TECHNIQUES AND COMPLICATIONS OF PARENTERAL NUTRITION

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SUMMARY: A review of the methods for cannulation of peripheral and central veins is given, and the cannulae available through the Joint Services Catalogue are detailed. The complications arising from venous cannulation, and the detailed monitoring of parenteral nutrition are discussed.

Introduction

In a recent paper on parenteral nutrition¹ the authors considered in detail the pathophysiology, indications, and planning of intravenous feeding regimes. Cannulation techniques, their complications, and detailed monitoring of progress were beyond its scope. The purpose of this second paper is to discuss the techniques available for applying the principles previously outlined.

Intravenous cannulae

The intravenous cannulae available to the Service clinician through the Joint Services Catalogue are listed in Tables I and II.

The first long cannulae to become widely available were introduced through a needle, which was then withdrawn from the vein and attached to the skin. Protective devices were supplied in an effort to prevent the needles slicing through the cannulae, but accidents were so common that the Department of Health and Social Security issued a warning against their use². Now that safer alternatives are available there is no justification for the use of such cannulae, of which the Abbot drum catheter is an example.

Table I
Peripheral (short) venous cannulae available through the
Joint Services Catalogue

JSC Cat No	Designation	Size
6515-99-210-3422	Hamilton Bailey	Small gilt
6515-99-210-3424	Hamilton Bailey	Large gilt
6515-99-210-3426	Guest	18 SWG by 2 in
6515-99-211-4251	Argyle Medicut	14 SWG by 2in
6515-99-211-4252	Argyle Medicut	16 SWG by 2 in
6515-99-211 4253	Argyle Medicut	18 SWG by 2 in
6515-99-211-4254	Argyle Medicut	20 SWG by 2 in
6515-N 03830	Argyle Medicut	12 SWG by 2 in
6515-99-211-4489	Venflon	VF 14 (2.00 mm ext diam 1.45 mm int diam)
6515-99-211-4485	Venflon	VF 16 (1.70 mm ext diam 1.25 mm int diam)
6515-99-211-4486	Venflon	VF 17 (1.40 mm ext diam 1.05 mm int diam)
6515-99-211-4487	Venflon	VF 18 (1.20 mm ext diam 0.85 mm int diam)
6515-99-211-4488	Venflon	VF 19 (1.00 mm ext diam 0.65 mm int diam)

Table II
central (long) venous cannulae available through the
Joint Services Catalogue

JSC cat no	Designation	Size
6515-99-211-5526	Intra-medicut	14 SWG 30 cm long
6515-99-211-5517	Intra-medicut	16 SWG 30 cm long
6515-99-211-5518	Intra-medicut	18 SWG 30 cm long
6515-99-211-5519	Intra-medicut	14 SWG 70 cm long
6515-99-211-5520	Intra-medicut	16 SWG 70 cm long
6515-99-211-5507	Vygon trocaxflex	17 SWG 60 cm long
6515-N 03057	Deseret E Z catheter	14 SWG by 12 in.
6515-N 03059	Deseret E Z catheter	16 SWG by 12 in.
6515-N 03060	Deseret E Z catheter	18 SWG by 8 in.
6515-N 93604	Deseret E Z catheter	14 SWG by 36 in.
6515-N 03711	Leader catheter	18 cm long
6515-N 03790	Abbot drum catheter	

Cannulation sites

There are at least nine sites at which access may be gained to the venous circulation. In an emergency any of these or the arterial route³ may be used for initial resuscitation. However, long term cannulation for parenteral nutrition demands a more selective approach. The intra-arterial route and the veins of the lower limb should never be used, as the risks and sequelae of intravascular coagulation are too dangerous⁴. Scalp veins although ideal for routine intravenous therapy in small children are too small and fragile for the infusion of hyperosmolar solutions.

The veins of the back of the hand and forearms may be used for short term feeding. Ideally a vein mid-way between the wrist and elbow should be selected to allow freedom of movement, while maintaining maximum splintage. When a peripheral vein is selected the site should be changed routinely every 48 to 72 hours⁴. Established thrombophlebitis may rapidly destroy all the available veins, and leaves the patient with a painful and potentially dangerous arm. Small doses of heparin, either subcutaneously or added to the infusion, have been shown to prolong drip life by reducing spontaneous stoppages due to clotting in and around the catheter tip⁵.

Long term feeding is only feasible via a caval catheter. Access to the venae cavae may be achieved via the femoral, jugular (internal and external), subclavian and ante-cubital fossa veins. The inferior approach through the femoral vein should be avoided. Technically the ante-cubital fossa veins are the easiest to cannulate⁶ whereas the subclavian or jugular sites are more easily managed once established.

