SURGICAL PROCEDURES IN GENERAL PRACTICE

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METHODS OF GIVING BLOOD TRANSFUSIONS

BY

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In the consideration of this subject a brief note on some of the indications for blood transfusion and on the selection of a donor and the withdrawal of the blood forms a suitable introduction.

Indications for Blood Transfusion

In the anaemia of acute or chronic haemorrhage blood transfusion should be regarded as imperative if the haemoglobin falls to 40 per cent. (Haldane). A drop below this level is dangerous to life; if the haemorrhage has been controlled transfusion will shorten an otherwise long convalescence. In a severe infection (with or without proved septicaemia) transfusion is indicated if the haemoglobin recedes to 65 per cent.: it aids the patient's resistance by combating the anaemia and also by supplying fresh human complement.

Before a severe surgical operation a minimal haemoglobin figure of 70 per cent. should be aimed at. In surgical shock blood transfusion constitutes the best method of increasing blood volume, which has diminished owing to stagnation of blood in the abdominal veins. Lastly, blood transfusion is a valuable therapeutic weapon in the haemorrhagic states and in blood diseases; in the former it is the only specific, though temporary, remedy for haemophilia.

Selection of a Donor

Any adult individual of either sex, with a normal but not necessarily robust bill of health, is suitable. Syphilis and malaria form the two significant transmissible diseases that must be excluded, and allergic individuals are best avoided. Good superficial elbow veins are of practical advantage. It is better that the donor should be of the same blood group as the patient than that Group O subjects should be employed as "universal" donors. In addition to the standard grouping (satisfactory agglutinating serum is now available commercially, from Messrs. Burroughs Wellcome and Co., with a duration of potency of six months) a direct test for compatibility between a drop of the intended donor's blood and the recipient's serum is advised; this provides a check on the original groupings and also excludes the possibility of a subgroup reaction peculiar to the two individuals concerned. Where grouping sera are not available this direct test may alone form the basis of compatibility. It is preferable that a donor should not have had a heavy meal within two hours of being bled; women may donate without ill effect during menstruation providing the latter be normal.

Collection of Blood from Donor

The donor should lie supine on a table, couch, or bed with the selected arm supported on a small firm pad or sandbag. The pneumatic cuff of a sphygmomanometer is adjusted round the upper arm, and the skin over the front of the elbow well cleaned with ether. The veins are rendered full and prominent by inflating the cuff to a

pressure of 75 to 85 mm. of mercury and also by the donor opening and closing his hand on a roller bandage. On selection of a suitable vein (using palpation, if necessary, as well as inspection) a small intradermal injection of 1 to 2 minims of 2 per cent. novocain is given over the site of intended puncture; about two minutes are allowed for this to act. A tiny nick of about 1/8 inch is then made in this anaesthetized area of skin with the point of a scalpel, its length being only slightly greater than the diameter of the small French's needle to be subsequently introduced; it heals rapidly, does not require a stitch, causes no inconvenience, and is not to be confused with a deliberate incision by cutting down on the vein.

Removal of the blood is carried out by a small French's needle (Fig. 1) attached to about twelve inches of stout

FIG. 1.—Small French's needle (stainless steel; length of shaft 35 mm.; 7 S.W.G. at mount, tapered to 13 S.W.G. at point; uninterrupted lumen).

rubber tubing of relatively wide bore (internal diameter 5/16 inch) and preferably interrupted by a short glass tubing connexion near the needle to serve as a window. The needle is inserted into the lumen of the distended vein through the small nick in the skin and held firmly in position by the operator; slight adjustment in the depth of insertion ensures the maximum flow of blood, which is aided by the donor opening and closing his hand on a roller bandage about every half-minute. The secret in securing a satisfactory volume of blood from a donor without difficulty is to obtain a good and rapid flow through the needle and tubing throughout the period of collection; liability to clot formation is thus reduced to a minimum.

Sets of rubber tubing with the glass connexions may be sterilized by boiling, or by being wrapped in a towel and put in an autoclave at 120° C. for half an hour. The French's needles, the points of which it is imperative to inspect regularly with a lens and keep well sharpened, are sterilized in spirit or placed in liquid paraffin in a small glass container that is put in a hot oven at 155° C. for one hour. The tubing and attached needle are well rinsed through with sterile normal saline preparatory to use.

