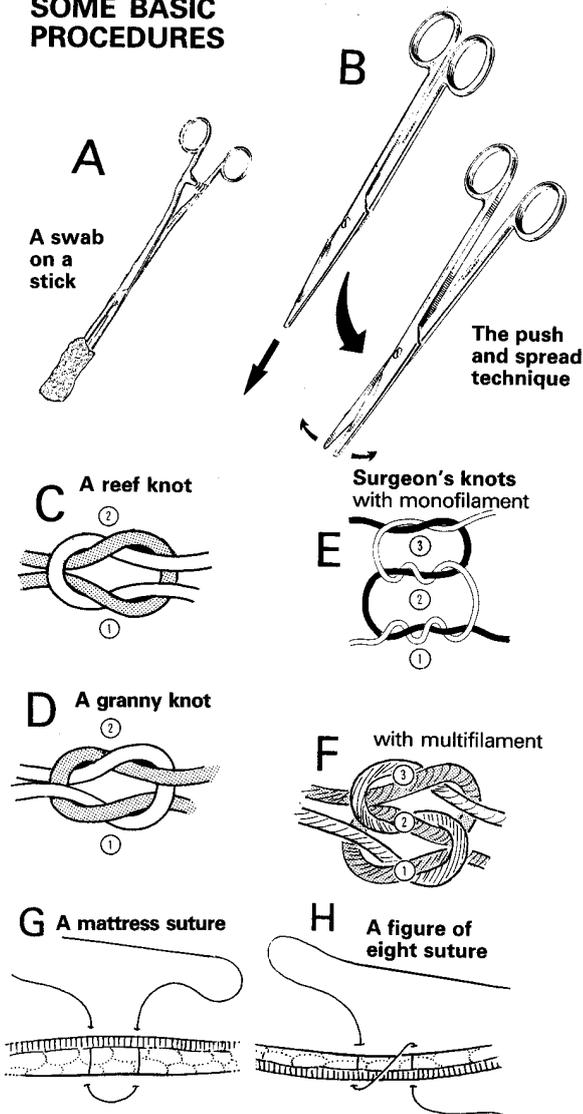
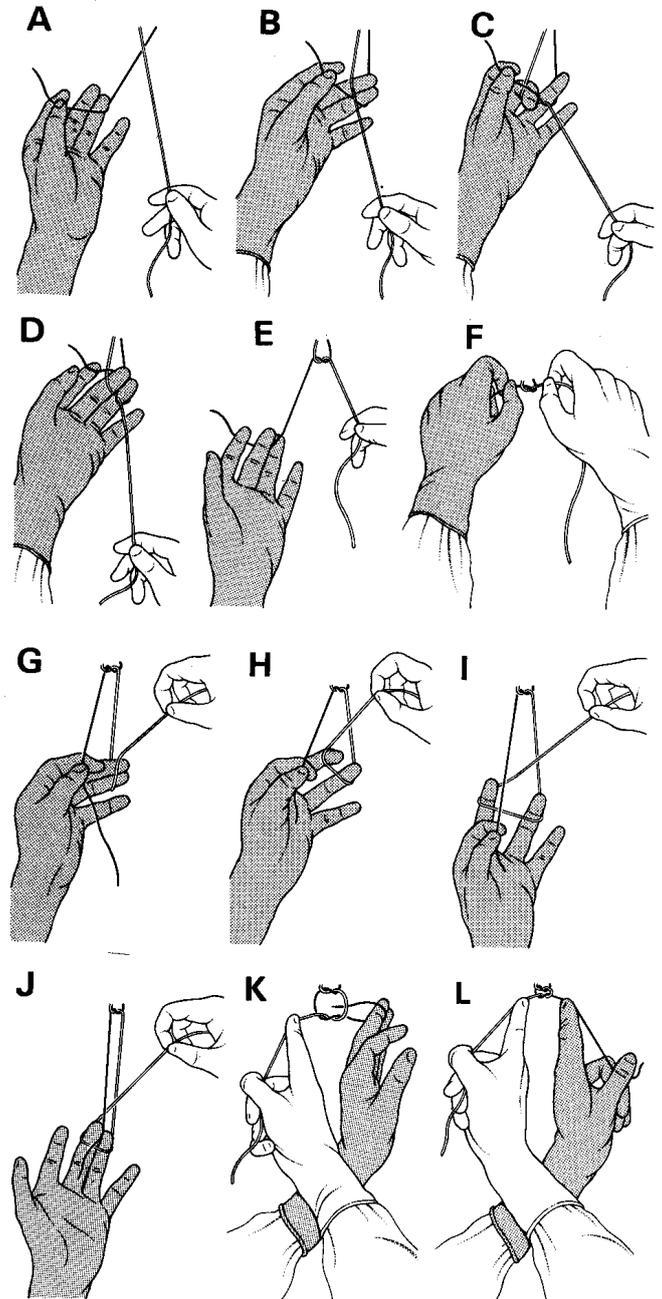
SOME BASIC PROCEDURES

Fig. 4-9 SOME OF THE BASICS.

A, Sponge holder grasping a swab ('a swab on a stick') can be a useful instrument for dissecting delicate structures, as when separating the peritoneum from the vagus nerves (13-13). B, as well as cutting with scissors you can push them into the tissues and then gently open them to spread structures apart. This is the 'push and spread technique'. Be gentle! It is useful for tissue planes, but forceful spreading can injure thin walled structures, such as veins. C, A 'reef' or 'square' knot. D, A 'granny knot' which does not hold so well. E, a surgeon's knot for monofilament has three hitches (or 'throws') with 2 turns (or more) on the first 2 hitches and 1 turn on the 3rd. F, A surgeon's knot with multifilament is less likely to slip and need only have a single turn on each of the three hitches. Note that each hitch should ideally make a reef knot with the previous one. G, A mattress suture. H, A 'figure of 8' suture, which is like a mattress suture, except that the needle is inserted in the same direction both times. Do not use this on the finger.

KNOTS. Tie reef (square) knots, *not* 'granny knots'. These are both made from 2 half hitches; in a reef knot they go in opposite directions, in a granny knot they go in the same direction. Pull equally on both ends, pull horizontally, and watch the knot go down. If one end is tense and the other loose, you will get a slip or sliding knot.

A REEF KNOT (FIRST METHOD)Fig. 4-10 TYING A REEF KNOT: 1st METHOD.

The standard method without using instruments. Difficult steps are C, and D, in which you grasp one of the ends between your middle and ring fingers, and I, and J, where you do the same again.