Cannulation techniques

Whatever type of venous cannula is used sterility on insertion and during subsequent nursing care is likely to determine success or failure⁷. Most nutrient solutions make excellent cultural media, and septicaemia in the malnourished patient may prove fatal. A strict aseptic technique must therefore be used for all manoeuvres. When inserting a central venous line full surgical scrub up with gown and gloves is mandatory⁸, and whenever possible cannulation should be carried out in an operating theatre⁹.

Peripheral short cannulae

It may appear impertinent to reiterate the principles of placing a needle into

a vein, but it is the author's experience that faulty technique is the cause of most failed cannulations. Veins should be properly demonstrated using a venous tourniquet. A blood pressure cuff is ideal, although a half-width of Esmarch bandage or commercially produced velcro tourniquets are adequate substitutes. The use of a nurse or technician to squeeze the limb is to be discouraged as they may release the pressure at the most inopportune moment. They are better employed as assistants rather than human tourniquets.

Light tapping and massage of the desired area, allied to patience will invariably produce a suitable vein. In the conscious patient it is kind to deaden the skin overlying the proposed puncture site by subcutaneous injection of local anaesthetic. However, this may distort the anatomy. The actual technique of cannulation is to some extent a matter of individual preference, but the needle should always be inserted through the skin and then into the vein as two distinct movements. Distal stretching of the skin serves to stabilise the vein, particularly at the extremes of age. A small incision over the proposed puncture site may add to the ease with which cannulation can be achieved.

There is little to choose between the Argyle medicut and Venflon cannulae. The former are cheaper and marginally easier to insert, whereas the latter incorporate an injection port. Readers should experiment with both and decide which suits their specific requirements. There is no place for the Hamilton Bailey or Guest Cannulae in modern practice.

Peripheral cannulae should be firmly fixed in position. Zinc oxide and transpore tape are both suitable for this purpose, and are more effective if the skin is shaved. Micropore should be avoided as it loses its adherence and integrity on wetting. The giving set should not be attached to the limb close to its joint with the cannula, because movement tends to disconnect one from the other. The practice of splinting limbs and wrapping cannulation sites in crepe bandages should be discouraged. Leaks, disconnections, and early signs of thrombophlebitis must be readily visible.

Central long cannulae

The underlying pathology of patients requiring long term feeding via a central venous cannula can be diverse, and access to the possible cannulation sites very variable. Severe burns of the head and neck may exclude the jugular veins, thoracic injuries may rule out one or both subclavians, and compound fractures of the upper arms may contra-indicate the use of those in the ante-cubital fossa. The clinician must therefore be familiar with the techniques of cannulation of all three sites, in order to be able to utilise that most appropriate to the presenting circumstances.

External jugular vein

The external jugular vein is easily visualised in the neck particularly if the patient is tipped head down or performs a Valsalva manoeuvre. Cannulation is carried out under direct vision, with the patient's head turned to one side. Intramedicut (30 cm) or Deseret (8 or 12 in.) E Z catheters are suitable for this site. Difficulty may be encountered in passing the cannula deep to the superficial fascia behind the clavicle. Adjustment of the degree of extension of the neck and the position of the arm may help to overcome this problem.

Internal jugular vein

The internal jugular vein is attached to the deep surface of the sternomastoid muscle slightly lateral to its mid-line. Cannulation is achieved by puncturing the

skin 3 cm above the clavicle on the lateral border of the muscle. The needle point is directed caudally and medially aiming at the suprasternal notch, and advanced until the vein is entered. Intra-medicut (30 cm) or Deseret (12in.) E Z catheters are suitable for this technique.

Subclavian vein

The subclavian vein is held stable at its widest point as it passes between the first rib and the clavicle. Either side may be cannulated, but the right is to be preferred because of its more medial position and the presence of the frail thoracic duct on the left side. Venepuncture may be achieved by either the infraclavicular or supraclavicular approach.

Infraclavicular approach. The skin is punctured 1 cm below the clavicle just lateral to its mid-point. The needle is directed cephalad at 15 degrees to the horizontal and aimed at the sterno-clavicular joint. It is advanced keeping close to the posterior border of the clavicle. The intra-medicut (30 cm) and Vygon trocaxflex (60 cm) cannulae are suitable for this technique, although the latter is too long. Subcutaneous skin tunnels can be fashioned to lead the hub of the catheter away from the cannulation site, and are claimed to prolong catheter life. A non-operative technique has recently been reported.¹⁰

Supraclavicular approach. This route carries less risk of pleural or arterial puncture. It has the advantage of definite cutaneous landmarks, and a shorter skin to vein distance. The angle between the upper border of the clavicle and the lateral margin of the sternomastoid muscle is defined. The needle is inserted at the tip of this angle at 45 degrees to the horizontal, and advanced slightly forward for 1 to 1.5 cm until the vein is entered. Intra-medicut (30 cm) and Deseret (8in.) E Z catheters may be used for this purpose.