The donor's blood is collected in a sterile graduated receptacle containing sodium citrate solution as an anticoagulant, admixture being ensured by gentle agitation as the blood flows in. Fifty c.cm. of 3.8 per cent. (isotonic) sterile citrate solution is recommended for 600 c.cm. of blood, this amount being increased or decreased according to whether a larger or smaller volume of blood is to be collected. A concentrated sterile solution of sodium citrate—1 gramme in 4 c.cm. of distilled water—is put up by the British Drug Houses Ltd. in small dark-glass ampoules, and keeps well under these conditions; the contents of two of these ampoules added to 50 c.cm. of distilled water or normal saline (the latter resulting in a slightly hypertonic solution) form a satis-

factory anti-coagulant for 600 c.cm. of blood. The amount of citrate used allows of considerable latitude, but, speaking generally, it should be in the proportion of approximately 0.3 gramme for every 100 c.cm. of blood collected; this is known to err on the safe side, as well as being harmless. It is advisable that the water (including that used in the preparation of normal saline) be rendered as free as possible of dead bacteria and other organic particles by being doubly distilled.

When the requisite volume of blood has been obtained from the donor the sphygmomanometer cuff is deflated and the needle then withdrawn. A dry dressing, to be kept on for forty-eight hours, is all that is required; the application of iodine is to be deprecated, on account of its liability to cause a burn. The donor should lie down for half an hour and be given some light refreshment before leaving. Maximum suggested donations from an average man or woman are 800 c.cm. and 650 c.cm. of blood respectively.

"Cutting down" and exposure of a donor's arm vein by deliberate incision should be quite unnecessary (it is rightly not permissible on the members of the vast majority of voluntary blood transfusion services). It will be seen from the foregoing that the indirect use of citrated blood from the donor is advocated; both to the operator and to the donor it has definite advantages over the direct arm-to-arm technique with whole blood, and the small addition of the anti-coagulant salt has from wide experience proved in no way deleterious to recipient or to transfused blood.

Transfusion of the Patient

The types of transfusion used fall under two headings, depending mainly on the rate of flow and volume of blood given: (I) the ordinary relatively rapid transfusion of quantities up to 800 c.cm. of blood; (II) the slow continuous-drip transfusion of much larger volumes (necessitating two or more donors). For Type I, which has the wider application—although 750 c.cm. of blood raise the actual haemoglobin of an average-sized adult patient by approximately 15 per cent. only—three convenient methods are described, and they are, in order of simplicity:

TYPE I.—(A) FUNNEL GRAVITATION METHOD

The apparatus consists of:

1. A 300-c.cm. capacity graduated cylindrical glass infusion funnel (Fig. 2), attached to the outlet of which is two feet of rubber tubing (3/16-inch bore) ending in a male Record-fitting mount. The funnel and tubing are run through with normal saline, which displaces air in the latter, and about 40 c.cm. of saline are allowed to remain in the funnel by closing a screw clip on the upper part of the tubing. (A Laurie glass drip bulb can be conveniently interposed in the tubing near the funnel, but is not essential.) The mouth of the funnel is lightly plugged with sterile gauze.

2. Two inches of narrow stout-walled tubing (1/8-inch bore) having a female Record-fitting mount at one end and a similar male mount carrying a Record-fitting needle (1.5 mm. diameter or smaller, and 36 mm. length) with a short bevel at the other. A bulldog clip is affixed to the proximal part of the tubing (Fig. 3).

The anterior elbow veins of the patient are rendered full and prominent by inflating a sphygmomanometer cuff placed round the upper arm to about 80 mm. of mercury, the patient co-operating, if possible, by opening and closing his hand on the same side. The arm is fully extended with adequate support, in a good light.

The skin at the site of puncture of a chosen vein is anaesthetized by a small intradermal injection of 2 per cent. novocain and a small nick is made in it, as described for bleeding a donor. The Record needle, attached to the short piece of narrow stout-walled tubing already described, is pushed through the skin nick into the vein;

its point is indicated to be in a satisfactory position in the lumen of the latter by a brisk flow of blood from the female mount at the end of the tubing on momentarily releasing the bulldog clip; slight adjustment in the depth of the needle may be necessary to obtain this. The sphygmomanometer cuff is then immediately deflated and the needle fixed firmly in position with a

FIG. 2.—Cylindrical glass infusion funnel.