A surgeon's knot is merely a reef knot with a 3rd half hitch in the same direction as the 1st one. This 3rd half hitch makes the knot less likely to undo. Some surgeons tie 3 hitches in all suture materials.

Some suture materials undo more easily than others. Non-absorbable multifilament makes the safest knots. Knots of braided suture seldom undo, but knots of monofilament undo much more easily. So either use a surgeon's knot or at least 4 hitches when you tie monofilament. For important knots put ≥ 2 turns on the 1st and 2nd hitches. With multifilament a single turn is enough on each hitch.

Practise these knots with string or your shoelaces, until you can do them quickly, and do them blind. Learn the various ways of doing them in the following order.

A REEF KNOT (SECOND METHOD)

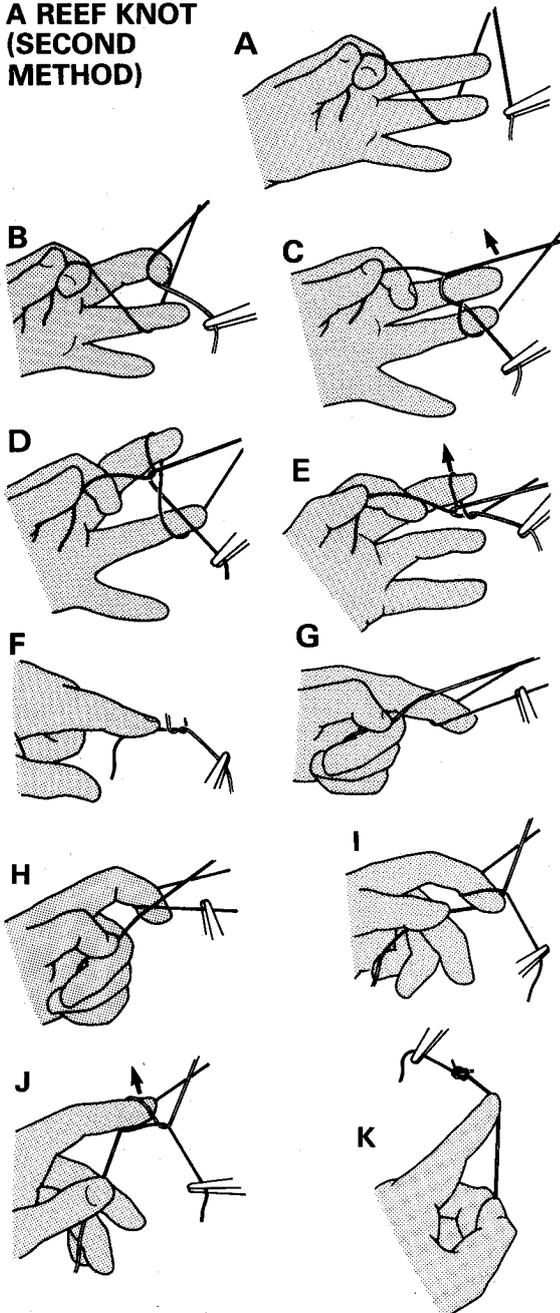


Fig. 4-11 TYING A REEF KNOT: 2nd METHOD. This method is similar to 4-10 except that you are using forceps in your right hand. Use it if you are working in a hole.

REEF KNOTS can be tied in several ways. The 1st method (4-10) is the surest way of tying a knot and is the one to use if you want to exert continuous pressure while you tie. In the 2nd method (4-11) use forceps in your right hand. The 3rd (4-12) is an 'instrument tie' and is useful if one end of a suture is short, or if the knot is in a deep cavity. The short end can be quite short. First, make a loop with the instrument in front of the long end. Grasp the short end and pull it through this loop. Then pull the first half hitch tight in the plane of the knot. To make the second half hitch, start with the instrument behind the long end.

A REEF KNOT (THIRD METHOD)

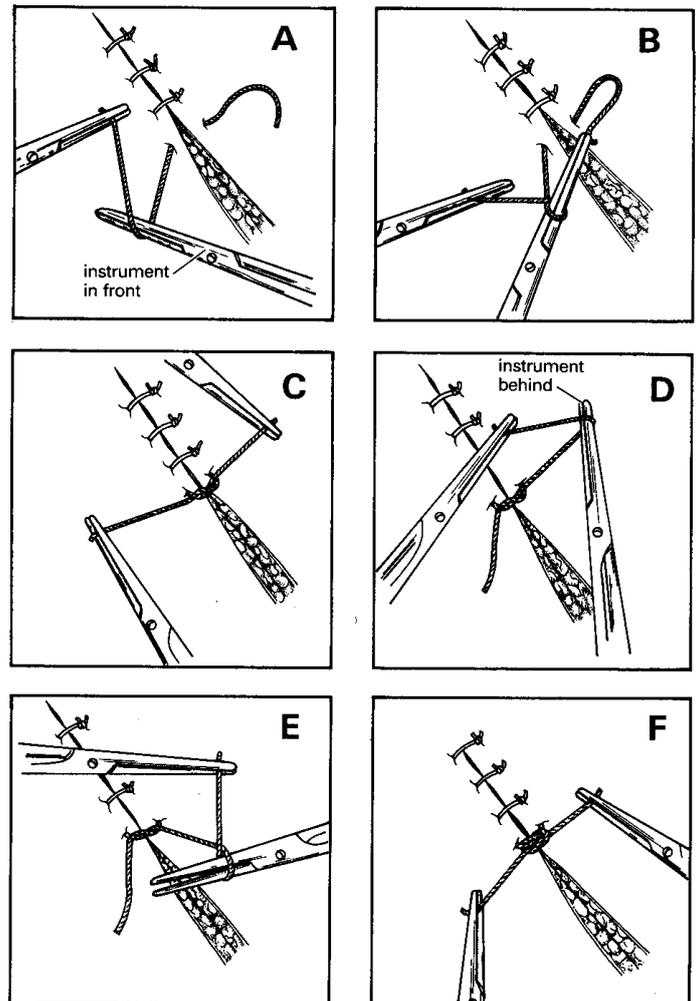


Fig. 4-12 TYING A REEF KNOT; 3rd METHOD.

If there is not enough room for your fingers, use forceps in each hand. This is an 'instrument tie'. Notice that for the 1st half hitch the instrument is in front of the long end (A), and for the 2nd one it is behind (D). In this way you will tie a reef knot, *not* a 'granny' knot.