Anti-cubital fossa veins

Ideally the right median cubital or basilic vein should be selected. The left arm is technically more difficult, but may be used if the veins of the right are inaccessible. The technique of introducing the cannula into the vein is exactly the same as for the peripheral vein. Difficulty may be encountered as the cannula is threaded cephalad. Initially it tends to catch on the venous valves, and then its progress may be obstructed as it passes deep to the clavi-pectoral fascia. Twisting the cannula and abduction of the arm beyond 90 degrees usually overcomes these problems. Intra-medicut (70 cm) and Deseret (36 in) E Z catheters are both suitable for use at this site. The former are somewhat messy to use, as blood inevitably leaks around the cannula as it is passed through the introducer. The latter possess a wire introducer, the added stiffness of which may aid cannulation in difficult cases.

Maintenance and care of the cannulae

The position of a central venous cannula should always be checked before hyperosmolar solutions are infused through it. A chest X-ray will usually reveal the cannula tip, but if difficulty is encountered a small volume of contrast media should be injected as the X-ray is repeated. It is very much easier to insert and position a cannula under direct vision using an image intensifier. Unfortunately this facility is rarely available.

A cannula intended for parenteral nutrition should be regarded as sacrosanct, and should not be used for blood sampling, blood transfusion, or intermittent intravenous drug therapy¹¹. If such facilities or techniques are vital then a second cannula should be inserted.

Central cannulae should be sutured to the skin a few millimetres from the puncture site. The whole site should then be sprayed with an antiseptic aerosol, which should incorporate an antifungal agent. Povidone iodine is suitable for this purpose. An occlusive, waterproof dressing is then applied. Op-site is ideal as it mechanically secures the lines so that minimum friction necrosis occurs at the puncture site, forms a sterile barrier, and allows visual inspection without disturbance. This should be changed every second day in order to keep the puncture site clean and dry. Full aseptic technique must be employed. The site should be cleaned with hibitane or chlorhexidine 0.5 per cent in spirit, allowed to dry, resprayed with antiseptic, and a fresh dressing applied.

Established thrombophlebitis requires active, aggressive treatment. The cannulae should be removed immediately and its tip sent for culture and sensitivity. Lotio plumbii dressings may be applied locally, but spreading lymphangitis demands appropriate systemic antibiotic therapy. A new line should be established at another site as infection will inevitably result in additional metabolic demands. Some authorities recommend that 24 hours should elapse before this is done, but such advice may not always be practicable. The development of a pyrexia of unknown origin gives considerable cause for concern. However, blood, sputum, MSU, wound swab, and other appropriate cultures should all be performed in order to eliminate the many other causes, before the cannula is blamed and removed.

Monitoring

Once the decision to commence parenteral nutrition has been taken a considerable responsibility for the surveillance of fluid, electrolyte, and metabolic balance falls upon the clinician. Table III details the routine investigations that must be per-

Table III
Routine investigations

Regime	Investigations
Daily	Fluid balance. Haemoglobin and PCV. Plasma urea and electrolytes. Urinary urea and electrolytes. Acid base status. Urine esting for glucose (four hourly).
Twice weekly	Body weight. Blood sugar. Liver function tests. Plasma proteins. White blood count and differential. Platelet count. Prothrombin time. Creatinine. Blood culture. Serum calcium and phosphorus. Urinary calcium and phosphorous. Osmolality.
Every two weeks	Serum magnesium. Serum zinc. Serum iron. Iron binding capacity. Serum folate. Serum B ₁₂ .

formed in addition to those dictated by the patient's primary illness. The most important aspects of monitoring are the daily fluid balance, urinary urea and electrolytes serum electrolytes, and four hourly urine testing for glucose. This information is essential, and enables the supervising clinician to prescribe the next day's regime with confidence. The need to measure nitrogen balance is less pressing, since the daily excretion of urea may be used as a guide. It is equivalent to 75 to 80 per cent of total urinary nitrogen.

Two problems that often catch one unawares are hyperglycaemia and hypo-

natraemia. Patients on parenteral nutrition regimes undergo changes in carbohydrate metabolism and intra- and extra-cellular sodium fluxes. In addition large carbohydrate loads are less well tolerated and may cause non-ketotic hyperglycaemia with hyperosmolality. This will result in a solute diuresis and secondary dehydration. Hence the requirement to monitor carefully urinary and plasma glucose, osmolality, and sodium concentrations. The necessity and frequency of other investigations will vary according to the nature of the patient's underlying illness, and the type of feeding regime.