FIG. 3.—Needle tubing connexion.

piece of adhesive strapping passing over the mount and the proximal part of the shaft. Warning is given to the patient not to move the arm. Firm connexion is now made, by adjusting the mounts, between the needle tubing and that attached to the funnel; the bulldog clip on the former is removed, the screw clip on the latter opened, and with the funnel held above the patient's level saline will flow into the vein. Before the saline is exhausted the donor's blood at 37° C. is added to the funnel and replenished from time to time when the level falls to about the 50-c.cm. mark. The rate of flow can be controlled by the screw clip or by raising or lowering the funnel in relation to the patient. At the end of the transfusion the bulldog clip is replaced on the needle tubing, the needle withdrawn, and a simple dry dressing applied.

With the exception of the needle the whole of this simple apparatus may be sterilized by boiling or in an autoclave. In a patient who is very restless, or in whom the veins are small and difficult, the Record-fitting mount at the end of the funnel tubing may be inserted into two inches of narrow tubing carrying a small glass Keynes cannula; the latter is then tied into a suitably exposed vein (see Method C below), after displacement of the air, by running through some of the saline from the funnel.

(B) JUBÉ SYRINGE METHOD

The apparatus (Fig. 4) consists of:

1. The special syringe. This comprises a glass barrel with two side metal tube openings, and a metal plunger with a longitudinal groove which does not quite reach its base. The components are fitted together by means of a screw cap; the capacity of the syringe may be either 5 or 10 c.cm. With the plunger pushed right down and the longitudinal groove opposite one of the side openings withdrawal will suck in fluid only by way of the latter; if the plunger be now rotated through 180 degrees, so that the groove is directly opposite the other side opening, pushing it down will empty the syringe through this orifice. The principle depends on unmasking one of the barrel openings with the groove of the piston while sealing the other with the convexity.

2. Two pieces of narrow stout-walled tubing which fit the side metal tube openings on the barrel of the syringe. One of these, about ten inches in length, has a weighted perforated sinker at one end; the other, about six inches long, terminates in a male tubing mount which exactly fits into the mount of the metal Jubé needle.

3. The Jubé needle, with its well-fitting trocar, the sharp point of which projects just beyond the rounded end of the needle when the mounts of both are in apposition.

The two pieces of rubber tubing are fixed to the side tubes of the syringe, and the perforated sinker at the end of one is placed in sterile saline solution. The syringe and attachments are now filled completely with saline by drawing the latter into the barrel whilst the groove on the plunger is opposite the saline connexion opening, and expressing it through the other piece of tubing after rotating the barrel through 180 degrees to bring the groove opposite the outlet orifice; more saline is then drawn into the syringe, which is left full.

FIG. 4.—Jubé syringe and needle.

With the same technique as described under Method A, the Jubé needle, with its projecting trocar, is pushed into a distended anterior elbow vein of the patient through a nick in anaesthetized skin at the site of intended puncture. A rapid efflux of blood from the needle following momentary withdrawal of the trocar indicates a satisfactory insertion. The sphygmomanometer cuff is immediately deflated and the needle fixed to the skin by adhesive strapping, which passes over its shoulder. The trocar is now withdrawn and the male mount on the end of the syringe outlet tubing quickly attached to the needle mount. By pushing down the plunger of the syringe, with the groove opposite the outlet orifice, and injecting saline into the vein it can be seen whether the needle is well inserted. This assured, the tubing end with the perforated sinker is transferred from the saline to the container with the donor's citrated blood. The latter is drawn up into the syringe and injected into the patient in a series of syringefuls by manipulation of the plunger as described. At the termination of the transfusion the needle is withdrawn still attached to the tubing mount and a small dry dressing applied.

The Jubé syringe components and the needle and trocar may be sterilized in spirit and then rinsed in sterile saline; the pieces of tubing and their fittings may be boiled. In cases of difficulty the recipient's vein may be exposed and

the needle and trocar inserted direct; on withdrawal of the latter the needle may be pushed a short distance up the lumen of the vein so as to anchor it more firmly.