TO CUT A SUTURE almost close the scissors, slip their open ends over the suture material, and move them gently down towards the knot. Twist the tip to give you the length of tail you want, then cut. Cut the tails of interrupted skin sutures short enough to prevent them tangling in the next suture. Leave buried catgut sutures with 5mm tails, others with 2mm tails. Cut buried sutures close beside the surgeon's knot.

CAUTION! Keep the tips of the scissors in view, and do not cut unless you can see what you are cutting.

AN ABERDEEN KNOT (4-13) is a useful method to secure a mass closure of the abdomen (11.8); hold the suture in a loop and pass successive loops of the suture through the 1st loop, c. 4-6 times, and then pass a single strand finally through the loop. Pull this taut, thus taking the slack off the loop, and creating the knot. You can then bury the suture end by taking a bite through adjacent tissue.



Fig. 4-13 AN ABERDEEN KNOT.
This is a very secure knot, especially useful for securing an abdominal closure.

REMOVING SUTURES. Leave them until the wound has healed adequately. Some sutures can be removed on the 2nd day, others not until the 14th. Remember the function of sutures is simply to approximate tissues, not to tie edges together! Here is a guide:

Skin sutures on the face and eyelids	2-3 days
The tongue	4 days
The scrotum	5 days
The scalp	6-7 days
The arm, hand and fingers	7 days
The abdomen: transverse incision	7-9 days
vertical incision	9-11 days
The skin of the back over the shoulders	11-12 days
The skin of the legs	14 days

N.B. Add 50% to these values for patients taking corticosteroids or cytotoxic medication.

When you remove a suture, try not to pull any part of the suture material which has been on the surface through the tissues, or you may contaminate the wound. Clean the skin, cut the suture where it dips under the skin with sterile scissors or a blade. Remember that after 3wks a wound has only 15% of the strength of normal skin, at 4months 60%, and only full strength at 1yr.

4.9 Drainage tubes

Inserting a drainage tube may be the principal aim of surgery, as when you drain the pleural cavity (36.1), or it may merely be part of an operation, as in decompressing the stomach when the bowel is obstructed (12-4, 12-6). You can also use tubes to drain pus and exudate. The insertion of a tube for gastrostomy (13.9), jejunostomy (11.7), caecostomy (11.6), and cholecystostomy (15.4) are described elsewhere: first we describe the use of nasogastric tubes, which are of great value, even though they are a burden to nurses and an irritation to patients.

TUBE, nasogastric, plastic, Ryle's, with several side holes near the tip, Ch14, Ch16, Ch18. Transparent plastic tubes are better than rubber ones, because they are less irritant, they do not collapse, and you can see what is inside them. Most tubes have markings, the first at 45cm showing that the tip is about to enter the stomach, and the second that it is in the antrum.

TUBE, stomach, plastic, adult and child, assorted sizes Ch8-22. These are critically important for making sure that a patient's stomach is empty before he is anaesthetized, and for washing it out if he has swallowed a corrosive (30.3). Adults need tubes of Ch16-22, children Ch10-14, and infants Ch8-10.

A. NASOGASTRIC (NG) TUBES

INDICATIONS.

(1) To remove fluid from the stomach before anaesthesia, so as to reduce the risk of the inhalation.

N.B. The solid food from a recent meal will not come up a small nasogastric tube, so if you want to anaesthetize a patient safely who has recently eaten, or has intestinal obstruction, you will have to empty the stomach with a large nasogastric tube.

(2) To decompress the stomach during upper abdominal surgery or in cases of high intestinal obstruction.

(3) To keep the stomach empty after a laparotomy for acute intestinal obstruction and in cases of pancreatitis.

(4) To feed a patient.

(5) To monitor severe gastric bleeding.

For all these reasons, it is good practice to pass a tube whenever you do an emergency laparotomy. *It is, however, not necessary with simple cases of appendicitis, cholecystectomy, or elective bowel resection and most gynaecological procedures.*

CONTRA-INDICATIONS.

- (1) If you suspect oesophageal varices.
- (2) After corrosive injury of the oesophagus where the mucosa is friable and easily perforated.
- (3) Where there is severe respiratory embarrassment: (a gastrostomy (13.9) is better).
- (4) A deformed or blocked nasal passage.
- (5) If you suspect a basal skull or cribriform plate fracture: *the tube may penetrate into the brain!*

PASSING A NASOGASTRIC TUBE.

Lubricate the tip of the tube with a water-soluble jelly. Sit the patient up and tell him what you are going to do. Choose the nostril which has the widest channel. If he is agitated, spray the nostril with lidocaine. Pass the tube horizontally through the nose. When the tube touches the posterior pharyngeal wall, he will gag, so give him a little water to sip, as you slowly advance the tube. The act of swallowing will open the *cricopharyngeus* and allow the tube to enter the oesophagus. Continue to advance it until its second ring reaches the nose; its tip should now be in the stomach.

If the tube is too flexible and curls up in the pharynx, put it in the freezer for 2mins and try again.

CAUTION! If you are only aspirating through the tube, you cannot do much harm, but *never start tube feeding until you are sure a tube is in the stomach.* You can easily pass a tube into the trachea of an elderly, debilitated, or unconscious patient and drown him with feed.

To make sure the tube is correctly placed in the stomach:

- (1) Aspirate greenish-grey stomach secretions and test these with blue litmus paper, which should turn red.
- (2) Inject a little air down the tube and listen over the stomach with a stethoscope for a gurgling sound.
- (3) Listen to the end of the tube. The sound of moving air confirms that the tube is *not* in the stomach, but is in the trachea or bronchi.

When you are satisfied that the tube is in the right place, secure it with 2 narrow strips of tape, one on the side and the other on the bridge of the nose, extending downwards on to the tube. In this way you will avoid pressure necrosis of the *alae nasae*.

Connect the tube to a bedside drainage bottle or plastic bag, to let the stomach contents syphon out. Assist this by aspirating. Suck the contents out hourly, or more frequently if there is much aspirate, to prevent the tube blocking. If you cannot aspirate anything, try irrigating the tube with 5-10ml of water; its terminal holes may be plugged. *Never clamp the tube!*

If the tube fails to decompress the stomach:

- (1) Its tip may still be in the oesophagus.
- (2) It may be kinked or blocked.
- (3) The stomach may be filled with large food particles.
- (4) Excessive suction may have sucked food or mucosa into the holes in the tube and blocked it.