The nursing of patients receiving parenteral nutrition must be of the highest calibre. Fluid balance and temperature charts have to be maintained with obsessional care, attention to flow rates and volumes infused is of paramount importance, and careful aseptic technique during all dressings cannot be over emphasised.

Complications

The decision to insert a caval cannula necessitates a high standard of care and asepsis during its introduction and maintenance. Such requirements should never be allowed to constitute a contra-indication to intravenous feeding. However, it should be undertaken with a clear appreciation of the potential hazards involved. These may conveniently be sub-divided into those associated with the actual cannulation and cannula problems of later onset.

Immediate problems associated with cannulation

Table IV lists the problems associated with the cannulation of central veins in general, and Table V catalogues the additional complications encountered if the

Table IV
General complications of central venous cannulation

Failure	Stimulation of tricuspid valve—dysrhythmias
Dissection down the vein wall	Cardiac perforation—tamponade
Air embolus	Local extravasation of nutrients
Catheter embolus	

Table V
Complications specific to subclavian vein cannulation

Brachial plexus injury	Haemothorax
Subclavian artery damage	Subcutaneous emphysema
Arterio-venous fistula	Perforated vessel—infusion of fluid into the
Pneumothorax	pleura and mediastinum.

subclavian vein is selected. It should be noted that serious problems are seldom seen unless the subclavian vein is routinely used.¹²

Failure is clearly the most serious complication, but like all the others can be eliminated by careful attention to detail and expertise. If problems do inadvertently occur it is imperative that they are recognised promptly and treated¹³ Abandoning the use of the Abbot drum catheter will eliminate cannula embolism, and cannulation under X-ray control should minimise the others. Selection of the

supraclavicular approach to the subclavian vein should decrease the complications associated with that route.

Later complications of cannulation

Table VI lists the later problems associated with central venous cannulation. Thrombosis is the most frequent sequelae, clinical manifestations occurring in seven per cent of cases. It is most common when the basilic vein is used, but unusual if the jugular is selected. Embolism occurs in 0.2 per cent of basilic vein cannulations. 0.6 per cent of subclavian, and virtually never with the jugular route¹².

Table VI
Later complications of central venous cannulation

Air embolus	Thrombosis—Embolus
Catheter embolus	Infection (bacterial/fungal)—Septicaemia.
Thrombophlebitis	Bacterial endocarditis

Infection may develop in as many as 10 per cent of cannulations. Occasionally it can be traced to contamination during manufacture of the intravenous nutrient¹⁴, although the introduction of plastic containers should eradicate this source. More commonly the contamination is introduced by intrinsic factors, such as the cannulae, giving sets, airways, drug additives, and the staff (pharmacist, nurse and doctor). Infection may range from a local thrombophlebitis to a generalised septicaemia, often associated with bacterial endocarditis. Thrombophlebitis develops most frequently if forearm veins are used, the incidence increasing with the length of time the cannula is left in situ. The organisms responsible for these infections vary widely, but when broad spectrum antibiotics have been used the risk of fungal infection is much increased. There have been reports of patients perishing from generalised candidiasis secondary to thrombophlebitis¹⁵.

Conclusions

Despite the horrifying number of complications reported in the literature in association with central venous cannulation and parenteral nutrition, the clinician must not be deterred from using the technique. Careful attention to detail, manual dexterity on insertion of the cannula, good nursing, and obsessional monitoring will eliminate serious complications and ensure maximum benefit to the seriously ill patient.

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UNUSUAL CASES

DERMATOBIA HOMINIS

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A Serviceman, six weeks returned from Belize, reported to the Medical Reception Station with an itchy, discharging spot on the back of his thigh, which had "come to a head" over the last few days.

Examination showed an inflamed swelling approximately 1.5 cm across, pointing in the centre with a yellow head about 3mm diameter. Exploration produced a larva of the "Human Botfly" (*Dermatobia hominis*).

Dermatobia hominis has been described¹ as follows "In tropical South America the "Human Botfly" (*Dermatobia hominis*) which does not feed at all, unlike the semi-domestic Calypterate flies, lays its eggs on the underside of a biting calypterate fly *Stomoxys*, or a jungle mosquito, especially selecting members of the genus *Psorophora*. When these insects bite a human host, one or more of the eggs attached to them will hatch, and the resulting maggots quickly bore into the surface tissues. Severe ulceration and secondary infections often result, since the larvae may remain in situ for several months."

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