(C) THE KEYNES FLASK METHOD

The equipment (Fig. 5) for this comprises:

1. A thick glass conical flask of about a litre capacity provided with a side tube to which a piece of rubber tubing

FIG. 5.—The Keynes flask and fittings.

carrying a glass air filter and rubber bellows may be attached. The flask is graduated in 100 c.cm.

2. A rubber bung which closely fits the mouth of the flask and carries a curved glass delivery tube angulated inside the flask so that its lower end, ground slightly obliquely, reaches into the corner. (This part of the delivery tube may with advantage be interrupted at about its middle by two inches of stout-walled rubber tubing.) The portion of the delivery tube outside the flask is curved to end vertically in a tapered extremity, which projects through a small rubber cork about the level of the upper part of the flask neck.

3. A small glass barrel of some 10 c.cm. capacity which serves as an air lock. The mouth of this accurately fits the cork on the delivery tube, and to its lower end is attached two feet of rubber tubing (3/16-inch bore) terminating in a male Record-fitting mount, with a small glass window interposed immediately above the latter; close to the mount is a bulldog clip.

Blood is collected from the donor direct into citrate solution in the flask; the bung with the delivery tube is then inserted tightly into the mouth (it is wise, before collection of the blood, to confirm the correct position of the end of the delivery tube with the bung inserted), and the air bellows and filter are attached to the side tube. The barrel of the air lock and its tubing are completely filled with normal saline and placed ready in any suitable sterile container.

With a similar Record needle and short rubber tubing attachment and mounts as described under Method A, the needle is inserted in an anterior elbow vein of the patient by an identical technique and strapped in position. The mount on the end of the air-lock tubing is now fitted to that on the needle tubing and the clip on the latter removed. On releasing the clip on the tubing of the air lock, held above the patient's arm, satisfactory insertion of the needle will be indicated by a slight drop in the saline level in the barrel. The mouth of the latter is then fixed securely to the rubber cork on the end of the delivery tube and the clip on the air-lock tubing removed.

Positive pressure being produced inside the flask with the bellows, citrated blood rises in the delivery tube, pushing the air in the latter into the barrel of the air lock, from which a corresponding volume of saline passes into the recipient's circulation. As the blood begins to flow into the air lock the remainder of the saline solution is driven on into the patient's circulation, to be followed by the blood, an upper level of which is present in the barrel. The rate of flow, as judged by the efflux from the delivery-tube nozzle in the air lock, is easily controlled by variation in the positive pressure produced by the bellows. When the flask is almost empty it is held tilted towards the end of the delivery tube inside so as to aid exhaustion; as soon as air rises in the delivery tube and displaces the blood level in the air lock the tubing on the latter is clipped and the needle withdrawn from the patient's vein. If preferred a Jubé needle and trocar, with a corresponding mount at the end of the air-lock tubing, may be employed for the venepuncture.

When the veins are small or inaccessible a Keynes glass cannula with a short narrow tubing connexion tied on to the air-lock tubing mount and full of saline can be used. Omitting application of a sphygmomanometer cuff, except for preparatory localization, the vein is cut down on and exposed for about three-quarters of an inch under local anaesthesia (2 per cent. novocain with a small addition—1 minim to each drachm—of liq. adrenalin. hydrochlor. 1 in 1,000, as a haemostatic). With a blunt aneurysm needle three separate lengths of No. 0 catgut (or No. 0 silk) are passed under the vein, and the latter tied distally with one of these. Just proximal to this ligature a transverse cut (not complete division) is made with a sharp pair of iris scissors in the wall of the vein, held in forceps; the end of the cannula is introduced into the lumen of the vein through this opening and tied in position around the slight constriction on its neck with one of the lengths of catgut already in position. At the termination of the transfusion the ligature around the cannula is cut and removed; an assistant then withdraws the latter as the vein is tied above the opening in its lumen with the remaining lengths of catgut. The edges of the skin incision are sutured with horsehair.

Sterilization of the apparatus (omitting the bellows) is best carried out in the autoclave after wrapping in towels; the needles are placed in spirit.