Occasional sips (not gulps) of water will help to ease the patient's misery. Keep a fluid balance chart, and as a general rule replace gastric aspirate by IV 0.9% saline or Ringer's lactate.

CAUTION! *If you do not care for the mouth adequately,* the parotid may become infected. So arrange 4hrly mouth care as a routine after major surgery, especially if there is a nasogastric tube *in situ*.

REMOVING A TUBE.

As a general rule, leave a tube in place until:

- (1) There is no abdominal distension.
- (2) There is no longer any nausea.
- (3) The bowel is active normally, indicated by the passage of flatus. If there are only c.400ml gastric aspirate daily, this is the normal volume; if you aspirate ≥ 750 ml, suspect ileus or bowel obstruction.

CAUTION! *Do not remove a nasogastric tube if the patient is nauseated,* or the abdomen is distended and he has passed no flatus, or has >500 ml of gastric aspirate od. If he has any of these, he probably has paralytic ileus, obstruction (12.15), peritonitis (10.1), or an anastomosis that is too narrow. However, if the tube has migrated down into the duodenum, it will continue to produce large volumes: withdraw it then by 10cm and observe the effects.

DIFFICULTIES WITH NASOGASTRIC TUBES

A patient who is very weak, dehydrated or shocked, may vomit through the act of passing a tube and inhale the vomit. If so, lie him on the side, with the head tilted down, and pass a large stomach tube (Ch30). If he vomits he will now do so under controlled conditions. Afterwards, pass the nasogastric tube.

If pulmonary complications develop, these may partly be caused by the discomfort of the tube through:

- (1) causing ineffective coughing, and
- (2) drying out the mouth by making nose breathing difficult.

If the nasal cartilages necrose (rare), you applied tape unwisely. Pressure is usually caused by an acute angulation of the tube. A debridement of the dead tissue will be necessary.

If oesophageal erosions develop, you may have been using too hard a tube. Also, a large tube may allow regurgitation through the cardiac sphincter and cause an erosive oesophagitis.

B. OTHER DRAINS

Not all wounds need drains, and drains have their risks:

- (1) Bacteria may enter from outside, especially if nursing care is poor. This risk is small if you use a closed drainage system.
- (2) Bacteria may come from inside a patient and infect the tissues through which the drain passes, particularly the abdominal wall.
- (3) A drain may erode a vessel or a suture line, especially if you leave it in for a week or longer.
- (4) A drain may block.
- (5) A drain reduces mobility and so delays convalescence.
- (6) A drain may knot itself.

INDICATIONS.

- (1) To remove blood, serous oozing, or lymph from a loosely confined space (*e.g.* breast, scrotum, neck, wound): in this case a suction drain is most efficient.
- (2) To drain urine, bile or pancreatic juice, which may leak from a suture line, or formally to drain the bladder (27.2,6,7,8), gall bladder (15.5), or pancreas.
- (3) To drain the pleural cavity (9.1): here you need an underwater sealed drain or special system to prevent air being sucked into the pleural space.
- (4) To complete the drainage of an abscess cavity: you can let the exudate flow down a tube, or you can let it seep away round the edge of a Penrose fine rubber drain.
- (5) To permit the controlled escape of content from a possibly leaky suture line, for example when you are worried about an extra-peritoneal, *i.e.* oesophageal or rectal anastomosis.

N.B. There is no evidence to support the use of drains in the peritoneal cavity to 'control' secretions. They block or seal off within 24 and 48hrs anyway, unless kept irrigated. Do not insert a drain unless there is a good reason to do so. Therefore do not drain all wounds routinely; insert a drain when there is a proper indication to do so. Drains may actually cause the fistula they are trying to 'control'.

PENROSE FINE RUBBER DRAINS are useful for abscesses. Cut more than an adequate hole in the superficial tissues, cut a strip of rubber to fit loosely and push this into the depth of the wound (4-14B). Do not make the hole for the drain so small so that it is tight (4-14C). Use a cutting needle to transfix it with a suture and anchor it to the skin, then tie the ends of the suture several times. When you shorten a drain, you may be able to leave a loop of suture material securing it. A safety pin will prevent it slipping inside the wound, but will not prevent it slipping out.

TUBE DRAINS are useful in large wounds where you expect much exudate, or in areas of infection (4-14D). They are especially useful in the abdomen (4-14E). Have 2-3 sizes of drainage tubes ready sterilized with suitable adaptors. Use silicone rubber or polyethylene, rather than red or latex rubber, which is more irritant.

- (1) Try to use a tube drain with a tight seal which will lead the exudate safely into a bottle, rather than a piece of rubber which will lead it into dressings.
- (2) Try to place the drain at the bottom of the cavity to be drained, so that exudate can easily flow out downwards; make it follow a straight path.