All the above methods—A, B, and C—will give satisfactory results. The infusion-funnel gravitation technique involves the use of very simple apparatus; but it has not the reserve of pressure sometimes necessary to overcome venospasm in a collapsed patient. The Jubé apparatus is compact, easily sterilizable, reliable, but expensive. The Keynes apparatus is very satisfactory in the hands of those well acquainted with their own apparatus; the various connexions and the glass and rubber tubing need frequent supervision and overhaul.

Whatever method is employed sterility throughout is imperative and all apparatus must be scrupulously clean; both for donor and recipient the employment of well-sharpened needles in rendering the task of the operator easier cannot be too strongly emphasized. The blood should not be transfused into the patient too rapidly—a pint in half an hour is a reasonable rate. Lastly, in this relatively rapid type of transfusion care should be taken to give the blood at as near body temperature as possible; strict attention to this also eliminates mild reactions in the patient resulting from minor degrees of cold agglutination. In Method A warm blood is added to the infusion funnel about 150 c.cm. at a time. In B and C the blood receptacle and the Keynes flask respectively are stood in water at 37° C. during transfusion. In infants and young children, in whom the antecubital veins are very small, the introduction of a needle or fine glass Keynes cannula into the internal saphenous vein, exposed near the ankle, is recommended.

Untoward post-transfusion (non-haemolytic) reaction in a patient is best controlled by the hypodermic injection of morphine tartrate 1/6 to 1/3 grain, and adrenaline hydrochloride (1 in 1,000) 7½ to 15 minims, the dose varying according to the size of the patient and the degree of reaction.

TYPE II

The slow continuous-drip transfusion, introduced by Marriott and Kekwick in 1935, has proved very valuable in raising the haemoglobin percentage of a severely anaemic patient to a high level by giving such amounts as one to four litres over twelve to forty-eight hours. It is especially applicable in severe gastric or duodenal haemorrhage: besides markedly improving the general condition of the patient treated medically, it renders surgical intervention much safer should this prove necessary.

The apparatus (Fig. 6), based on the original description, comprises:

1. A glass container of about four-pint capacity fitted with rubber bung carrying two short pieces of bent glass tubing. To the inner end of one of these a piece of rubber tubing is attached reaching to the bottom of the container; through it filtered oxygen can be bubbled, so preventing red cell sedimentation. The other piece of glass tubing, furnished with a filter, is an exit for the oxygen. The container is encircled by a metal hanger for suspension.
2. A long Laurie glass drip bulb,* fitted to the outlet on the container by about four inches of rubber tubing on which is an adjustable screw clip.
3. Six or seven feet of fine pressure tubing (5 mm. external diameter) connected to the lower end of the drip bulb via a glass adapter and terminating in a special Marriott glass cannula (supplied in three sizes). The right-angled bend near the bulbous tip of the latter enables it to be tied into a vein without causing kinking.
4. An oxygen cylinder with pressure regulator and fine adjustment tap, connected to the inlet glass tubing on the rubber bung of the glass container by rubber tubing interrupted with two or three filters.

About 100 c.cm. of sterile normal saline are poured into the glass container, suspended three to four feet above the patient; by opening the screw clip wide some of this saline is allowed to run through the drip bulb

* The provision of a short side tube towards the upper end of the drip bulb is a recent improvement introduced by the originators of this technique. The side tube terminates in a short piece of rubber tubing closed by a metal clip. By means of this lateral airway the level of the blood in the bulb is easily adjusted during the course of the transfusion. Further, by applying to it a syringe containing air, and closing the screw clip on the tubing above, the pressure in the bulb can be momentarily raised to expel any small clot obstructing the terminal cannula.

and displace air in the pressure tubing and terminal cannula. A saline level with air lock is produced in the drip bulb by momentarily inverting it. The screw clip is then almost closed and the saline flow in the bulb reduced to a slow drip; this and the corresponding flow from the end of the cannula is stopped by occluding the pressure tubing, a short distance proximal to the latter, by a strong bulldog clip. Under local anaesthesia a vein in the forearm, antecubital fossa, or the internal saphenous just above the malleolus is exposed and ligatured; the cannula is introduced up to the shoulder of its bend and tied into the vein just distal to this—using a technique