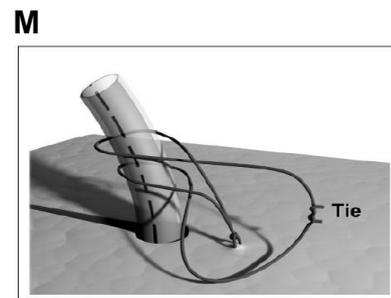
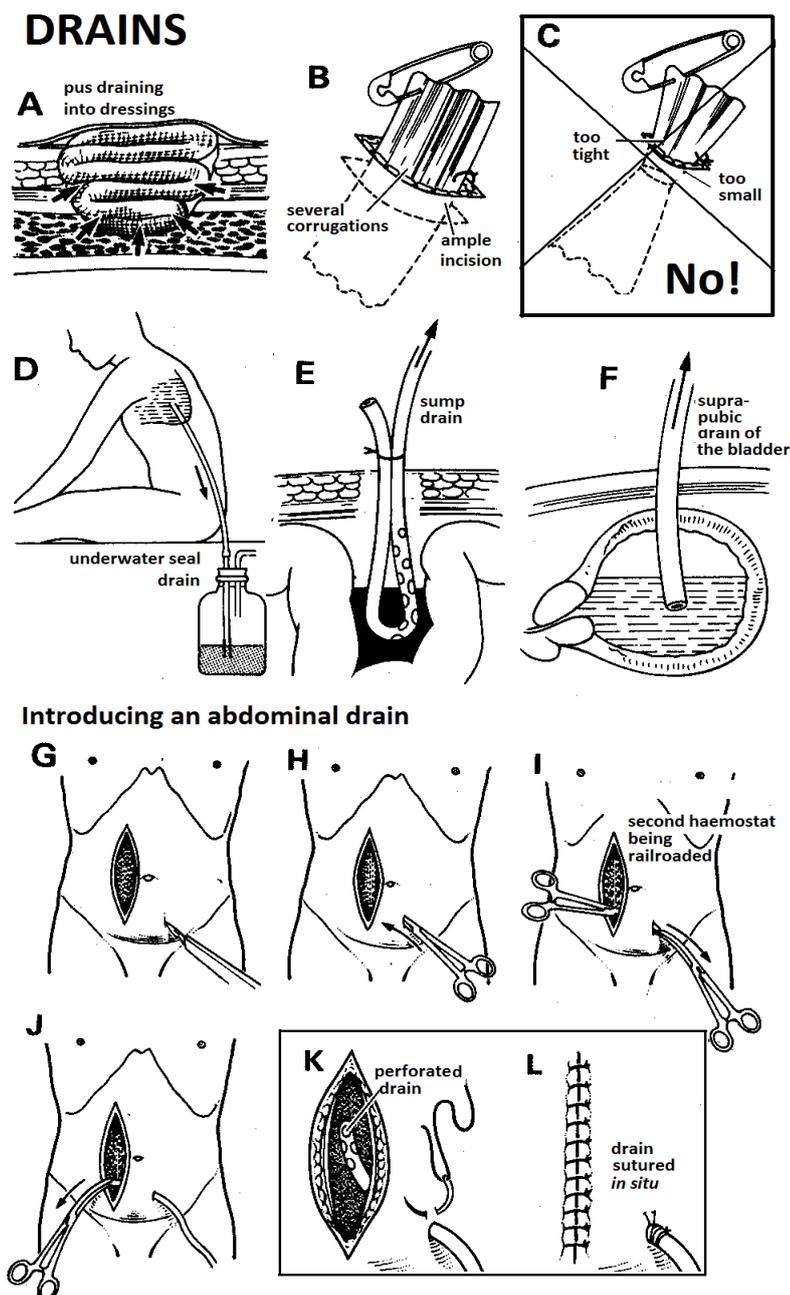


Fig. 4-14 DRAINS.

A, in a superficial wound pus can drain into the dressings. B, a corrugated drain should usually consist of several corrugations and fit loosely through an incision in the superficial tissues. C, do not push a drain tightly through a small incision. D, chest drain. E, sump drain. F, draining the bladder. G-L, introducing a tube drain into the abdomen. G, making the incision. H, inserting the 1st haemostat. I, catching a 2nd haemostat by the 1st and pulling it through out of the abdomen. J, releasing the 1st haemostat and pulling a drainage tube inside with the 2nd. K, holes cut in the end of the drainage tube. L, drain sutured in place and the abdominal wall closed. M, method of fixing the drain so it is held tight.

After Shokrollahi K. A simple method for securing a surgical drain. *Ann R Coll Surg Engl* 2005; 87: 388.

(3) Insert the drain through a separate stab incision, not through a sutured wound.

(4) If a drain is in any danger of falling out, stitch it in as it passes through the skin (4-14L).

(5) Keep dressings over the drain separate from the main wound, so the former does not contaminate the latter.

(6) *Do not try to drain the whole peritoneum in peritonitis:* it is impossible anyway. Instead, wash out the peritoneal cavity (10.1).

(7) Finally, be sure to explain to the ward staff why you have inserted a drain, how they are to manage it, and when they are to remove it.

(8) Make sure, if there is more than one drain, that they are labelled appropriately with a permanent marking pen.

TO INTRODUCE AN ABDOMINAL TUBE DRAIN, try to fit a wide bore tube tightly in a small hole. Make a small incision in the skin. Use a 10mm (Ch30) tube, and cut side holes in the end. Make a small hole in the tissues and 'railroad' the drain in (4-14G-J), using a hand to protect the bowel. *Try to do this under direct vision!* Anchor the drain to the skin with a suture. Insert a skin stitch, tie a second reef knot distal to the first one and then tie the ends of the suture round the drain with a surgeon's knot (4-14L). Finally, tape the drain to the skin. Connect it to a sterile bottle.

SUCTION DRAINS are ideal, especially the disposable plastic kind. More practical are the reusable 'Redivac' suction bottle type, which have disposable drainage tubes.

SUMP DRAINS are useful if you have a suction pump and you want to drain fluid, such as urine, or pancreatic juice which is welling up from the depths of a wound.

THE TIME TO REMOVE A DRAIN varies with the fluid to be drained. Here are some guidelines:

Blood	48-72 hrs
A suspect bowel anastomosis	5-7 days
A septic cavity	usually 5-7 days
Bile, pancreatic fluid or urine	10 days

Do not leave a drain in longer than is necessary, because you run the risk that it may erode a vessel. There is seldom any need to leave a drain >2wks at the most, except in a very large deep abscess. If you remove a drain too early, pus may build up and seek to discharge itself elsewhere. If a drain is long, shorten it progressively over several days before you remove it. Shorten it by pulling it out, not by cutting it off. Place a safety pin through it and tape this to the patient's skin.

TUBING, red, rubber sterilizable, 2mm wall, (a) 10mm bore, (b) 15mm bore. This is multipurpose tubing, the 10mm size is for draining air and blood, the 15mm size is for pus. The firmness of the wall of a drainage tube is important. The tube from a chest drain should be firm enough to ensure an open pathway through the chest wall. The abdominal wall is less likely to pinch a drain closed, so a firm drainage tube is less important. If necessary, use a large bore catheter.

DRAIN, corrugated red rubber, sheets 1x50x300mm. Pus drains between the corrugations. Cut the sheets to make drains of various shapes and sizes. *Do not discard used sheet rubber drains:* wash them, boil them, and store them in antiseptic solution (2.6). For tiny drains, cut up old intravenous sets or gloves.

SUMP DRAIN, rubber or plastic. In an ordinary drain the holes through which fluid is sucked frequently block. A sump drain overcomes this difficulty by having 2 tubes, an outer one with many holes in it, and an inner one through which fluid is sucked. Fluid trickles into the outer tube and is then sucked away down the inner one. Ideally, suction down the inner tube needs to be applied with a low pressure pump. There should also be a single hole in the inner tube close to the surface to prevent too high a pressure building up in the sump. There are many kinds, and you may be able to improvise one. A sump drain is particularly useful for draining large quantities of fluid from fistulae or a large localized abscess in the peritoneal cavity. Alternatively, use a folded catheter. Suck through one end and let air enter through the other (4-14E).