FIG. 6.—Continuous-drip transfusion apparatus (Marriott and Kekwick).

on the lines previously described for a Keynes cannula. Removal of the bulldog clip should now allow the flow of saline as observed in the drip bulb to begin again. The skin edges are sutured above and below the point where the cannula enters the vein. The barrel of the cannula and the distal eighteen inches of tubing, loosely looped, are securely fixed with strips of adhesive strapping to the surface of the limb, covered with sterile gauze and wool, and bandaged lightly. The oxygen is now turned on at a rate of 80 to 100 bubbles per minute, as judged by its flow, through the remaining saline in the container (a Woulfe's bottle, half full of water, through which the oxygen passes, can with advantage be interposed between the cylinder and the suspended container). The rubber bung is temporarily removed and sterile citrated compatible blood up to two pints introduced. The blood used in the container must all be of one group, preferably the same group as the patient; provided care is exercised in its collection from the donors into the citrate solution there is no need to strain it. Forty drops per minute—that is, a pint in four hours—is a satisfactory rate of drip for which to adjust the screw clip, but a faster or slightly slower delivery can be utilized, according to indications.

The frequent attention of a nurse is necessary to control by the screw clip any fluctuation in the rate of drip; it is essential that this be not allowed to slow up unduly or cease for even a short interval. In addition the oxygen flow must be maintained but over-frothing controlled; prevention of red cell sedimentation is also assisted by an occasional manual agitation of the container. More blood is added to the latter when its contents have dropped to about 150 c.cm. The amount necessary to bring the haemoglobin percentage up to a given level can be assessed on the knowledge that 750 c.cm. of blood in an average-sized adult will raise the haemoglobin about 15 per cent.; in the presence of bleeding more is required. A haemoglobin estimation carried out from time to time during the course of the transfusion is helpful.

The donors are conveniently bled in pairs and their blood stored in a cool place; it is shaken up gently and brought to body heat before addition to the reservoir. The advantage of using a forearm vein in the patient is that some mobility of the limb can be allowed. With an antecubital or the internal saphenous vein (thrombosis is less liable with the former) insertion of the larger-size cannula is possible and advantageous, but the limb should then be immobilized with a small splint or sandbags. At the end of the transfusion the screw clip is closed and the cannula removed under local anaesthesia; the vein is then ligatured, if necessary, on the proximal side and the skin edges resutured. All the apparatus used, except the oxygen cylinder, is sterilized by autoclaving in a dressing drum.

In concluding this article it must be emphasized that the methods of blood transfusion are legion; those described above represent a few proved techniques by means of which this valuable remedy may be employed in general practice.

The apparatus of the various techniques considered is obtainable from Messrs. Willen Bros., New Cavendish Street, W.1, who have kindly provided the drawings.

S. Lomholt (*Ugeskr. Laeg.*, 1937) bases his belief that gonorrhoea is on the increase among women in Copenhagen on the returns of the venereal disease dispensaries which provide free treatment under the auspices of the municipal authorities. These dispensaries, which deal with at least two-thirds and possibly three-quarters of all the recent cases of venereal disease in Copenhagen, make detailed monthly returns. The figures for 1931 showed 1,207 male cases and 312 female cases. The corresponding figures for 1936 were 1,647 and 631 respectively. It will thus be seen that the figures for female patients have been more than doubled in five years, whereas the rise in the number of male cases has been much less marked. After discussing possible sources of error which might exaggerate these variations, the author admits that the true rise in the number of male cases may be comparatively small. But the enormous rise in the number of female cases is not to be gainsaid, and he attributes it to the growing alacrity with which young women at the present time indulge in premarital and extramarital sexual relations. It is particularly between the ages of 16 and 18 that this movement has been most marked. The author points out that at least 50 per cent. of all cases of inflammation of the uterine appendages are gonorrhoeal, and that the annual reports of the five municipal surgical hospitals in Copenhagen for 1935 and 1936 have shown that more than 500 cases of salpingitis were treated in them. Every year between 1,000 and 1,200 young women contract gonorrhoea in Copenhagen, and as the prospect of their early and complete cure is problematic, the outlook with regard to stamping out this disease is very poor in the absence of any reliable specific drug or remedy.