DRESSINGS

If dressings are in short supply, wash the wound with water 2-4hrly and cover it with a dressing towel (1.11). Gauze will stick to raw wounds, and paraffin gauze is the standard alternative, but is expensive. You can make your own non-stick dressing with liquid paraffin, coconut or red palm oil.

LEAVING WOUNDS OPEN POSTOPERATIVELY, where you can, is a useful economy. Do this if a wound is not going to discharge. If it oozes a little, put a thin dressing of gauze or whatever you have on it for 24hrs. If you do use postoperative wound dressings, *do not routinely change them unless they are wet, soiled, or smelly, or you suspect a wound infection because of a fever.*

LAYERS OF GAUZE AND COTTON WOOL will collect the discharges from a wound which is too shallow to let you insert a rubber drain (4-14A). Change these dressings frequently. If necessary, place a sheet of plastic or waterproof paper between the outermost layer and the patient's clothes.

4.10 Stapling devices

A large variety of mechanical devices is available, and you may have some to use; *do not let them gather dust because you think they are too sophisticated for you to use!*

(1) SKIN STAPLES.

Skin staples are metal clips with fine sharp teeth at both ends; mount them on a special instrument and lift them off with a toothed dissecting forceps of the correct calibre. Bring skin edges for closure carefully together, apply some tension to straighten the wound and crimp the clip with the forceps to hold the edges together. Then repeat the process moving along the wound.

Disposable clip applicators exist; these are placed across the opposed skin edges as above, and fired sequentially.

(2) CIRCULAR ANASTOMOSIS GUN.

The first device to staple together bowel was invented by Russian technicians; the instrument has a safety catch to prevent inadvertent firing. It has a cartridge of 1 or 2 concentric rows of staples mounted on a rod, and an anvil at the end of the spindle.

Insert the gun into the lumen of the organ to be anastomosed, and tie it down with a snug purse-string suture around the rod over the cartridge; put the anvil inside the lumen of the other organ to be anastomosed and tie another purse-string to hold that end snug. Fix the spindle of the anvil onto the rod of the gun, and screw them together by turning the end of the handle of the gun, till the desired point is reached (marked on the instrument). This traps the tissues to be stapled between anvil and cartridge. Release the safety catch, and with one firm movement, pull the trigger. This fires the staples across the tissue and simultaneously cuts a central portion of excess tissue away. Release the trigger, and wiggle the instrument out with a gentle twisting movement. Unscrew the instrument: you should find 2 *complete* doughnuts of tissue under the head of the anvil if it has worked properly. An incomplete ring will mean a defect exists, which you then need to close by hand. *This may be very difficult!*

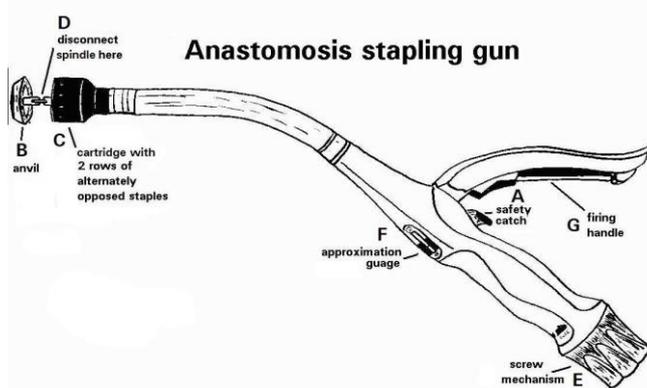


Fig. 4-15 ANASTOMOSIS GUN.
A, safety catch. B, anvil. C, cartridge with staples. D, spindle. E, screw for approximating anvil and cartridge. F, gauge to measure adequate approximation. G, firing handle.

Typical uses of the anastomosis gun are in colorectal anastomosis (12.10) and oesophageal transection (13.6)

LINEAR CUTTING & STAPLING DEVICES

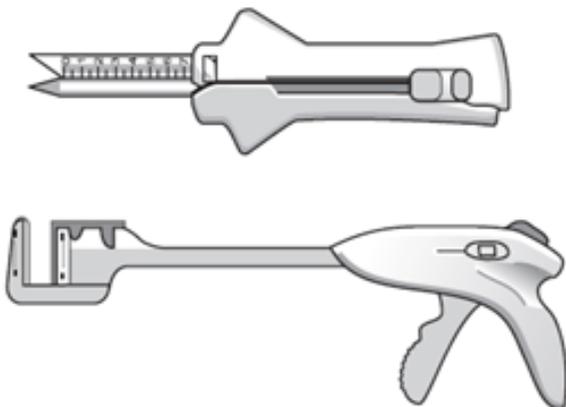


Fig. 4-16 LINEAR STAPLING DEVICES used to divide & close bowel.

(3) LINEAR RESECTION/STAPLER DEVICES

The linear stapler inserts 4 parallel rows of staples and cuts between the 2 middle rows; the instrument divides into 2 parts which can be locked together. Place the separate jaws of each half of the instrument inside the bowel lumina to be anastomosed, making sure that no excess tissue is inadvertently trapped between the jaws.

Slide the cutting handle down the full length of the 2 jaws, and separate them. This should create a perfect anastomosis; any defect must be closed by hand. You can then close the remaining open ends with another linear stapler.

Typical use of the linear stapler is in bowel anastomosis, e.g. in a right hemicolectomy (11.3) or in a gastrectomy (13.10)

(4) HAEMOSTATIC CLIPS

'Ligaclips' are useful for closing blood vessels or ducts deep in the pelvis when ties by hand are awkward because of limited space; apply the clips double with a special instrument for better safety.

4.11 Miscellaneous equipment & materials

Some of the humblest equipment is also the most necessary. Here are many of the things which you should not be without.

TUBES, rectal, rubber, (a) child's size 8mm (Ch24); (b) adult's size 10mm (Ch30). You can also connect these to a large bore funnel and use them to give an enema. Introduce them carefully: you can easily perforate the sigmoid colon.

CONNECTORS, end-to-end, polypropylene, external diameter (a) 4mm, (b) 7mm, (c) 10mm, (d) 15mm, (e) 19mm. Use these to join short lengths of tubing together for suction or drainage etc.

CONNECTORS, plastic 3 way 'Y', assorted sizes.

CLIPS, towel, cross action, 90mm. These are the simplest towel clips.

CLIPS, towel, with ratchet, Backhaus. These are more expensive than the towel clips listed above, but they have several other uses, including holding the sucker tube, and the ribs in chest injuries.

FORCEPS, sponge holding, Rampley, straight, (a) 240mm, box joint. (b) 120mm. Use these for swabbing, and for "swab dissection".

LOUPE, binocular, Bishop Harman, x2 magnification. Perch its 2 lenses on the very tip of your nose, or wear it over your spectacles. Curl its ear pieces, so that it fits your face. This is a twentieth the price of a binocular loupe, and is invaluable for fine operations like repairing nerves, or arteries, or 'cut-downs', or removing splinters. The disadvantage of a loupe is that it focuses close to your nose, so use short-handled instruments.

TROCAR AND CANNULA, straight, with nickel silver or stainless steel cannula and metal handle, (a) 4mm (Ch12). (b) 8mm (Ch24). (c) 12mm (Ch36). The small size is useful for tapping hydroceles, the middle one for suprapubic cystostomy, and the largest one for chest drainage.

CANNULA WITH SIDE ARM. Attach suction to the side arm and use it to aspirate the gall bladder etc. (15.3).

PROBES, malleable, with eye, nickel silver, 150mm, 3 sizes. Use this to probe perianal fistulae etc.

HERNIA DIRECTOR, Key's. Use this for opening the neck of a hernial sac.

DIRECTOR, probe-ended, Brodie, 165mm. Use this for exploring sinuses.

RING CUTTER. Try, before using this, to remove a ring with soap and string.

NEEDLES, aneurysm, Dupuytren, (a) needle curving right, (b) needle curving left. These are curved needles on the end of a handle. Use them for passing a ligature under something (3-4).

NEEDLES, aneurysm, small, with blunt point. Keep these in your 'cut down sets', and use them to pass ligatures under a vein.

CATHETER, metal female.

BRUSH, for cleaning instrument jaws. The jaws and joints of surgical instruments need brushing regularly. You can also use suede brushes with bronze bristles.

RAZOR, safety, for preoperative preparation. Shaving a patient preoperatively is not the essential ritual that it was once assumed to be. You can also adapt a safety razor for skin grafting. Because of the risk of cross-infection, especially of HIV, these should be disposable.

BUCKET, stainless steel, with handles.

KIDNEY DISHES, stainless steel, with half curled edges, 4 sizes 100-300mm.

GALLIPOTS, stainless steel or autoclavable plastic, set of 6 sizes 40-200mm. Use these for lotions, swabs etc.

JAR, stainless steel with dropover lid, 150x150mm. Use these for spirit swabs.

JUG, plastic, autoclavable, conical, 3 litre. Stainless steel jugs have become standard, but plastic ones are satisfactory.

BIN, soiled.

JELLY, hydroxymethylcellulose, sterile petroleum jelly. This is a sterile non-greasy jelly for catheters etc.

'BIPP', bismuth iodoform and paraffin paste. This is a mildly antiseptic self-sterilizing anaesthetic packing material. You can leave it in the nose for a week without significant infection, or much smell (29.6). If you do not have any, smear gauze or bandage with any non-adherent antiseptic ointment.

CARPENTER'S EQUIPMENT (a) Saw. (b) Twist drill. (c) Hammer, claw head. If you cannot get the surgical equivalent of these, you will find these very useful.

OTHER MATERIALS include gauze, cotton wool, bandages, adhesive tape, and laparotomy pads (1.11).

4.12 Instrument sets

For most operations you will need about 50 general purpose instruments called 'the general set', with a few special ones when necessary. You can handle additions to the general set in three ways:

(1) You can keep special instruments in the cupboard, and sterilize them when needed. It is useful for the theatre staff that you have cards indicating which instruments you need for which operations. If you do not know in advance what you will need, you can sterilize as many of your basic instruments as you can, lay them out on a sterile towelled trolley, and select immediately before each operation what you will need. You then cover the trolley with a sterile towel till you are ready for the next operation. Obviously, take care not to contaminate the trolley between operations. This method has been very successfully used in Manama, Zimbabwe, where the sterilizer took the better part of the day to heat up!

(2) You can make incomplete special sets, such as a burr hole set or an orthopaedic set, with their special instruments, which you use with the general set when necessary. The advantage of this method is that you will have these special instruments ready when needed in a hurry, and you do not waste re-sterilizing instruments not required. You can use this method in combination with (1) and (3);

(3) If you have enough instruments, particularly haemostats, you can make complete special sets. This is the best method, and the one which we follow here, but it requires many more instruments, and it is very important that someone trained puts the right instruments in the sets. If this is not possible, revert to system (1).

You can do an occasional emergency operation with only one general set, but when you have a list of patients to operate on, you will need several general sets, if you are not to wait too long between operations. Boiling a set takes at least 15mins, and autoclaving 30mins. A set costs between US\$750 and US\$1000; about 30% is the cost of the haemostats.

If instruments are limited, start by collecting a general set adapted for Caesarean section and laparotomy, and also the more important special instruments.

Once you have all these, try to complete a chest drainage set, a tracheostomy set, 2 cut down sets, and a 2nd laparotomy set. When you have these, your next objective should probably be a minor set for such operations as wound repairs and circumcisions. If you perform many uterine evacuations, 2 or more sets would be useful.

A Caesarean Section is only a particular kind of laparotomy. The set differs mainly in that it includes 2-6 Green-Armytage (or sponge-holding) forceps, and the large round-ended Doyen's retractor, which is specially designed for pelvic operations, replaces Balfour's. (A wide Deaver or Morris retractor is an alternative.)

The sets below mostly start with 6 towel clips and a towel holder, which you can also use to hold the sucker tube. Next come 4 Rampley's sponge-holders, the first 2 of which are used for preparing the patient's skin, after which they can be used to hold towels. The remaining 2 are for 'swabs on sticks', and for swab dissection. Then come toothed and plain dissecting forceps, 2 scalpel handles, and a heavy and a light needle-holder. There are also 4 pairs of Allis tissue forceps, and various retractors, depending on the set. The expensive items, because of the large number you need, are the haemostats, straight, curved, big, and small, clipped together in groups of 6 on Mayo's pins. The more experienced you are, the fewer of these you will need. We list 6 of each, which is a generous number for a beginner. Finally, there is the Pool's sucker and its tube; this is a perforated suction tube which does not suck up bowel. *Do not use haemostats as towel clips!*

Keep an inventory of equipment and a check list for each set posted where the set is packed and stored. Nice instruments tend to disappear. One aid to keeping instruments together is to provide them in pairs, or in even-numbered quantities where possible. For example, the nurses will find it useful to remember that haemostats and towel clips should always be in half-dozens.

The theatre is the best place in the hospital for sterilizing equipment. So try to develop a simple 'central sterile supply' service which can prepare sets for the wards.

INSTRUMENT SETS You will want the following sets, some of which are described elsewhere: a uterine evacuation set (2 if possible), a general purpose set (preferably 2 sets), a Caesar set, a cut down set, an abscess set, several minor set (for hernias, etc.), an orthopaedic set (for drilling for osteomyelitis, etc.), an intestinal clamp set (for resecting bowel), a fine instrument set (for hand surgery), an eye set (28.1), a burr hole set, a chest drain set, and a tracheostomy set.

SHARP EQUIPMENT needs to be kept separately, because it gets blunt if it is autoclaved too often. Keep scissors separate from other instruments. Keep osteotomes and gouges in a cupboard and put them in sterilizing fluid 30 minutes before you use them. Autoclave the bone saw when you want it. Keep the bone drill and the twist drills to go with it in a special sterile pack.

CAUTION! *Always re-autoclave the packs and drums regularly.* A pack which has not been re-sterilized for some time is a risk, especially if it is only covered in towels. You may find termites inside it!

THE CONTENTS OF PARTICULAR INSTRUMENT SETS

THE GENERAL SET (including the instruments for laparotomy)

6 towel clips.
 1 Backhaus towel forceps.
 4 Rampley's sponge-holders.
 1 toothed dissecting forceps (Treves).
 1 plain dissecting forceps (Bonney's).
 1 #4 & 1 #5 scalpel handle.
 2 needle-holders, a heavy and a light.
 2 Allis tissue forceps.
 2 Lane's tissue forceps.
 6 200mm curved haemostats (Spencer Wells).
 6 120 or 140mm straight haemostats (Halstead's or Crile's).
 6 120 or 140mm curved haemostats (Halstead's or Crile's).
 2 Kocher's artery forceps.
 2 Czerny's (or Langenbeck's) retractors.
 2 Morris' retractors.
 Poole's sucker tube.
 1 20cm receiver & 2 gallipots.
Desirable additions include Lahey's curved gallbladder forceps.

CAESAR SET (US\$950).

6 towel clips.
 1 Backhaus' towel forceps.
 4 Rampley's sponge holders.
 1 18cm toothed dissecting forceps.
 1 18cm plain dissecting forceps.
 2 #4 scalpel handles.
 2 180mm needle-holders.
 2 Allis tissue forceps.
 6 Green-Armytage forceps.
 12 150mm straight Spencer Wells haemostats.
 6 230mm curved Spencer Wells haemostats.
 1 Morris retractor.
 1 Doyen's retractor.
 Poole's sucker and tube.
 1 300mm bowl (for blood clot),
 1 200mm receiver & 2 gallipots.
Desirable additions include a tenaculum, and a self-retaining retractor.

MINOR SET (US\$750).

6 towel clips.
 2 Rampley's sponge holders.
 4 Backhaus' towel forceps.
 1 #4 & 1 #5 scalpel handle.
 1 toothed dissecting forceps (Treves).
 1 plain dissecting forceps (Bonney's).
 4 Allis tissue forceps.
 1 West's self-retaining retractor.
 2 Czerny's retractors (or Langenbeck's).
 12 125mm curved haemostats (Spencer Wells).
 6 200mm curved haemostats (Spencer Wells).
 1 20cm receiver & 2 gallipots.
Desirable additions include a dissector and a Volkmann's spoon.

ABSCESS SET.

2 Rampley's sponge-holding forceps.
 4 towel clips.
 1 knife handle.
 1 sinus forceps.
 1 Mayo's scissors.
 1 toothed dissecting forceps.
 1 150mm receiver,
 2 gallipots and some gauze swabs.
 2 towels.

UTERINE EVACUATION SET.

2 ovum or sponge-holding forceps (without ratchets).
 1 Sims' vaginal speculum.
 1 vaginal speculum (Sims, Auvard's or Collin's).
 2 Teal's vulsellum forceps.
 1 set of Hegar's dilators.
 Karman suction curettes
 Uterine curettes with sharp and blunt ends (several sizes each).
 1 200mm Kocher's forceps.
 1 toothed dissecting forceps.
Have intra-uterine contraceptive devices (IUDs) available.

ORTHOPAEDIC SET.

6 towel clips.
 4 Rampley's sponge holders.
 4 dissecting forceps: (1 heavy toothed 180mm Lane's or Chamley's, 1 light Adson's 125mm, 1 plain 180mm, 1 McIndoe's 180mm).
 6 curved 150mm Spencer Wells haemostats.
 6 curved 200mm Spencer Wells haemostats.
 1 #4 & 1 #5 scalpel handle.
 4 220mm light bone levers, Lane's or Trethowen's.
 4 275mm heavy bone levers.
 1 Faraboeff's elevator.
 1 large & 1 small periosteal elevator (for the femur and humerus).
 1 Size C double-ended Volkman's bone scoop.
 1 350g mallet.
 1 sequestrum forceps.
 1 180mm Read Jensen bone nibbler.
 1 bone file or rasp.
 1 220mm Liston's bone cutters.
 1 200mm bone hook.

BURR HOLE SET.

1 Hudson's standard perforator 12mm.
 1 Hudson's set of conical burrs 13mm and 16mm.
 Hudson's brace.
 1 West's self-retaining retractor.
 1 60mm brain sucker.
 1 Ch14 soft rubber catheter.
 1 20ml syringe for washing out.

SMALL (Hand) INSTRUMENT SET.

2 small sponge holding forceps.
 1 plain 150mm McIndoe dissecting forceps.
 1 plain 100mm Silcock's ophthalmic dissecting forceps.
 1 toothed Adson's 120mm dissecting forceps.
 4 165mm Gilles skin hooks.
 1 light 190mm McIndoe dissecting scissors.
 1 light 140mm curved Aufrecht's scissors.
 12 curved Crile's mosquito haemostats.
 1 Bard Parker #4 scalpel handle.
 2 114mm Derf needle holders. 2 small 178mm Meydering retractors.
 2 114mm Harlow Wood tendon hooks.
 1 small curette.
 2 assistant's scissors.
 1 fine probe.

KIRSCHNER WIRE PACK.

6 wires of each size 0.75mm, 1.0mm, 1.5mm.
 1 Pulvertaft's Kirschner wire introducer.
 1 pair of Kirschner wire cutters.